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GLOBAL CHEMICALS OUTLOOK II

FROM LEGACIES TO INNOVATIVE SOLUTIONS

SYNTHESIS REPORT (2019)

IMPLEMENTING THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Global Chemicals Outlook II

From Legacies to Innovative Solutions: Implementing the 2030 Agenda for Sustainable Development – Synthesis Report

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About the Global Chemicals Outlook II

The first edition of the *Global Chemicals Outlook*, published in February 2013, assembled scientific, technical and socio-economic information on the sound management of chemicals. It covered trends and indicators for chemical production, transport, use and disposal, and associated health and environmental impacts; economic implications of these trends, including costs of inaction and benefits of action; and instruments and approaches for sound management of chemicals.

Decision 27/12, adopted by the Governing Council of the United Nations Environment Programme in 2013, recognized the significance of the findings of the first *Global Chemicals Outlook*, which highlighted the significant increase in the manufacture and use of chemicals globally, their importance to national and global economies and the costs and negative effects on human health and the environment of unsound chemicals management, and made recommendations for future action. Decision 27/12 also requested the Executive Director to continue work on the *Global Chemicals Outlook*, particularly in areas where data were found to be lacking or inadequate, and to enhance transparency through regionally balanced stakeholder involvement, inter alia, with a view to developing in the future a tool for assessing progress towards the achievement of the sound management of chemicals and hazardous wastes, including the existing 2020 goal, taking into account and building upon other existing sources of information.

Resolution 2/7, adopted by the United Nations Environment Assembly in 2016, requested the Executive Director to submit an update of the first *Global Chemicals Outlook*, addressing, inter alia, the work carried out particularly in relation to lacking or inadequate data to assess progress towards the 2020 goal, the development of non-chemical alternatives, and the linkages between chemicals and waste, in coordination with the Global Waste Management Outlook, and providing scientific input and options for implementation of actions to reach relevant Sustainable Development Goals and targets up to and beyond 2020. Resolution 2/7 also requested the Executive Director to ensure that the updated *Global Chemicals Outlook* addresses the issues which have been identified as emerging policy issues by the International Conference on Chemicals Management (the governing body of the Strategic Approach to International Chemicals Management) as well as other issues where emerging evidence indicates a risk to human health and the environment.

UN environment assembly

The second edition of the *Global Chemicals Outlook* has been prepared with substantive contributions from more than 400 experts and under the guidance of a Steering Committee, which provided oversight, strategic directions and guidance on all aspects of the report's development, as well as technical inputs, where applicable. The Steering Committee was composed of representatives from Governments, non-governmental organizations (including civil society, industry/the private sector, and academia) and inter-governmental organizations, with participation from all regions and a wide range of stakeholders.

This *Synthesis Report* of the *Global Chemicals Outlook II* summarizes key findings and insights of the full *Global Chemicals Outlook II* and follows the same five-part structure as the full report. A shorter *Summary for Policymakers* was tabled as a working document of the fourth session of the United Nations Environment Assembly and is available in all six UN languages. The full *Global Chemicals Outlook II* is launched in April 2019 at the third meeting of the Open-Ended Working Group of the International Conference on Chemicals Management.

Acknowledgements

The *Global Chemicals Outlook II* has been developed through substantive input from a wide range of experts, and through collaboration with numerous partner organizations. The United Nations Environment Programme wishes to thank all individuals and organizations that have generously contributed their expertise, time, and energy.

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Lead authors responsible for the drafting of foundational papers and specific chapters were: Francisco Alpizar, Thomas Backhaus, Nils Decker, Ingo Eilks, Natalia Escobar-Pemberthy, Peter Fantke, Ken Geiser (in addition: coordination of Part I), Maria Ivanova, Olivier Jolliet, Ho-seok Kim, Kelvin Khisa, Haripriya Gundimeda, Daniel Slunge, Stephen Stec, Joel Tickner, David Tyrer, Niko Urho, Rob Visser (in addition: coordination of Parts II and III), Mario Yarto, and Vania Gomes Zuin. Lead authors for capturing regional perspectives were Babajide Alo, Vera Barrantes, Anna Makarova and


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A Consultative Meeting for the Preparation of the *Global Chemicals Outlook II* took place in April 2016 in Geneva, Switzerland. It was attended by 70 experts. Subsequently a wide range of stakeholders provided input at five workshops. These consisted of a series of regional expert workshops in March-April 2018 in Nairobi, Kenya (Africa); Frankfurt, Germany (Europe, including Central and Eastern Europe); Panama City, Panama (Latin America and the Caribbean and North America); and Bangkok, Thailand (Asia Pacific and West Asia), attended by a total of 115 participants; and a global workshop (June 2018, Bonn, Germany) with some 100 participants. Paul Hohnen provided valuable support, including by moderating sessions at several workshops.

Independent experts, identified based on nominations received from the Scientific and Technical Advisory Panel of the Global Environment Facility, the secretariat supporting the preparation of the next Global Environment Outlook, and the International Solid Waste Association, were invited to review the draft GCO-II. In addition, external experts were invited to review selected sections based on their expertise. The following individuals provided valuable feedback: Marlene Agerstrand, Tom Bond, Weihsueh Chiu, Victoria de Higa, Paul Dumble, Henning Friege, Martin Führ, Sarah Green, Jamidu Katima, Sayed Khattari, Joy Aeree Kim, Olwenn Martin, Ackmez Mudhoo, Carlos Ocampo Lopez, Stephen Macey, Prasad Modak, Naglaa Mohamed Loutfy, Jennifer McKellar, Percy Onianwa, Kamlesh Pathak, Andreas Prevodnik, Alexander Romanov, Mark Rossi, Ted Smith, Gustavo Solorzano, Gerard Swaen, Mohamed Tawfic, Zijian Wang, and Meriel Watts.

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Foreword

Chemicals are part of our everyday lives. From pharmaceuticals to plant protection, innovations in chemistry can improve our health, food security and much more. However, if poorly used and managed, hazardous chemicals and waste threaten human health and the environment.

As the second *Global Chemicals Outlook* lays out, global trends such as population dynamics, urbanization and economic growth are rapidly increasing chemical use, particularly in emerging economies. In 2017, the industry was worth more than US$5 trillion. By 2030, this will double. Whether this growth becomes a net positive or a net negative for humanity depends on how we manage the chemicals challenge. What is clear is that we must do much more.

Large quantities of hazardous chemicals and pollutants continue to leak into the environment, contaminating food chains and accumulating in our bodies, where they do serious damage. Estimates by the European Environment Agency suggest that 62 per cent of the volume of chemicals consumed in Europe in 2016 were hazardous to health. The World Health Organization estimates the burden of disease from selected chemicals at 1.6 million lives in 2016. The lives of many more are negatively impacted.

We have made some progress in managing chemicals through national and stakeholder action, international treaties and voluntary instruments. At the World Summit on Sustainable Development in 2002, countries committed to minimizing the adverse effects of chemicals by 2020. At our current pace, we will not achieve this goal. Considering the expansion of the market, and the associated increase in contamination, we cannot continue to gamble with our health.

Solutions do exist, as the report shows. Sustainable supply chain management, innovations in green and sustainable chemistry, and adopting common approaches to chemicals management can reduce the risks to human health, ecosystems and economies.

But a solution is only as good as the will to implement it. Now, more than ever, key influencers such as investors, producers, retailers, citizens, academics and ministers must act. We have the chance to do what needs to be done. We are implementing the 2030 Agenda for Sustainable Development and developing a future framework for the sound management of chemicals and waste beyond 2020.

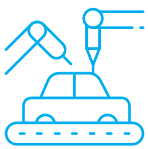
We cannot live without chemicals. Nor can we live with the consequences of their bad management. My hope is that this Outlook inspires us all to increase our efforts to safely capture the benefits of chemistry for all humanity.

Joyce Msuya
Acting Executive Director
UN Environment

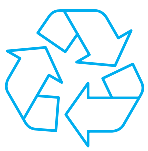
Key findings

The global goal to minimize adverse impacts of chemicals and waste will not be achieved by 2020. Solutions exist, but more ambitious worldwide action by all stakeholders is urgently required.

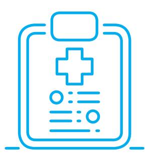
1. The size of the global chemical industry exceeded United States dollars 5 trillion in 2017. It is projected to double by 2030. Consumption and production are rapidly increasing in emerging economies. Global supply chains, and the trade of chemicals and products, are becoming increasingly complex.



2. Driven by global megatrends, growth in chemical-intensive industry sectors (e.g. construction, agriculture, electronics) creates risks, but also opportunities to advance sustainable consumption, production and product innovation.



3. Hazardous chemicals and other pollutants (e.g. plastic waste and pharmaceutical pollutants) continue to be released in large quantities. They are ubiquitous in humans and the environment and are accumulating in material stocks and products, highlighting the need to avoid future legacies through sustainable materials management and circular business models.



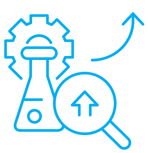
4. The benefits of action to minimize adverse impacts have been estimated in the high tens of billions of United States dollars annually. The World Health Organization estimated the burden of disease from selected chemicals at 1.6 million lives in 2016 (this is likely to be an underestimate). Chemical pollution also threatens a range of ecosystem services.

5. International treaties and voluntary instruments have reduced the risks of some chemicals and wastes, but progress has been uneven and implementation gaps remain. As of 2018, more than 120 countries had not implemented the Globally Harmonized System of Classification and Labelling of Chemicals.

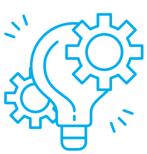
6. Addressing legislation and capacity gaps in developing countries and emerging economies remains a priority. Also, resources have not matched needs. There are opportunities for new and innovative financing (e.g. through cost recovery and engagement of the financial sector).

7. Significant resources can be saved by sharing knowledge on chemical management instruments more widely, and by enhancing mutual acceptance of approaches in areas ranging from chemical hazard assessment to alternatives assessment.

8. Frontrunner companies – from chemical producers to retailers – are introducing sustainable supply chain management, full material disclosure, risk reduction beyond compliance, and human rights-based policies. However, widespread implementation of these initiatives has not yet been achieved.



9. Consumer demand, as well as green and sustainable chemistry education and innovation (e.g. though start-ups), are among the important drivers of change. They can be scaled up through enabling policies, reaping the potential benefits of chemistry innovations for sustainable development.



10. Global knowledge gaps can be filled. This can be achieved, for example, by taking steps to harmonize research protocols, considering health or environmental impact information and harm caused to set and address priorities (e.g. emerging issues), and strengthening the science-policy interface through enhanced collaboration of scientists and decision-makers.

List of acronyms

CLP	Classification, labelling and packaging
DDT	Dichlorodiphenyltrichloroethane
DEHP	Bis(2-ethylhexyl) phthalate
EDCs	Endocrine-disrupting chemicals
EPIs	Emerging policy issues
EU	European Union
FAO	Food and Agriculture Organization of United Nations
GCO	Global Chemicals Outlook
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
HHPs	Highly hazardous pesticides
ICCM	International Conference on Chemicals Management
ILO	International Labour Organization
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IPM	Integrated pest management
LCA	Life cycle assessment
OECD	Organisation for Economic Co-operation and Development
PCBs	Polychlorinated biphenyls
PFASs	Per- and polyfluoroalkyl substances
POPs	Persistent organic pollutants
PRTRs	Pollutant Release and Transfer Registers
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
SAICM	Strategic Approach to International Chemicals Management
SDGs	Sustainable Development Goals
SMEs	Small and medium-sized enterprises
SVHC	Substances of Very High Concern
UNEA	United Nations Environment Assembly
UNITAR	United Nations Institute for Training and Research
US	United States
VOCs	Volatile organic compounds
WHO	World Health Organization
WSSD	World Summit on Sustainable Development
ZDHC	Zero Discharge of Hazardous Chemicals

Contents

Introduction: chemicals and waste in the broader sustainable development context

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The *Global Chemicals Outlook II* (GCO-II) is released at a crucial moment. Since the publication of the GCO-I in 2013, the global consumption and production of chemicals[1] has continued to grow, with a number of trends that are a cause for concern about human health and the environment. This period also witnessed the adoption in 2015 of the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), which include several targets specifically related to chemicals and waste management. Shortly thereafter, the International Conference on Chemicals Management (ICCM), the governing body of the Strategic Approach to International Chemicals Management (SAICM), initiated an intersessional process to prepare by 2020 recommendations regarding the Strategic Approach and the sound management of chemicals and waste beyond 2020.

By using a back-casting approach which envisaged a sustainable future, GCO-II has identified a range of actions for consideration by policy-makers around the world and informing chemicals and waste management beyond 2020.

Table 1 Chemicals and waste in the 2030 Agenda for Sustainable Development: SDG Targets 3.9 and 12.4

SDG 3: Ensure healthy lives and promote well-being for all at all ages

3 GOOD HEALTH AND WELL-BEING

Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

SDG 12: Ensure sustainable consumption and production patterns

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

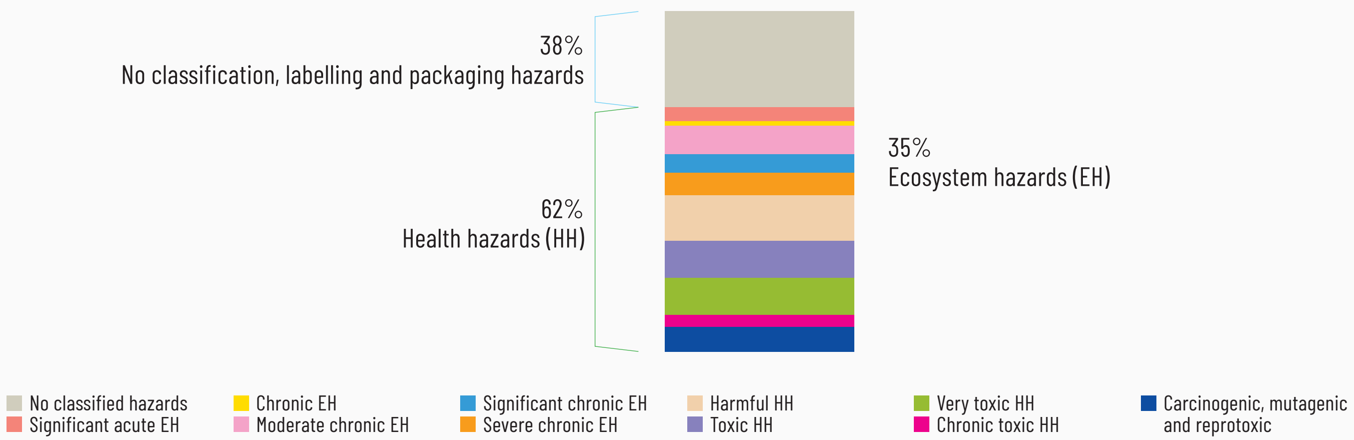
1 The term "chemicals" is understood throughout this report to include pharmaceuticals, unless otherwise noted.

Sound management and innovations in chemistry are essential for sustainable development

From pharmaceuticals and plant protection products to the production of cars, computers and textiles, many manufactured chemicals have helped improve human health, food security, productivity and quality of life throughout the world. While the number of chemicals registered by the American Chemical Society's global Chemical Abstracts Service exceeds 142 million, only a fraction of these chemicals are placed on the market.

A 2018 draft report jointly developed by the United Nations Environment Programme and the International Council of Chemical Associations estimated the total number of industrial chemicals in commerce globally at 40,000 to 60,000, with 6000 of these chemicals accounting for more than 99 per cent of the total volume. The number of chemicals on the market is exceeded by a larger – and growing – number of chemical-intensive products such as computers, mobile phones, furniture and personal care products. [Relevant sections in the GCO-II: Introduction; Part I, Ch. 1]

Figure 1 Share of the volume of chemicals consumed in the European Union in 2016 by hazard categories (based on European Environment Agency 2018)



According to data from Eurostat, the statistical office of the European Union (EU), compiled in 2018 by the European Environment Agency , approximately 62 per cent of the 345 million tonnes of chemicals consumed in the EU in 2016 were hazardous to health. In presenting the data, the Agency noted that volumes of hazardous chemicals consumed are not a proxy for the risks posed by those chemicals. [Introduction]

Many chemicals, products and wastes have hazardous properties and continue to cause significant adverse impacts on human health and the environment because they are not properly managed. Chemicals or groups of chemicals that are receiving attention in research and policy-making because of their hazardous properties and potential risks include, but are not limited to, carcinogens, mutagens and chemicals hazardous to reproduction, persistent bio-accumulative and toxic substances, endocrine-disrupting chemicals, and chemicals with neurodevelopmental effects. [Introduction; Part I, Ch. 1, 7; Part III, Ch. 1]

Ensuring the sound management of chemicals and waste, as called for internationally at the highest political level during several major United Nations Conferences, is essential for advancing sustainable development across its social, economic and environmental dimensions. Chemistry and the chemical industry have important roles to play in achieving the sound management of chemicals and waste within a sustainable development context. Addressing legacies, coupled with innovations in chemistry and materials science, have the potential to create safer chemicals, increase resource efficiency, and reduce the health and environmental impacts associated with the current global production and consumption system. [Introduction; Part II, Ch. 3; Part IV, Ch. 1]

Milestones in international chemicals and waste management

For several decades, the international community has recognized the need for action to advance the sound management of chemicals and waste. In 1992, at the Rio Summit, Heads of State and Government adopted Agenda 21, which includes chapters on chemicals and hazardous wastes. Also adopted in 1992, the Rio Declaration features a number of principles and approaches relevant to the sound management of chemicals and waste, including the polluter pays principle, the right-to-know, and the precautionary approach. Ten years later, the World Summit on Sustainable Development (WSSD) adopted the Johannesburg Plan of Implementation, in which Governments agreed to "achieve, by 2020, that chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment [...]". The 2020 timeline was reiterated at the Rio plus 20 Summit in 2012 (referring to chemicals and hazardous waste), as well as in the 2030 Sustainable Development Agenda through SDG Target 12.4 (referring to chemicals and all wastes). SDG Target 3.9, which focuses on reducing deaths and illnesses, features a 2030 timeline. [Introduction; Part II, Ch. 1]

Multilateral treaties and voluntary agreements

Since around the time of the Rio Summit and in the following decades, the international community has taken concerted action through multilateral treaties on some of the most harmful chemicals and on some issues of global concern. Prominent examples include the following:

- Montreal Protocol on Substances that Deplete the Ozone Layer (entry into force in 1989)
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (entry into force in 1992)
- International Labour Organization (ILO) Conventions: C170 – Chemicals Convention (entry into force in 1993) and C174 – Prevention of Major Industrial Accidents Convention (entry into force in 1997)
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (entry into force in 2004)
- Stockholm Convention on Persistent Organic Pollutants (POPs) (entry into force in 2004)
- World Health Organization (WHO) International Health Regulations (IHR) (2005) (entry into force in 2007)
- Minamata Convention on Mercury (entry into force in 2017)

Moreover, several voluntary international instruments adopted by the governing bodies of international organizations address a range of chemicals and issues. Prominent examples include the International Code of Conduct on Pesticide Management (hereinafter referred to as “Code of Conduct”), originally developed in 1985 with a fourth version adopted in 2013, and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) adopted in 1992. The GHS was specifically mentioned in the 2002 Johannesburg Plan of Implementation, with a view to the system being fully operational by 2008. [Introduction; Part II, Ch. 1]

BASEL CONVENTION
ROTTERDAM CONVENTION
STOCKHOLM CONVENTION
UN environment United Nations Environment Programme Ozone Secretariat
International Labour Organization
WHO
MINAMATA CONVENTION ON MERCURY

Adoption of the Strategic Approach to International Chemicals Management in 2006

In 2006, following the call made at the WSSD, the Strategic Approach to International Chemicals Management (SAICM) was adopted by the first session of the ICCM (ICCM1) as a multi- and cross-sectoral and participatory strategic approach. SAICM's overall objective is "to achieve the sound management of chemicals throughout their life cycle so that by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health". SAICM comprises the Dubai Declaration on International Chemicals Management, which expressed high-level political commitment to SAICM, and an Overarching Policy Strategy.

The Overarching Policy Strategy referenced the WSSD 2020 timeline, referring to the "2020 goal", a term subsequently used in various international fora. Objectives to achieve this goal are grouped under five areas: risk reduction, knowledge and information, governance, capacity-building and technical cooperation, and illegal international traffic. Furthermore, the Dubai Declaration recommends the use and further development of the Global Plan of Action as a working tool and guidance document for meeting the commitments to chemicals management expressed in, among others, the Johannesburg Plan of Implementation. In 2015, ICCM4 endorsed the "overall orientation and guidance for achieving the 2020 goal of sound management of chemicals" (hereinafter referred to as "overall orientation and guidance") as a voluntary tool that will assist in the prioritization of efforts for the sound management of chemicals and waste as a contribution to the overall implementation of the Strategic Approach. [Introduction; Part II, Ch. 1]

Chemicals and waste in the 2030 Sustainable Development Agenda

The 2030 Agenda for Sustainable Development, including its 17 SDGs (Figure 2) and 169 targets, was adopted by the United Nations General Assembly at a summit of Heads of State in 2015. The SDGs, which are integrated and indivisible, integrate the three dimensions of sustainable development: economic, social and environmental. While Targets 12.4 and 3.9 are of direct relevance for chemicals and waste management, the sound management of chemicals and waste is also relevant for the achievement of many other SDGs. Those include halting biodiversity loss, clean water and sanitation, facilitative access to clean energy, climate action, and ensuring quality education. Furthermore, implementation of other SDGs is essential in achieving the sound management of chemicals and waste, such as those concerned with education, financing and partnerships. [Introduction; Part II, Ch. 1; Part V, Ch. 1]

Chemicals and sustainability: concerns and opportunities

Despite global agreement reached at high-level UN Conferences and significant action already taken, scientists continue to express concerns regarding the lack of progress towards the sound management of chemicals and waste. These include calls for systemic and transformational changes towards safer chemicals

Figure 2 **The Sustainable Development Goals**

Sound management of chemicals and waste cuts across the Sustainable Development Goals. It is relevant for the achievement of much of the 2030 Agenda for Sustainable Development.

and innovations in chemistry that will contribute to sustainable development. In this context, "green chemistry", "sustainable chemistry", "one-world chemistry" and related concepts are challenging chemistry to help meet sustainable development needs. Other stakeholders have raised similar concerns. A number of initiatives in the private sector have also identified opportunities to advance sustainability in relation to chemicals. These initiatives include the World Business Council for Sustainable Development Chemical Sector SDG Roadmap, the Together for Sustainability initiative bringing together 22 companies in the chemical industry, and the Zero Discharge of Hazardous Chemicals (ZDHC) initiative bringing together frontrunner textile companies. [Introduction; Part IV, Ch. 7; Part V, Ch. 3]

Intersessional process on the Strategic Approach and the sound management of chemicals and waste beyond 2020

In 2015, Governments and other stakeholders participating in ICCM4 noted that "in most countries more progress has to be made towards actually minimizing the significant adverse effects on human health and the environment that may be associated with some chemical production, use and end-of-life disposal". They also noted "with urgency the limited time remaining to achieve the 2020 goal". Shortly after the adoption of the 2030 Agenda in 2015, Governments and other stakeholders participating in ICCM4 initiated a process to prepare recommendations regarding the Strategic Approach and the sound management of chemicals and waste beyond 2020. The Conference agreed that the process should be open to all stakeholders and be concluded by ICCM5in 2020. The period until 2020 thus represents a historic window of opportunity to reflect on lessons learned in international chemicals and waste management. [Introduction]

Opportunities to link international policy agendas

Given the relevance of chemicals and waste across the 2030 Agenda, the beyond 2020 intersessional process provides an opportunity to link and create synergies between chemicals and waste management and other international policy agendas. These synergies include: [Introduction]

- **Chemicals and health**: The sound management of chemicals and waste plays an important role in avoiding and minimizing risks posed by harmful chemicals to protect human health. While the links between chemicals and health are well-established and the health sector has been an important partner in efforts to minimize risks, further efforts to strengthen linkages, increase awareness of the important roles of the health sector in the management of chemicals, and enhance participation in international chemicals management activities can build on the WHO Chemicals Road Map approved by the 70th World Health Assembly in 2017.

- **Chemicals and the world of work**: Workers are among those most exposed to hazardous chemicals in various sectors and across global supply chains. Ratification and implementation of international labour standards help achieve decent work that is safe and healthy, while simultaneously advancing towards greener work processes.

- **Chemicals and climate change**: Linkages range from the remobilization of chemicals due to melting glaciers, to reducing the greenhouse gas emissions of the chemical industry, to the potential of chemistry to develop adaptation and mitigation solutions. The chemical industry and downstream sectors therefore have an important role to play in achieving the objectives of the Paris Agreement.

- **Chemicals and biodiversity**: The critical role of pollution and chemicals was recognized in the Strategic Plan for Biodiversity 2011-2020, adopted under the Convention on Biological Diversity. Given current activities to develop a biodiversity framework beyond 2020, opportunities exist to create linkages with the chemicals and waste process beyond 2020.

- **Chemicals, agriculture and food**: Chemicals play a major role with respect to agriculture and food, for example in plant protection and food conservation. This link has long been recognized, and many countries have long-standing legislation to control chemicals used in agriculture and food production. International agreements and bodies that address these and related topics include the Code of Conduct and the Codex Alimentarius, a collection of international food standards.

- **Chemicals and sustainable consumption and production**: Target 12.4 is embedded in SDG 12, reflecting the insight that chemicals and waste management is inextricably linked to the broader quest for resource efficiency, waste reduction, and the need to decouple economic growth from natural resource use and environmental impacts. Individuals, companies and organizations play a critical role through their consumption choices and directly or indirectly impact chemicals production and sustainability. Opportunities exist to strengthen linkages with the 10 Year Framework of Programmes on Sustainable Consumption and Production Patterns.

- **Chemicals and the international pollution agenda**: As highlighted at the third session of the United Nations Environment Assembly (UNEA), whose theme was "Towards a Pollution-Free Planet", chemicals and waste issues are a key dimension of a broader international and integrated approach to pollution. The UNEA 3 Declaration requested the United Nations Environment Programme to prepare an implementation plan on the issue of a pollution-free planet for consideration by UNEA 4 in 2019.

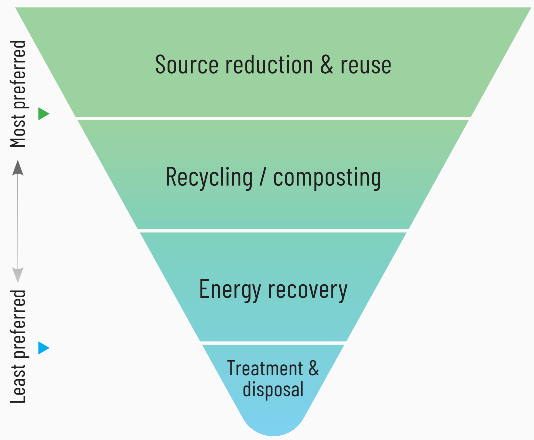
Recognizing the interface of chemicals and waste management

For many years, the chemicals and waste agendas have been addressed separately, both internationally and in many countries. For example, in Agenda 21 chemicals and waste management were covered in separate chapters. However, it has been increasingly recognized that the design and use of safer chemicals and sustainable production processes is essential for reducing releases throughout the life cycles of chemicals and products, including during the reuse, recycle and disposal stages. These front-of-the-pipe solutions also help ensure that secondary raw materials rechannelled into a circular economy are not contaminated with unwanted hazardous chemicals. In turn, the widely known waste hierarchy (Figure 3) focuses on source reduction, reuse and recycling of materials, while energy recovery, waste treatment and waste disposal are seen as least preferred options. The waste hierarchy

also emphasizes sustainable material management, resource efficiency and life cycle management. This brief discussion suggests that important aspects of chemicals and waste management are converging, in line with a life cycle management approach. [Introduction; Part I, Ch. 4-5; Part IV, Ch. 1]

At the international level, critical progress towards bringing the chemicals and waste management concepts together has been made through SDG Target 12.4 under SDG 12 on sustainable consumption and production, and through including waste in the mandate of the intersessional process on the Strategic Approach and the sound management of chemicals and waste beyond 2020. While GCO-II focuses on the sound management of chemicals and front-of-the-pipe-solutions, the interface with waste management is addressed throughout the report. [Introduction]

Figure 3 **The waste hierarchy, sustainable materials management and the circular economy (adapted from United States (US) Environmental Protection Agency 2017a)**



The waste hierarchy strives to achieve similar objectives as the related concepts of sustainable materials management and the circular economy. They have in common the quest to minimize the use of materials and maximize reuse. The sound management of chemicals and waste and innovations in chemistry play a key role to enable these concepts. [Introduction; Part I, Ch. 4-5; Part IV, Ch. 1]

Key messages for policymakers: a call for more ambitious action at all levels

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The 2020 goal will not be achieved: business as usual is not an option

The findings of the GCO-II indicate that the sound management of chemicals and waste and minimizing adverse impacts will not be achieved by 2020. Trends data suggest that the projected doubling of the global chemicals market between 2017 and 2030 will increase global chemical releases, exposures, concentrations and adverse health and environmental impacts unless the sound management of chemicals and waste is achieved worldwide. Business as usual is therefore not an option. However, accelerating progress in order to achieve sound management and minimize adverse impacts in the context of the 2030 Agenda is possible under a sustainability scenario. This will require more ambitious, urgent and worldwide collaborative action by all stakeholders and in all countries. [Part I, Ch. 1-8; Part II, Ch. 3-5; Part IV; Part V]

A comprehensive global framework is needed, with ambitious priorities and coherent indicators

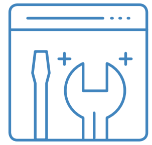
To address gaps, a global framework for the sound management of chemicals and waste beyond 2020 needs to be developed that is aspirational, comprehensive, and creates incentives to foster commitment and engagement by all relevant actors in the value chain. Drawing upon lessons learned from the Strategic Plan for Biodiversity 2011-2020, a global common vision, strategic goals, targets and indicators could facilitate linkages across all relevant agreements and initiatives, and make reporting schemes simpler, country-driven and linked to global targets. Under such a scheme, indicators would need to distinguish between outputs (e.g. adoption of legislation) and impacts (e.g. reduction of adverse impacts from hazardous chemicals). [Part II, Ch. 2; Part V, Ch. 2-3]

Implementation of actions up to and beyond 2020

Responding to the UNEA mandate, and based on a review of implementation of the 2020 goal to date, the GCO-II presents a range of options for the implementation of actions (hereinafter referred to as "actions") to reach relevant SDGs and targets up to and beyond 2020. The identified actions are considered of particular relevance to developing and implementing an international approach for chemicals and waste management beyond 2020. Equally important, they target policy- and decision-makers around the world and from all stakeholder groups in order to generate enhanced commitment for implementation.

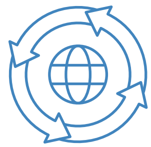
The actions are presented under ten topics which were derived using a back-casting method, imagining a sustainability scenario, where legacy problems are addressed and future legacies are avoided, including through green and sustainable chemistry innovation and sustainable consumption and production. They also cover commitments, already agreed internationally, which require urgent attention and renewed commitment due to implementation gaps. Examples include implementation of the GHS and the strengthening of basic chemicals and waste management systems. The ten areas of action are further spelled out in the Annex of this Synthesis Report. [Part V, Ch. 4]

Develop effective management systems: Address prevailing capacity gaps across countries, strengthen national and regional legislation using a life cycle approach, and further strengthen institutions and programmes.

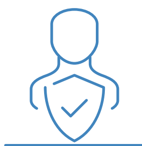


Assess and manage risks: Refine and share chemical risk assessment and risk management approaches globally, in order to promote safe and sustainable use of chemicals and address emerging issues throughout the life cycle.

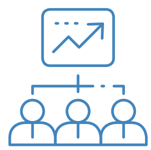
Mobilize resources: Scale up adequate[2] resources and innovative financing for effective legislation, implementation and enforcement, particularly in developing countries and economies in transition.



Use life cycle approaches: Advance widespread implementation of sustainable supply chain management, full material disclosure, transparency and sustainable product design.



Assess and communicate hazards: Fill global data and knowledge gaps, and enhance international collaboration to advance chemical hazard assessments, classifications and communication.



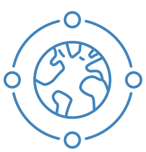
Strengthen corporate governance: Enable and strengthen the chemicals and waste management aspects of corporate sustainability policies, sustainable business models, and reporting.

2 To facilitate better understanding of the term "adequate" in this context, further analysis and international dialogue are needed on certain topics such as sustainability of funding.

Educate and innovate: Integrate green and sustainable chemistry in education, research, and innovation policies and programmes.

Foster transparency: Empower workers, consumers and citizens to protect themselves and the environment.

Bring knowledge to decision-makers: Strengthen the science-policy interface and the use of science in monitoring progress, priority-setting (e.g. for emerging issues), and policy-making throughout the life cycle of chemicals and waste.



Enhance global commitment: Establish an ambitious and comprehensive global framework for chemicals and waste beyond 2020, scale up collaborative action, and track progress.

Enhancing commitment by current stakeholders and increasing engagement by new actors

The period up to the conclusion of the intersessional process, by 2020, provides a brief but critical window in which to develop an ambitious and comprehensive global framework – as well as to increase engagement by all stakeholders. To facilitate commitment, ownership, mutual accountability and collective tracking of progress towards achieving the sound management of chemicals and waste, countries and all relevant stakeholders could develop, implement and share internationally results-based action plans and roadmaps. Stakeholders could pledge and showcase their action plans and roadmaps within the beyond 2020 framework and benefit from the input of other stakeholders (which might take different forms, such as peer review). Pledges could be reviewed globally against agreed goals and targets, with adjustments made, as appropriate. [Part V, Ch. 1-3]

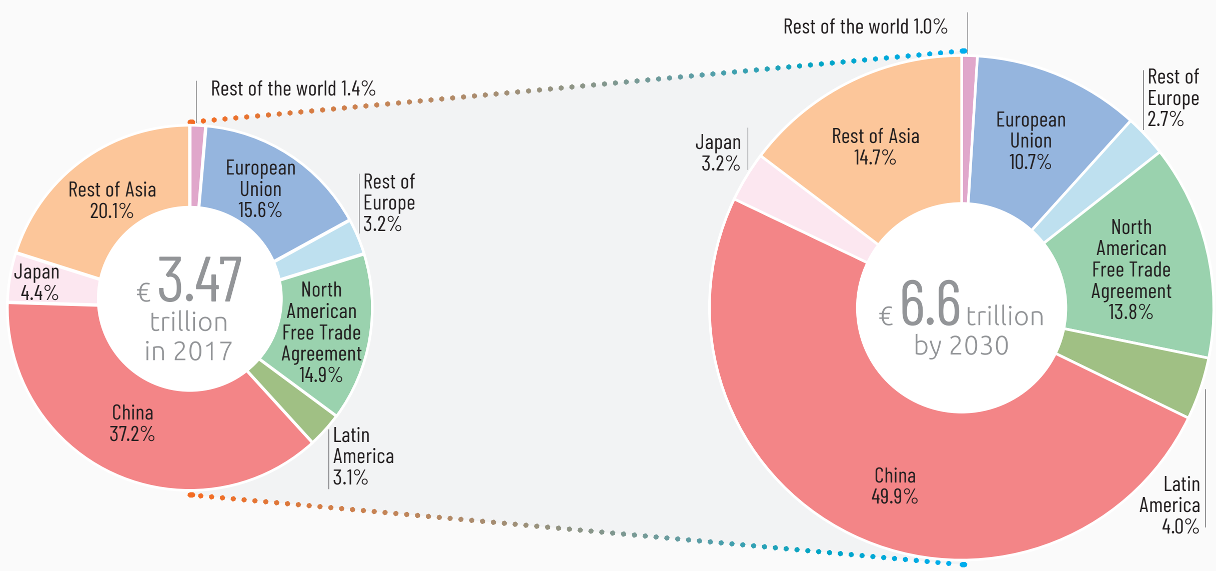
I. The evolving chemicals economy: status and trends relevant for sustainability

While many chemicals are important for sustainable development, trends presented in the GCO-II on releases of chemical pollutants; concentrations in the air, water, soil, biota and humans; and adverse impacts on human health and the environment are a cause for major concerns, requiring urgent action. Unless the sound management of chemicals and waste is achieved worldwide, the projected increase in chemical production and consumption will result in enhanced adverse impacts.

The production, use and trade of chemicals are growing in all regions

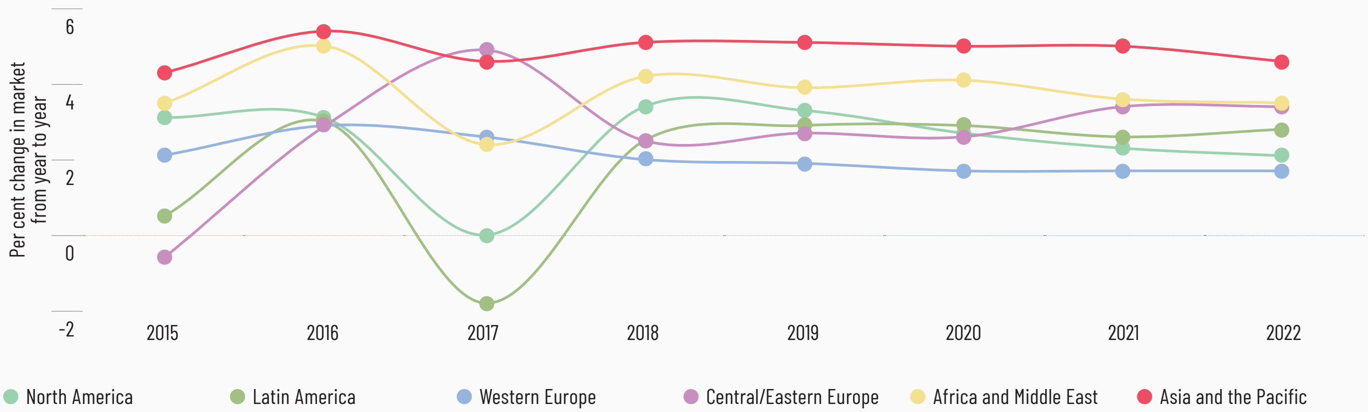
Between 2000 and 2017, the global chemical industry's production capacity (excluding pharmaceuticals) almost doubled, from about 1.2 to 2.3 billion tonnes. If pharmaceuticals are included, global sales totalled US dollars 5.68 trillion in 2017, making the chemical industry the world's second largest manufacturing industry. Growth has occurred not only in the volume and sales

Figure 4 **Projected growth in world chemical sales (excluding pharmaceuticals), 2017-2030 (adapted from European Chemical Industry Council 2018, p. 34)**



Global chemical sales (excluding pharmaceuticals) are projected to grow from EUR 3.47 trillion in 2017 to EUR 6.6 trillion by 2030. Asia is expected to account for almost 70 per cent of sales by then.

Figure 5 **Projection of annual production growth in the chemical industry by region, 2015-2022 (per cent change per year) (adapted from American Chemistry Council 2017)**



While production of chemicals is projected to grow in each region, annual growth rates are highest in regions with developing countries and emerging economies, in particular in Asia-Pacific, Africa and the Middle East.

of chemicals, but also in production capacity, suggesting continued future growth in the volume of chemicals produced. Sales are projected to almost double again from 2017 to 2030 (Figure 4). Projected growth will be highest in Asia, with China estimated to account for almost 50 per cent of global sales by 2030. [Part I, Ch. 1]

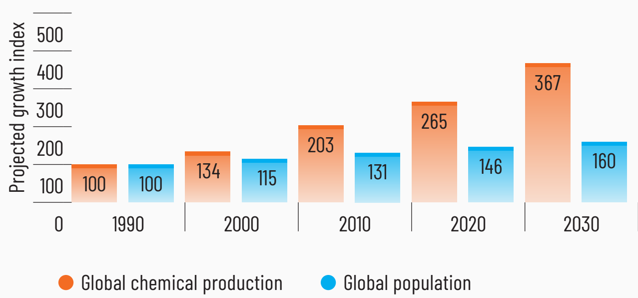
The production and consumption of manufactured chemicals continues to spread worldwide, with an increasing share now located in developing countries and economies in transition, many of which may have limited regulatory capacity. High growth rates are expected not only in Asia and the Pacific, but also in Africa and the Middle East (Figure 5). As the industry and its markets are growing, so is international trade in chemicals and products containing chemicals – many of which are hazardous. For example, the value of China's exports of chemicals has increased by 15 per cent since 2013, the year the first GCO was published. [Part I, Ch. 1]

The production and use of some hazardous chemicals addressed by international action have been phased out – as in the case of polychlorinated biphenyls (PCBs), or significantly reduced – as in the case of dichlorodiphenyltrichloroethane (DDT). However, ensuring environmentally sound waste management of these chemicals still poses significant challenges. Production and use of other chemicals causing concern remain stable or are increasing. Despite the regulatory actions taken, the market for most heavy metals (e.g. lead and mercury) remains stable. Production of plastics, fertilizers and pesticides, pharmaceuticals, per- and polyfluorinated substances (PFASs), flame retardants, nanomaterials and other groups of chemicals is increasing in many regions. [Part I, Ch. 2]

Global megatrends and industry sector trends create risks and opportunities

Global society is rapidly changing, driven by megatrends such as population growth, urbanization, globalization, digitalization and climate change. Increasing demand for electric vehicles and the growing market for automobiles in low- and middle-income countries is also expected to lead to increasing numbers of lead-acid batteries, the recycling of which is highly polluting when conducted informally or without proper pollution and occupational health and safety controls. Global economic growth and global population dynamics affect market demand for chemicals, creating both risks and opportunities. Under a business as usual scenario, the rate of growth of chemical production is projected to exceed that of population growth at least until 2030 (Figure 6). This means per capita consumption of chemicals is increasing steadily – highlighting the need to achieve sustainable consumption and production, as called for by SDG 12 of the 2030 Agenda. It also reinforces the need to decouple material use from economic growth, enhance resource- and eco-efficiency, advance sustainable materials management, and prioritize source reduction, reuse and recycling, as called for by the waste hierarchy. [Part I, Ch. 1, 3]

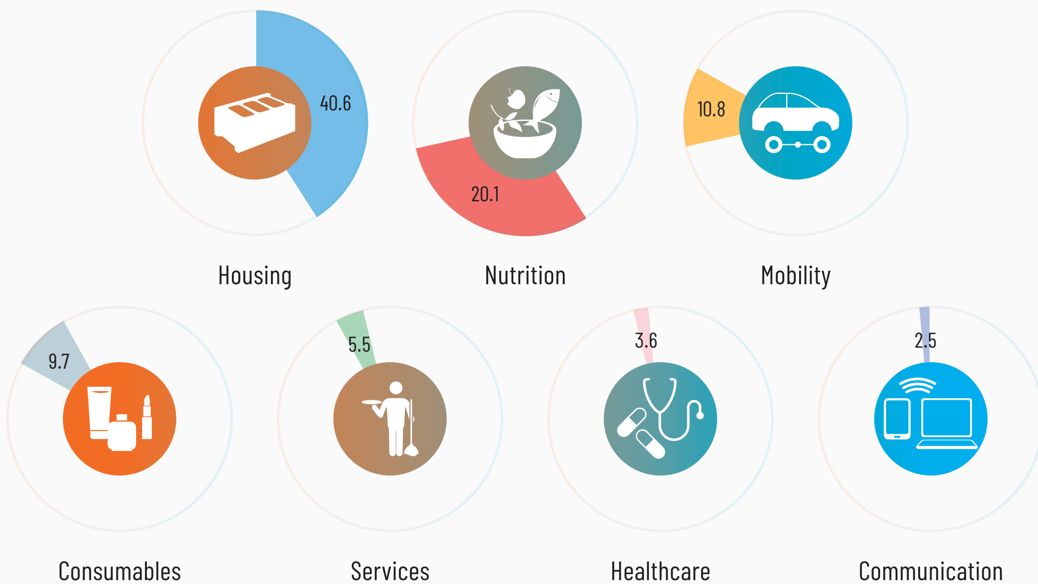
Figure 6 **Growth of basic chemical production capacity vs. population growth, 1990-2030 (based on UN Department of Economic and Social Affairs 2018 and Cayuela and Hagan 2019)**



The growth rates of chemical production capacity are derived from past and projected growth rates for basic petrochemical building blocks (ethylene, propylene, butadiene, benzene, toluene, and xylenes). [Part I, Ch. 3]

Growth in chemical-intensive industry sectors, such as construction, agriculture, electronics, cosmetics, mining and textiles, continues to drive growth in the respective chemical markets. For example, the construction sector is expected to grow by 3.5 per cent annually, with its chemicals market projected to grow by 6.2 per cent annually between 2018 and 2023. The growth of chemical-intensive industry sectors may pose significant risks to human health and the environment. For example, increased demand for weather-resistant textiles may, depending on the chemicals and technologies used, increase the use of PFASs. In addition, concerns have

Figure 7 **The global material footprint: extracted resources by key societal needs and consumables, 2015 (billion tonnes) (based on de Wit *et al.* 2019, p. 19)**



Six key societal needs and consumables represent the largest material footprint globally: housing and infrastructure (ca. 44 per cent), nutrition (ca. 22 per cent), mobility (ca. 12 per cent), consumables (ca. 11 per cent), services (ca. 6 per cent), healthcare (ca. 4 per cent) and communication (ca. 3 per cent). Each of these sectors is chemical-intensive in terms of both production processes and products, which range from asbestos used in steel beams, to pesticides in agriculture, to heavy metals in batteries, to parabens in cosmetics. [Part I, Ch. 1] emerged about chemical pollution and the management of waste associated with rapidly growing additive manufacturing (also known as 3-D printing). However, growth in industry sectors also creates opportunities for safer products and improved production processes. For example, following the regulation of asbestos in many countries, new business opportunities for safer materials in the building sector have emerged. [Part I, Ch. 3]

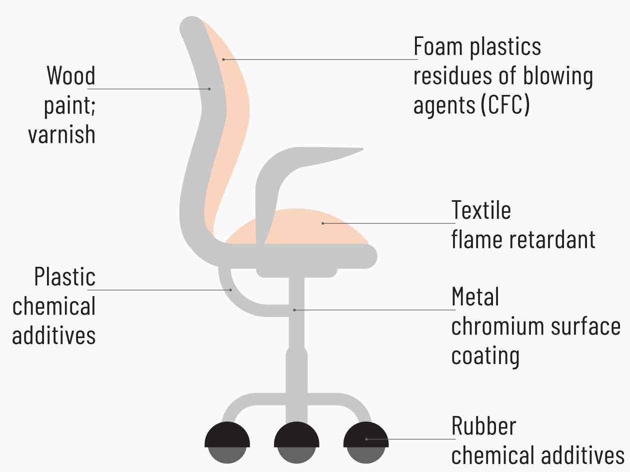
Chemicals are linked to and affect global material flows

The chemical industry plays an important role in turning raw materials and feedstocks into valuable products. It therefore performs a key function in the global system of production and consumption and is one of the drivers of resource extraction, together with chemical-intensive sectors (Figure 7). Researchers have mapped the magnitude of the chemical sector's material resources flows. In a single year (2015), almost 1.7 billion tonnes of feedstocks (mostly fossil fuels, but also bio-based and renewable feedstocks) and secondary reactants (mostly water) were used in this sector to produce 820 million tonnes of chemical products, while also generating almost the same amount of by-products (mostly carbon dioxide). [Part I, Ch. 1]

The transformation of resources into products containing chemicals also has a qualitative dimension. New compounds are created, in some cases with new or increased hazards. Chlorine chemistry, for example, turns basic feedstocks such as salt and water, together with other chemicals, into useful products such as water purification chemicals. At the same time, chlorine and many chlorine derivatives, as well as chemicals used in related production processes (e.g. asbestos or mercury), are hazardous and need to be well managed. Moreover, toxic chemicals such as mercury, lead and other heavy metals are mined, incorporated into products and disposed as wastes in the environment, where exposures of people and biota may be high. [Part I, Ch. 1, 2, 5]

It is also of concern that significant resources in value chains are lost due to low recycling rates and are largely unaccounted for. A contributing factor to this is the lack of information about the chemicals in these products, as the market for recycled products with unclear chemical composition is limited. Only 9 per cent of global material

Figure 8 Chemicals in an office chair (adapted from Swedish Chemicals Agency 2016, p. 7)



resources are recycled. Many durable products and buildings, as well as infrastructure and machinery, that contain hazardous chemicals (e.g. certain building materials containing asbestos or brominated flame retardants) remain in human-made material stocks (estimated to weigh 30 trillion tonnes in 2016) for years to come, creating potential future legacies. Mirroring this trend, less than 9 per cent of the 6.3 billion tonnes of plastic waste generated up to 2015 has been recycled, while 12 per cent was incinerated and 79 per cent was disposed in landfills or in the environment. [Part I, Ch. 5]

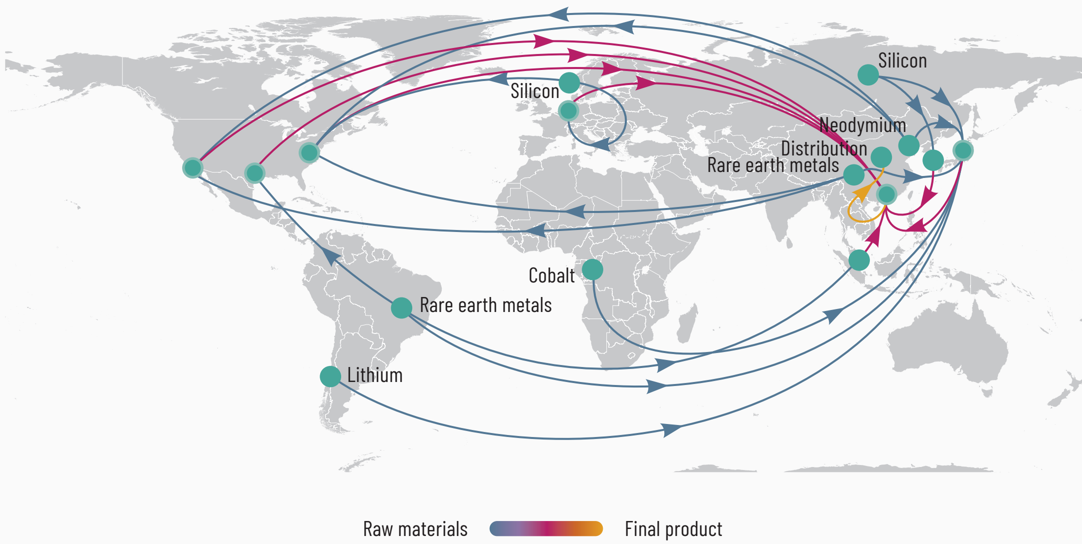
Chemical-intensive products and complex global supply chains create challenges for circularity

Modern-day products often contain hundreds of chemicals. Many of these chemicals may have hazardous properties. Some of them have raised considerable concern among national government authorities about their potential health or environmental effects. Examples include formaldehyde in shampoo, microbeads in toothpaste, phthalates in food packaging, certain flame retardants in televisions, and antimicrobials (e.g. triclosan) in soaps. Some formulated products (e.g. personal care products and household cleaners) contain chemicals of concern at significant concentrations. For example, the concentration of phthalates (some of which are potential endocrine disruptors) may be as high as 40 per cent in some plastic products. In addition, unintentional contaminants have been widely detected in a range of products. For example, food products may absorb chemicals from packaging, and pesticides may be present in fruits in various concentrations. Unintended chemical contamination of products may also result from recycling. [Part I, Ch. 4]

The presence of hazardous substances in products, whether intentional or unintentional, poses challenges to circularity and the implementation of the waste hierarchy, which emphasizes source reduction, reuse and recycling. Examples include flame retardants in children's toys made from recycled plastic, and polycyclic aromatic hydrocarbons in rubber playgrounds made from recycled tyres. Advancing sustainable materials management, full material disclosure and enhanced knowledge-sharing throughout the supply chain (including recyclers), and scaling up sustainable product design based on green and sustainable chemistry innovation, are important approaches to address hazardous substances in products throughout their life cycle. These approaches are equally important for minimizing potential future releases from material stocks and products, and for generating safe and sustainable secondary raw materials in a circular economy. [Part I, Ch. 4-5; Part IV, Ch. 1]

Specific challenges are created by the complexity of global supply chains and the cross-border trade of chemicals and chemical-intensive products, spanning many countries with distinct regulatory frameworks. The supply chain for electronics illustrates fragmentation in a specific economic sector and across geographic locations (Figure 9). Management challenges are manifold and include identifying and minimizing, releases of chemicals during manufacturing, consumer exposures during product use, and releases during recycling or disposal. A related challenge is the potential exposure of workers at all stages of the supply chain. Complex supply

Figure 9 **The complexity of global supply chains: the case of an electronic product (adapted from Sourcemap 2012)**



Chemical-intensive products, such as the electronic product depicted here, are traded through increasingly complex global supply chains, spanning many countries and regions. This poses a variety of management challenges.

chains make it difficult for product manufacturers and retailers to know the chemicals contained in products, a topic addressed in the SAICM Chemicals in Products Programme. Recent research shows that the import of chemicals or products often does not comply with the chemicals legislation of the importing country. Furthermore, rapidly growing direct sales of chemical products via the internet are circumventing traditional distributors, many of which have management systems in place, adding further complexity. Relevant in this context is that cross-border e-commerce is growing at 25 per cent annually. [Part I, Ch. 4]

Large amounts of chemical pollutants are released from production, products and wastes, illustrating the inefficient use of resources

The production, use and disposal of chemicals continues to cause significant releases of hazardous chemicals to indoor and outdoor environments. Despite the scaling up of international efforts, global emissions of mercury into the atmosphere rose by around 20 per cent between 2010 and 2015. Releases of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-furans (hereinafter referred to as dioxins and furans) appear to have remained stable globally and to have increased significantly in the Asia-Pacific region. Large amounts of chemicals are also released to oceans and freshwater bodies, including from industrial activities (e.g. trichloroethylene used in solvents) and municipal discharges (e.g. pharmaceutical residues). Agricultural runoff, including pesticides, nitrogen and nitrates, is a major source of water pollution and contaminant of groundwater aquifers. Developing countries and economies in transition face particular challenges, such as releases of heavy metals from battery recycling and of mercury from artisanal and small-scale gold mining, which pollute air, water and soil. [Pat I, Ch. 5]

Progress has been made in reducing releases of some chemicals of concern through national regulatory action and multilateral treaties. National policies established in conformance with the Montreal Protocol, for example, have led to the phase out of 99 per cent of ozone depleting chemicals, which has resulted in significant reductions in releases. Emissions of various POPs have decreased significantly since 1990 among Parties to the Convention on Long-range Transboundary Air Pollution (e.g. 95 per cent in the case of hexachlorobenzene). Implementation of the Stockholm Convention is expected to result in decreasing releases of unintentionally produced POPs in all regions. Data from developing countries and economies in transition are limited, but initial results show positive trends. [Part I, Ch. 5]

Production processes continue to generate significant chemical releases to air, water and soil as well as large amounts of waste, including hazardous waste. In the production of pharmaceuticals, for example, at least 25 kilograms (kg) of emissions and waste (and at times more than 100 kg) are generated for every kg of product, highlighting resource inefficiencies. Significant amounts of greenhouses gases are also emitted during the production of chemicals. In addition, chemical accidents in industrial facilities continue to release significant amounts of hazardous substances. Management action and innovative solutions, including innovations in chemistry, can reduce pollution, increase resource efficiency, and reduce the use of hazardous substances (e.g. water-based solvents can replace chlorinated solvents). [Part I, Ch. 5; Part IV, Ch. 1]

Moreover, hazardous chemicals are released from chemical-intensive products, many of which are present in the indoor environment. Examples include formaldehyde volatilized from pressed wood products, biocides leaching from carpets, Bis(2-ethylhexyl)

phthalate (DEHP) released from polyvinyl chloride materials, and microplastics from personal care products. Products such as perfumes, hairsprays, air fresheners, cleaning solvents and glues are all likely sources of volatile organic compounds (VOCs) in indoor air. Other products may contain significant concentrations of phthalates, phenols, flame retardants, chlorinated solvents, heavy metals, PFASs and other chemicals that may be released to indoor air. A 2018 study suggests that releases of chemicals from consumer products (e.g. cosmetics and paints) have become the primary source of VOCs from petrochemical sources in some industrialized cities. The slower release of semi-VOCs, such as phthalates and several classes of flame retardants, is also a cause for concern. [Part I, Ch. 4-5]

Discarding products that include hazardous chemicals may turn municipal waste into hazardous waste. The generation of electronic waste, only 20 per cent of which is recycled globally, is a rapidly growing source of hazardous waste. Since many countries and municipalities lack appropriate infrastructure for the collection, treatment, recycling and disposal of hazardous waste, direct releases to the environment, releases from waste dumps and informal recycling have become major sources of pollution to all environmental media. The use and disposal of certain products which are hazardous thus presents a major challenge. [Part I, Ch. 4-5]

Box 1 Plastics, microplastics and chemicals

- The annual production of plastics is projected to increase from 335 million tonnes in 2016 to approximately 1124 million tonnes by 2050.
- The growth of the plastics economy drives demand for chemical additives and chemicals used in the production of plastics. Some of these chemicals are hazardous.
- Microplastics are accumulating rapidly in the environment. They are now found in the world's oceans, rivers, lakes, soils and air, as well as in salt, honey, beer, bottled and tap water, fish, and human faeces.
- Recently, significant regulatory actions have been taken – including bans of single-use plastics (e.g. Kenya), a waste import ban (China) and a ban on sales of personal care products containing microbeads (e.g. the United Kingdom) – alongside citizen and private sector initiatives to reduce plastic pollution.
- However, further voluntary and regulatory action, as well as accelerated research and development of more sustainable alternatives, are needed.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[Part I, Ch. 2, 5-6; Part II, Ch. 3; Part IV, Ch. 1, 7]

Box 2 Legacy chemicals are found in some of the remotest regions of the world

PCBs have been detected at high concentrations in small animals (amphipods) captured 10,000 metres deep in ocean sediment (the Mariana and Kermadec trenches). Some concentrations were higher than in those of animals living in highly polluted rivers in industrialized regions. Another study found certain organochlorine pesticides, regulated under the Stockholm Convention, in Himalayan glaciers. These studies demonstrate that chemicals whose production and use have long been banned may still be found at high concentrations in the environment due to their persistence. Persistent chemicals whose production and use have not yet been banned or restricted may thus create future legacies. [Part I, Ch. 6]

Chemical pollutants are ubiquitous in the environment and in humans

Chemical pollutants continue to be detected in air, water, soil and biota in all regions. Soils throughout the world are contaminated by hazardous chemicals, including PCBs, heavy metals and certain pesticides. Many hazardous chemicals, as well as microplastics, are found in food for human consumption. Microplastics, pharmaceutical residues, mercury and many other substances of concern have been detected in water bodies and in marine animals, which are often consumed by humans. High concentrations also occur in animals, such as brominated diphenyl ethers in birds in China, and mercury in marine species and bird eggs in North America. Concentrations of chemical pollutants are found in some of the most remote and unexpected parts of the planet (Box 2). [Part I, Ch. 6]

Chemicals of concern are also routinely detected in humans. Examples are dioxins and furans in breast milk, phthalates in urine, and heavy metals in human blood. Significant variations have been found in concentrations in human milk across analyzed substances, countries and regions. For example, concentrations of certain flame retardants are higher in developed countries, while concentrations of certain pesticides are higher in developing countries and economies in transition. Analyzing concentrations of four bisphenols in samples of adults taken over 14 years, a study found concentrations of bisphenol A to be declining and concentrations of bisphenol S to be increasing, which could reflect the replacement of bisphenol A with bisphenol S. Recent studies have detected previously banned flame retardants in the umbilical cord blood of newborn children, indicating one pathway, among others, for the transfer of legacy substances to new generations, which is a typical feature of persistent and bio-accumulative substances. [Part I, Ch. 6]

Mixed trends can be observed. In Arctic air, for example, concentrations of certain flame retardants seem to be

Box 3 Outcomes of the effectiveness evaluation of the Stockholm Convention (United Nations Environment Programme and Secretariat of the Stockholm Convention 2017, p. 4)

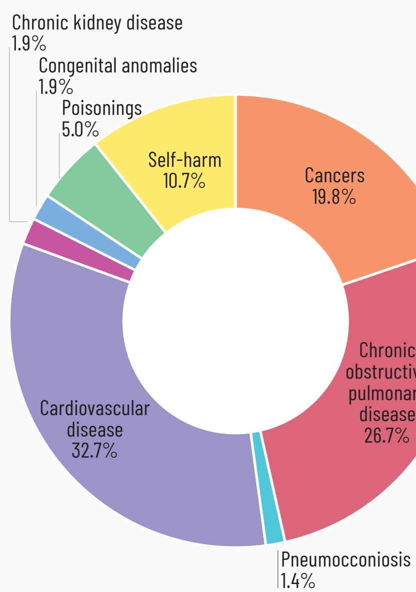
The effectiveness evaluation of the Stockholm Convention made available in 2017 found, among other outcomes, that "monitoring results indicate that regulations targeting POPs are succeeding in reducing levels of POPs in humans and the environment. For POPs listed in 2004 under the Convention, concentrations measured in air and in human populations have declined and continue to decline or remain at low levels due to restrictions on POPs that predated the Stockholm Convention and are now incorporated in it. For the newly listed POPs, concentrations are beginning to show decreases, although in a few instances, increasing and/or stable levels are observed".

© Eric Valenne geostory/Shutterstock, Colored dye reservoirs and vats in a traditional tannery declining while those of others appear to be increasing. Limited available data indicate that concentrations of some POPs (e.g. PCBs and DDT) are decreasing in air and human milk. Blood levels of lead in humans are declining in different regions across the globe, including southern Africa, China and North America. However, high levels are still measured in a number of developing countries (e.g. the Philippines and Nigeria). [Part I, Ch. 6]

The burden of disease from chemicals is high, and vulnerable populations are particularly at risk

Examples of the adverse effects of hazardous chemicals include deaths from acute poisonings involving heavy metals or pesticides, intellectual disability from exposure to lead, cancer caused by exposure to asbestos or dioxins, and endocrine disruption from various chemicals. The 2017 report of the *Lancet* Commission on Pollution and Health identified chemical pollution

Figure 10 **Deaths (total: 1.6 million) attributed to selected chemicals in 2016 (per cent) (adapted from WHO 2018, p. 2)**



as a significant and "almost certainly underestimated" contributor to the global burden of disease. [Part I, Ch. 7]

In 2018, the WHO estimated the disease burden preventable through sound management and reduction of chemicals in the environment at around 1.6 million lives and around 45 million disability-adjusted life years in 2016 (Figure 10). These are likely to be underestimates, given that they are based only on exposures to chemicals for which reliable global data exist (including lead causing intellectual disability, occupational carcinogens such as asbestos and benzene, and pesticides involved in self-inflicted injuries). The 2016 Global Burden of Disease study published in the *Lancet* estimated that in 2015 almost 500,000 deaths are attributable solely to lead exposure. In addition, chemical accidents in facilities continue to result in high human fatalities, adverse environmental impacts and high economic costs. [Part I, Ch. 7]

Workers are typically subject to disproportionally high exposures to hazardous chemicals, particularly in small and medium-sized enterprises (SMEs) in developing countries and economies in transition and in the informal economy, where they may not be sufficiently informed and protected. Workers are exposed to hazardous chemicals throughout the supply chain, from extraction, to manufacturing, to recycling and disposal. In 2015, almost 1 million workers died from exposure to hazardous substances, including dusts, vapours and fumes (an increase of more than 90,000 workers compared to 2011), based on estimates released by the ILO. [Part I, Ch. 7]

Foetuses, infants, children, pregnant women, the elderly and the poor are among the most vulnerable to the adverse effects of chemicals and waste. For example, the foetal brain is especially vulnerable to methylmercury. The poor may be disproportionally exposed because they frequently live near sources of hazardous chemical releases, such as hazardous waste dumpsites and manufacturing facilities. Vulnerability and exposures of women and men to chemicals may also differ. In general, women are often more likely to be exposed to hazardous chemicals in certain cosmetics, while men have significantly higher occupational exposures in certain sectors. [Part I, Ch. 7]

Chemical pollution threatens biota and ecosystem functions

A range of adverse impacts of chemical pollutants on biota continue to be observed. Examples include lethal and chronic effects on fish from brominated flame retardants; suppression of immune systems in seals and turtles due to exposure to PCBs and PFASs; and dioxins causing the thinning of some bird eggs. Certain chemicals have been found to have endocrine-disrupting effects on some animals. Examples include feminization of male fish due to exposure to synthetic oestrogen, and abnormalities in the reproductive system in alligators caused by pesticide pollution. A 2018 study from India indicates that the drug diclofenac continues to adversely affect the health of the vulture population more than a decade after it was banned. [Part I, Ch. 7]

Impacts of hazardous chemicals in weakening or putting stress on ecosystems and life support functions have also been observed. The depletion of the ozone layer is a prominent example of how certain chemicals may affect the functioning of a critical life support system. A number or critical ecosystem services are also affected by chemical pollution. For example, some pesticides have been found to negatively impact non-target insects and pollinators such as bees, as well as nutrient cycling and soil respiration. Excess use of phosphorous and nitrogen in agriculture continues to contribute to ocean dead zones around the world. Furthermore, some chemicals (e.g. those used in sunscreens) put pressure on the health of coral reef ecosystems. Studies also indicate that environmental releases of some antimicrobials, heavy metals and disinfectants contribute to antimicrobial resistance. [Part I, Ch. 7]

The costs of inaction and the benefits of action are estimated to be significant, but methods need to be refined

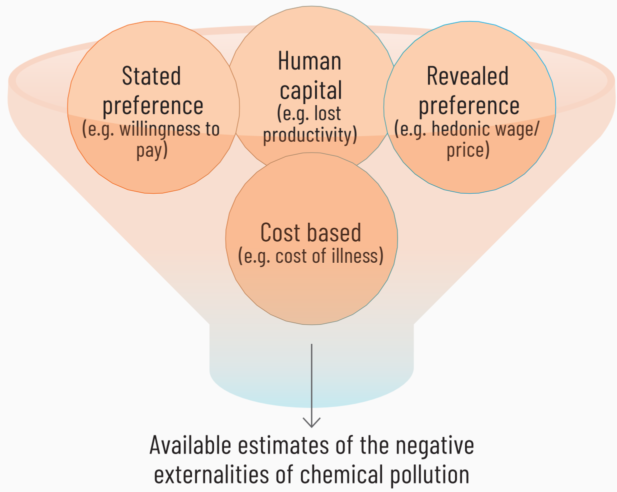
The costs associated with unsound management of chemicals and waste include productivity losses, health care costs, damage to ecosystems, litigation costs, and reputational damage to businesses. A 2015 study estimated the costs from neurobehavioural deficits caused by certain chemicals to be more than US dollars 170 billion per year in the EU alone. Another study estimated the economic costs attributable to childhood lead in low- and middle-income countries at a total cost of international dollars 977 billion. Some studies estimate costs from environmental chemical exposures to be as high as several percentage points of global gross domestic product, with developing countries

Box 4 How robust is the global knowledge base to support sound management of chemicals and waste

Although a wealth of data and knowledge has been generated, many data gaps and unknowns remain. Knowledge about the number and volumes of hazardous chemicals already on the market, as well as those newly entering it, is lacking in many countries and regions. While environmental, health and safety data are available for the majority of the highest production volume chemicals, knowledge gaps remain for many lower production volume chemicals. Complete data sets concerning the hazard potential of a significant number of chemicals are missing. Knowledge is also still very limited regarding outdoor and indoor releases of chemicals both during production processes and from products, exposures in varying contexts, concentrations of various hazardous chemicals in environmental media, and the adverse impacts of chemicals (e.g. on health). Disparities remain in data collection and availability across time and countries, making the identification of baselines, trends, and emerging issues and priorities challenging. Various barriers (e.g. insufficient communication of policy needs to scientists, and vice versa) pose challenges in making policy-relevant knowledge available for informed decision-making. [Parts I-III] and economies in transition bearing the highest costs. Conversely, both regulatory and voluntary action can deliver socio-economic benefits in the form of reduced or avoided damage to human health and the environment. A 2017 study conservatively estimated the cumulative benefits of chemicals legislation in the EU to be "in the high tens of billion Euro per year". [Part I, Ch. 8]

However, robust socio-economic analysis is challenging and estimation methodologies need further refinement. A key challenge is the existence of multiple causal factors, making it difficult to establish epidemiological relationships and attribute costs and benefits to specific actions. This is aggravated by a lack of data for quantifying, and assigning monetary values to, the physical impacts of chemical releases. A global study of the economic and social effects of using harmful chemicals, comparable to the Stern Review on the Economics of Climate Change, does not exist. Such a study could raise awareness of the global scale of these effects and catalyse further action. [Part I, Ch. 8]

Figure 11 **Identifying the economic costs of inaction and the benefits of action [Part I, Ch. 8]**



Box 5 Pharmaceuticals and the environment

- Pharmaceuticals are one of the chemical industry's fastest growing segments. This segment has a projected annual growth rate of 6.5 per cent, to reach more than US dollars 1 trillion by 2022.
- Due to releases from various sources, pharmaceutical residues are present worldwide in surface water, groundwater, soil and other environmental media.
- Some pharmaceuticals are transferred within food webs (e.g. accumulating in riparian spiders) and taken up by plants (e.g. food crops). In some river streams, exposure of aquatic and riparian biota to certain pharmaceuticals may be comparable to human dosages.
- Some pharmaceuticals have been found to have endocrine-disrupting effects in animals (some pharmaceuticals being intentional endocrine disruptors).
- Evidence is mounting that environmental releases of some antimicrobials, as well as heavy metals and disinfectants, contribute to the spread of antimicrobial resistance.
- Research on green and sustainable pharmacy reveals opportunities such as resource efficiency in production processes, and mineralization of pharmaceuticals in the environment.
- Opportunities also exist to include environmental criteria in good manufacturing practices.

[Part I, Ch. 2, 5-7; Part II, Ch. 4; Part IV, Ch. 1]

II. Where do we stand in achieving the 2020 goal – assessing overall progress and gaps

© International Institute for Sustainable Development, Closing plenary of the World Summit on Sustainable Development, 4 September 2002, Johannesburg, South Africa

In 2002 at the WSSD, Governments agreed to "achieve, by 2020, that chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment […]". The decision also encouraged actions at all levels, including the ratification and implementation of relevant international instruments, development of a strategic approach to international chemicals management, implementation of the GHS by 2008, and the establishment of Pollutant Release and Transfer Registers (PRTRs). Findings of the GCO-II indicate that while many countries have made progress across these and other areas, major gaps remain. [Introduction; Part II]

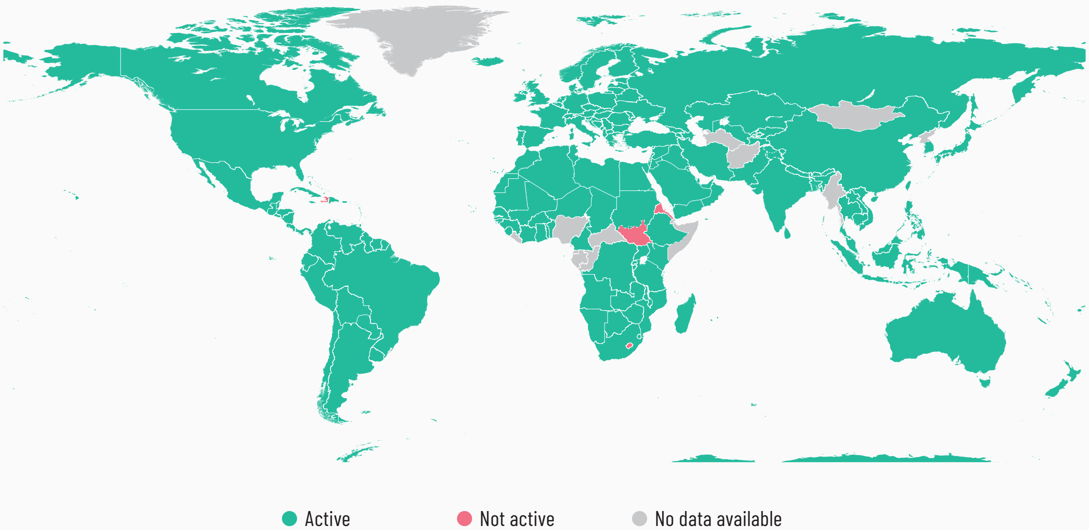
Many countries and regions have strengthened their legal and institutional capacities

Many countries have already made important headway in enacting laws, creating programmes, and implementing policies to achieve the sound management of chemicals and waste. Examples of major legal and policy initiatives or reforms in developed countries include adoption of the EU's Regulation concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) (2006), Japan's Chemical Substances Control Act (amended in 2009), Canada's Chemicals Management Plan (latest phase launched in 2016), and the US Lautenberg Chemical Safety for the 21st Century Act (2016). Since the first GCO, a number of developing countries and economies in transition have taken major steps, for example China with its Five-Year Plan for Chemical Environmental Risk Prevention and Control (2013). Several countries in Latin America and the Caribbean have established overarching chemicals management policies, for example Honduras in 2013, Ecuador in 2015 and Chile in 2017. Others have taken initial – but critical – steps, for example India with its draft National Action Plan for Chemicals, Kenya with its draft Environmental Management and Coordination (Toxic and Hazardous Chemicals and Materials Management) Regulations 2018, and Brazil with its landmark draft law on the inventory, evaluation and control of chemicals. These examples create the potential for cooperation, knowledge-sharing and potential replication. [Part II, Ch. 3]

Progress in the implementation of legal frameworks for pesticides is advancing. Yet significant further work is needed to fully implement best practices and minimize adverse effects from the use of pesticides. The voluntary Code of Conduct serves as a point of reference in relation to sound pesticide management throughout the life cycle, including for the development of legislation. In particular, it provides a critical reference for public and private entities engaged in, or associated with, the production, regulation and management of pesticides. [Part II, Ch. 3]

Regulatory bodies in all regions have also been taking action to identify, assess and manage a number of priority chemicals of concern. Prominent examples include Canada's Chemicals Management Plan, China's Prioritized List of Substances Subject to Control, the EU's list of Substances of Very High Concern (SVHC) and the US Environmental Protection Agency's Toxic Substances Control Act Work Plan. Moreover, a number of countries have adopted policies and programmes addressing

Figure 12 **Countries with pesticide legislation, according to Food and Agriculture Organization of the United Nations (FAO) data collected in the context of the Code of Conduct, February 2018 (adapted from FAO 2018)**



certain aspects of the safety of chemicals in products. Examples include Russia's regulation on chemicals product safety (2016), new toy safety standards in Egypt (2018), and several restrictions by countries in West Asia on chemicals in electrical and electronic equipment (2018). Some recent initiatives have focused on specific chemicals (e.g. Nigeria's national policy framework for the management of PCBs of 2015), while others focus on waste management and recycling (e.g. a 2016 act in Ghana). [Part II, Ch. 3]

Countries save resources by aligning and harmonizing their policies

While national priorities and instruments provide the basis for sound management of chemicals and waste, countries can save significant resources by aligning their approaches with those of other countries or with internationally agreed guidance. Such guidance includes that developed, for example, by the Organisation for Economic Co-operation and Development (OECD) and the WHO. Countries such as Brazil, Costa Rica, Malaysia and Thailand are aligning their legislative approaches with policy and technical guidance provided by the

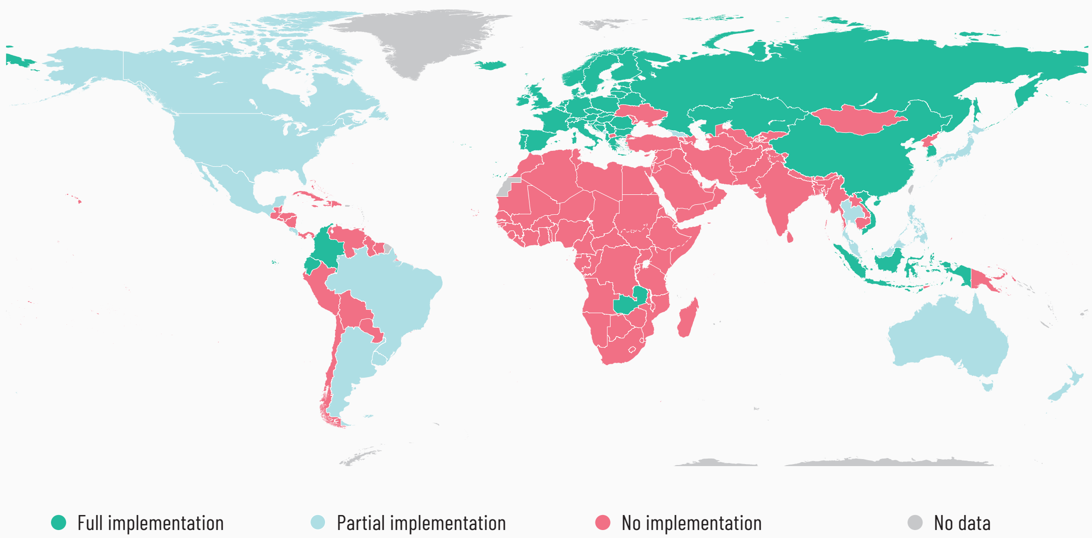
Table 2 **Examples of regional institutions and initiatives addressing chemicals and waste management [Part II, Ch. 3]**

Region	Examples of institutions and initiatives	Examples of implementation bodies activities
Latin America and the Caribbean	Southern Common Market	Action Plan on Chemical Substances and Products Ad-hoc group on environmental management of chemical substances and products
	Andean Community of Nations	Registry and trade control of chemical pesticides for agricultural use
	Regional Intergovernmental Network on Chemicals and Waste	Identification of regional priorities on chemicals and waste First Action Plan for 2019-2020
Asia-Pacific	Association of Southeast Asian Nations (ASEAN)	Establishment of the ASEAN-Japan Chemical Safety Database (2016)
	South Asia Association for Regional Cooperation	Development of regional standards for chemicals and chemical products
	Secretariat of the Pacific Regional Environment Programme	Projects to strengthen legislative frameworks and waste management capacity
West Asia	Gulf Cooperation Council	Common System for the Management of Hazardous Chemicals
Africa	Economic Community of West African States	Sahelian Pesticide Committee and West African Committee for Pesticide Registration Harmonization of chemicals' data requirements and test guidelines
	Southern African Development Community (SADC)	Technical Regulations Liaisons Committee SADC Policy on the GHS (2013)
Europe and Central Asia	Eurasian Economic Commission	Single registry of chemical materials and substances Adoption of a technical regulation on the safety of chemical products (2018)
	Commonwealth of Independent States	Harmonization with the GHS Cooperation on e-waste management
	European Union	REACH Regulation (2006) Regulation on Classification, Labelling and Packaging of substances and mixtures (CLP) (2008) Biocidal Products Regulation (2012)
North America	North America Agreement on Environmental Cooperation	Commission for Environmental Cooperation supports cooperation to address environmental issues of continental concern

OECD in areas such as testing of chemicals. Close trade relationships facilitate such alignment. Several countries (e.g. Turkey and the Republic of Korea) have modelled their regulations based on the EU's REACH legislation. These alignments and harmonization efforts create cost savings through benefiting from progress made in regions with advanced schemes, sharing workloads and facilitating trade. Altogether, such opportunities point to the value of scaling up global knowledge-sharing and capacity development, building on work undertaken by intergovernmental organizations and other stakeholders. [Part II, Ch. 3]

Cooperation across countries, including at the regional level, can provide important benefits, for example through sharing experiences and lessons learned. Numerous success stories showcase how regional institutions and organizations have advanced regulatory harmonization and the development and implementation of policy-oriented action plans across regions (Table 2). Close trade relationships create opportunities for collaboration and harmonization, while maintaining a high standard of protection. Regional economic and political integration organizations have assumed an important role in addressing chemicals and waste in all regions. [Part II, Ch. 3]

Figure 13 **Global GHS implementation status, 2018 (adapted and updated based on Persson *et al.* 2017, p. 8)**

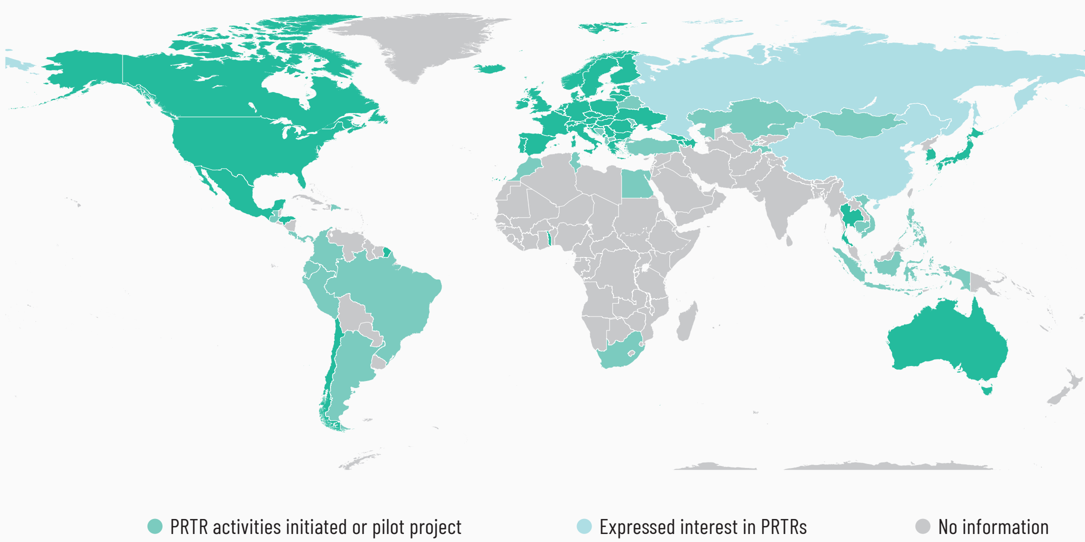


In achieving the environmentally sound management of chemicals and waste, each region faces a set of distinct trends, challenges and opportunities. To identify chemicals and waste management priorities, as well as to develop appropriate solutions, it is therefore important to consider regional dimensions and differences. Multilateral environmental agreements (e.g. the Basel Convention and the Stockholm Convention) have established networks of regional centres to provide technical assistance and training, as well as to promote the transfer of technology to developing country Parties and Parties with economies in transition relating to the implementation of their obligations under the treaties. Under SAICM, regular meetings are held, among others, to discuss regional priorities and explore opportunities for regional collaboration. Opportunities exist to create further linkages among various regional processes and initiatives. [Part I, Ch. 3; Part II, Ch. 3]

Overall progress towards achieving the sound management of chemicals and waste is uneven across countries, regions and actors

While significant progress has been made towards achieving the sound management of chemicals and waste, major implementation gaps remain. In particular, developing countries and economies in transition, including some with chemical production

Figure 14 Status of PRTRs, 2018 (adapted from United Nations Institute for Training and Research [UNITAR] 2018a)



facilities and projected growth in chemical production and consumption, still lack basic chemicals and waste management systems. For example, despite the GHS having been explicitly addressed by WSSD, it is not operational in more than 120 countries, mostly developing countries and economies in transition (Figure 13). [Part II, Ch. 3]

Furthermore, many countries still lack PRTRs (Figure 14), poison centres, and capacities for hazard and risk assessment and risk management. Gaps are particularly prevalent in the case or industrial chemicals and consumer products, with regulations on lead in paint being a revealing indicator: as of September 2018, only 37 per cent of countries had confirmed that they have legally binding controls on lead in paint. Moreover, even if regulations on specific chemicals are in place, implementation and enforcement may pose challenges. For example, news emerged in 2018 that the production and use of trichlorofluoromethane (CFC-11), a powerful ozone-depleting substance banned under the Montreal Protocol and also a potent greenhouse gas, may be ongoing. As regards e-commerce, 82 per cent of advertisements for hazardous chemical mixtures sold on the internet, recently investigated in EU countries, were found to be non-compliant with the EU's CLP Regulation. Concerning illegal international traffic, chemicals and waste (e.g. electronic waste) are frequently falsely declared while counterfeit products (e.g. pesticides and cosmetics) are traded across borders. [Part II, Ch. 3]

Progress has been made in many areas. For example, the number of countries having established PRTRs and implementing the GHS has increased since 2010.

Table 3 **Status of selected indicators of progress on the Global Plan of Action prepared under SAICM [Part II, Ch. 3]**

Indicator	Targets in SAICM GPA	Status in 2010	Status in 2016/ 2017
The GHS is implemented	2006-2010	41	65
PRTRs are established in all countries	2015	35	50
Number of countries that have adopted the Code of Conduct has increased	2010	n.a.	173
Responsible Care® is implemented in all relevant countries	2010	60	68
Poison centres are established in all countries	2010	91	90

However, progress remains insufficient, pointing to an urgent need to take concerted action to develop basic chemicals management systems in all countries (Table 3). [Part II, Ch. 3]

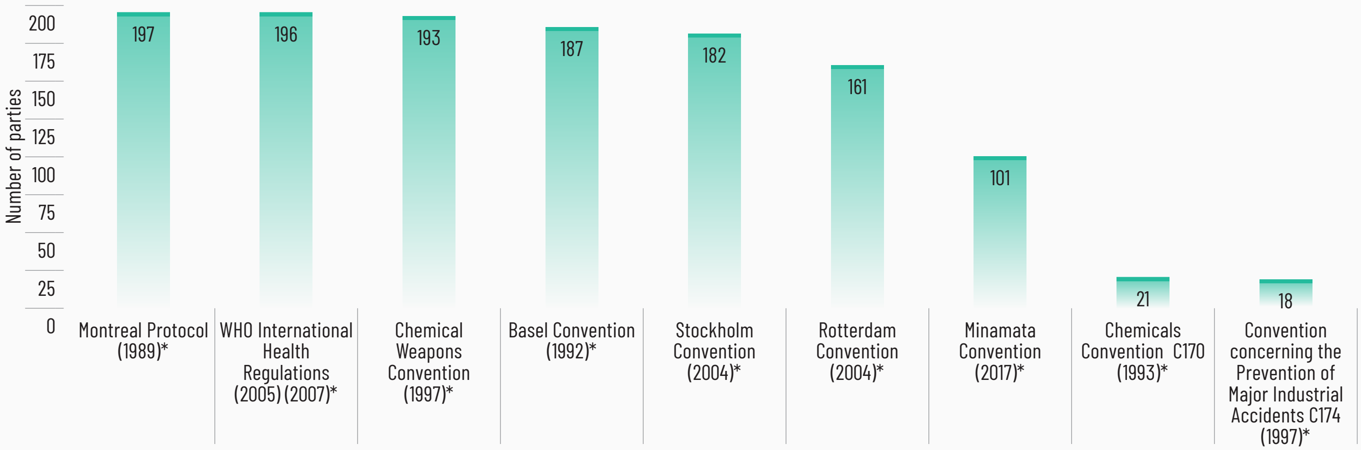
Similarly, industry involvement has not been sufficient and challenges have been noted regarding voluntary industry standards and initiatives. While industry is involved through programmes such as Responsible Care®, universal coverage is yet to be achieved. For example, major gaps remain in the implementation of Responsible Care® in a number of countries. Opportunities exist to review these programmes' effectiveness through the involvement of relevant stakeholders, as well as to scale up industry responsibility and leadership, drawing upon lessons learned, for example from the ZDHC initiative in the textile sector. Private initiatives, such as proactive standard-setting in downstream sectors beyond compliance (e.g. in the textile sector), could be strengthened through universal private sector participation. It could also stimulate similar initiatives in other chemical-intensive sectors. While such initiatives do not reduce the need for adequate legislation to define the role of industry, they could become important building blocks under a future approach to chemicals and waste management beyond 2020 and further advance implementation of the polluter pays principle. [Part II, Ch. 3; Part III, Ch. 4]

Multilateral treaties address some chemicals and issues of global concern, but implementation challenges remain

The international community has taken concerted action through legally binding treaties on some of the most harmful chemicals and on some issues of global concern. These treaties have catalysed selected regulatory actions, raised awareness, and succeeded in reducing some exposures to the targeted chemicals and wastes. Given that treaties are designed to address specific chemicals and issues – for example, some mainly focus on specific stages of the life cycle or specific

© UNITAR / Jordan De Haan,
Artisanal and small scale gold miner

Figure 15 **Number of Parties to relevant multilateral legally binding treaties (as of 14 January 2019)**



* year of entry into force

While some multilateral treaties, such as the Montreal Protocol and the WHO International Health Regulations (2005), have been virtually universally ratified, this is not the case for all of the treaties on chemicals and waste. [Part II, Ch. 1]

issues (e.g. ILO C174), specific chemicals (e.g. the Minamata Convention) or groups of chemicals (e.g. the Stockholm Convention) – many hazardous substances are beyond their scope. Levels of ratification are high in many cases, while in others positive trends can be identified (Figure 15). For example, between 2010 and 2018 the number of Parties increased from 173 to 187 for the Basel Convention, from 140 to 161 for the Rotterdam Convention, and from 172 to 182 for the Stockholm Convention. However, the ratification of a treaty is a valuable but not sufficient indicator to assess implementation. [Part II, Ch. 1, 3]

The Montreal Protocol, a widely cited success story of international cooperation, has succeeded in removing ozone-depleting substances from the atmosphere and protecting the ozone layer, thus avoiding more than 100 million cases of skin cancer. The Basel Convention has strengthened national capacities for the environmentally sound management of hazardous wastes; the Rotterdam Convention has facilitated exchange of critical information on the trade of hazardous substances; and the production and use of various POPs has been restricted or eliminated under the Stockholm Convention. The Minamata Convention on Mercury is also expected to achieve positive results, for example by facilitating formalization of the artisanal and small-scale gold mining sector; phasing out the use of mercury in various products; and ensuring the environmentally sound management of mercury wastes. [Part II, Ch. 1, 3]

The extent to which the objectives of a number of treaties have been achieved is uncertain. For example, the 2016 effectiveness evaluation of the Stockholm Convention concluded that "the Convention provides an effective and dynamic framework to regulate persistent organic pollutants throughout their life cycle". However, it identified areas for further work, such as gaps in regulatory and assessment schemes for industrial chemicals and the large remaining stockpiles of obsolete pesticides and PCBs. Significant progress has also been made in the case of other treaties. Nevertheless, further efforts are needed to achieve full implementation, as in the case of the chemicals dimension of the International Health Regulations (2015). [Part II, Ch. 3]

SAICM provides a unique voluntary policy framework, but weaknesses have been identified

The 2018 independent evaluation of SAICM found that it is unique in its ambition as an inclusive multi-stakeholder, multi-sector voluntary policy framework. The evaluation also found that SAICM creates a collaborative space for raising awareness, increasing knowledge and reducing risks. However, it pointed out weaknesses, such as insufficient sectoral engagement; the capacity constraints of national focal points; lack of tools to measure progress; limited financing of activities; and insufficient and uneven advances in substantive areas such as illegal international traffic. While the second progress report (2014) prepared under SAICM noted that stakeholders reported an increase in the number of activities undertaken for most indicators, such as on hazardous waste management arrangements, it was not possible to measure progress under the third report (2019) due to a very low response rate. [Part II, Ch. 1, 3]

Emerging policy issues identified internationally, but further action needed

To date, the ICCM has identified eight emerging policy issues (EPIs) and other issues of concern, understood to be issues involving any phase in the life cycle of chemicals and which have not yet been generally recognized, are insufficiently addressed or arise from the current level of scientific information, and which may have significant adverse effects on human health and/or the environment. The independent evaluation noted that the identification of, and actions taken on, the eight EPIs and other issues of concern were a major strength and uniqueness of SAICM, including by raising awareness. Nevertheless, it found that slow, modest and uneven progress has been made in implementing actions to address the EPIs, with the exception of lead in paint. The GCO-II provides evidence concerning a number of remaining challenges and presents a range of measures to further address the EPIs and other issues of concern (Table 4). [Part II, Ch. 4]

Table 4 **Emerging policy issues and other issues of concern identified by the ICCM [Part II, Ch. 4]**

EPIs and other issues of concern	Selected implementation measures identified by the GCO-II
Lead in paint	Urgently ensure that all countries have legally binding controls in place towards the phase-out of the manufacture and sale of lead paint.
Hazardous substances within the life cycle of electrical and electronic products	Ensure that all countries have regulations in place to protect workers, consumers and recyclers, while also advancing voluntary action.
Highly hazardous pesticides (HHPs)	Further scale up integrated pest management (IPM) and agro-ecological approaches, including development and use of non-chemical alternatives and other good agricultural practices.
Chemicals in products	Develop harmonized protocols to collect, manage, report and communicate information about chemicals in products across supply chains.
PFASs and the transition to safer alternatives	Generate further knowledge and advance international action on short-chain PFASs and non-fluorinated alternatives.
Environmentally persistent pharmaceutical pollutants	Provide incentive structures to advance green and sustainable pharmacy.
Endocrine-disrupting chemicals (EDCs)	Enable systematic screening and identification of EDCs by implementing scientific data requirements and assessment as part of national chemicals legislation.
Nanotechnology and manufactured nanomaterials	Enable systematic assessment of the risks of manufactured nanomaterials by further developing standardized tests.

Recent regulatory action taken based on emerging evidence of risk

The UNEA mandate requested that the GCO-II address other issues where emerging evidence indicates a risk to human health and the environment. A criteria-based approach was taken, whereby identification of recent (since 2010) assessments and regulatory risk management actions taken by public bodies on a chemical (or group of chemicals) not already covered under a multilateral treaty or SAICM was used as a starting point. The approach taken does not aim to conduct and deliver an international science-based assessment of specific chemicals or groups of chemicals. Rather, it is meant to facilitate international sharing of knowledge. By undertaking a meta-review and drawing attention to existing prioritization and risk management action, the objective is to facilitate understanding of issues of potential interest to governments and other stakeholders. [Part II, Ch. 5]

The criteria used resulted in the identification of issues for the following chemicals or groups of chemicals: arsenic, bisphenol A, glyphosate, cadmium, lead, microbeads, neonicotinoids, organotins, polycyclic aromatic hydrocarbons, phthalates and triclosan. While, for some of these, concerns had existed for a long time (e.g. regarding lead, which continues to be widely used in applications other than paint), recent regulatory action has been taken in several countries in light of new evidence on lower thresholds for adverse effects or additional evidence related to specific uses. In other cases, additional or new evidence has emerged in recent years, prompting regulatory action (e.g. on microbeads). In yet other cases, some countries have taken precautionary action based on existing knowledge. [Part II, Ch. 5]

National capacity development and action remains a priority

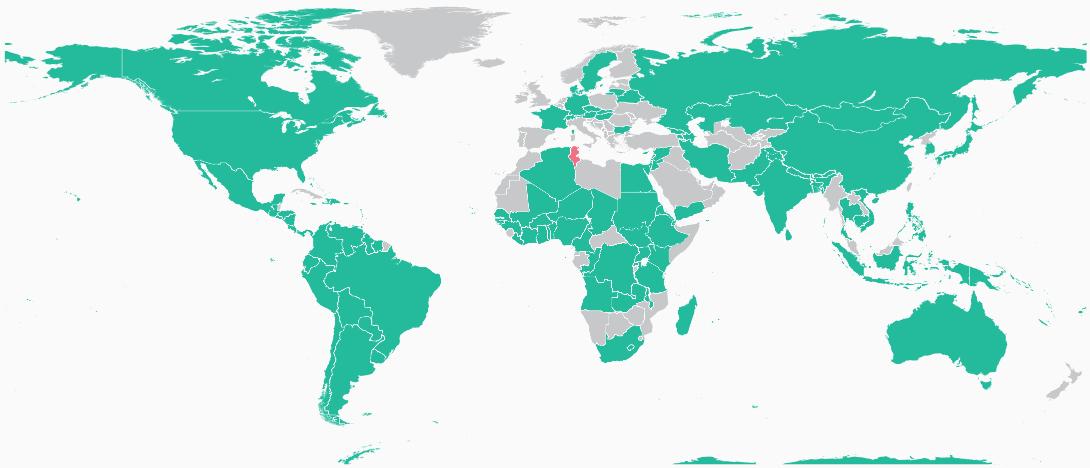
Valuable work has also been undertaken by countries through the development of national chemicals management profiles and plans to strengthen national chemicals and waste management programmes in a systematic and coordinated way. National profiles feature the status and gaps in areas such as legislation, institutional arrangements, and information systems (Figure 16). Often prepared through multi-sectoral and multi-stakeholder collaboration, they have led to the establishment of inter-ministerial committees in a number of countries, led to the production of country

Box 6 Identification of priority chemical issues at the international level

A diverse set of mechanisms has been established at the international level to identify emerging issues and set priorities for action. Bodies engaged in international prioritization efforts include, but are not limited to, the ICCM, the Persistent Organic Pollutants Review Committee of the Stockholm Convention, and the Scientific Assessment Panel of the Montreal Protocol. Existing bodies use different procedures, methodologies, selection criteria and organizing frameworks. Under the ICCM, EPIs are identified through a process whereby any SAICM stakeholder may submit nominations which, following several intermediate steps to review and group the nominations, are considered by the Open-ended Working Group and eventually by the ICCM. This process has resulted in the identification of a diverse set of issues ranging from endpoint-focused issues (e.g. EDCs), and specific applications (e.g. lead in paint), to broader management topics (e.g. chemicals in products). The Persistent Organic Pollutants Review Committee undertakes systematic science-based chemical-by-chemical assessments based on proposals received by Parties.

In developing a possible future process to identify international issues of concern beyond 2020, lessons learned from these mechanisms, and ensuring the complementarity of processes, are important, as is the use of science-based criteria for prioritization (e.g. use of information about health and environmental impacts and harm caused, and drawing on information from risk assessments). [Part II, Ch. 3-5]

Figure 16 **National profiles to assess the chemicals and management infrastructure, 2018 (adapted from UNITAR 2018b)**



National profiles have been prepared in many countries through multi-sectoral and multi-stakeholder collaboration. They provide valuable information to support future action. [Part II, Ch. 3]

baseline information, and facilitated the identification of priority actions. More recently, the Special Programme to support institutional strengthening at the national level for implementation of the Basel, Rotterdam and Stockholm Conventions, the Minamata Convention and SAICM has been operationalized to support country-driven institutional strengthening at the national level. It is currently funding projects in 24 countries. These initiatives provide a useful starting point for country-level action beyond 2020, taking into account SAICM's overall orientation and guidance. [Part II, Ch. 3]

Nevertheless, there has been a loss of momentum, marked by lack of sufficient funding for developing countries and economies in transition to develop basic capacities. Building on existing work, guidance could be adjusted to support the development or updating of national action plans and to link them further to internationally agreed targets and milestones under a beyond 2020 approach. Moreover, national profiles and action plans could be showcased and undergo review, including peer review, by interested stakeholders to provide feedback on potential measures likely to have the highest impact. [Part II, Ch. 3]

Effective implementation requires adequate financing, technology transfer and technical assistance

The integrated approach to financing, welcomed by the Governing Council of UN Environment in 2013, includes the three components of mainstreaming, industry involvement, and dedicated external financing. Further action is required to achieve full implementation of the integrated approach with respect to all three components. Action is also required in order to explore new opportunities such as sovereign wealth funds, philanthropic finance, and strengthened engagement of the financial sector and investors, so as to mobilize and help guide largely untapped resources to contribute to sustainable development. [Part II, Ch. 3; Part IV, Ch. 6]

Mainstreaming occurs when governments integrate sound management of chemicals and waste into their development plans and/or priorities, which has been successfully practised by various countries. However, limited progress has been made. Few success stories are known where mainstreaming of projects was followed up by the allocation of resources from national budgets/resources. Zambia retained fees raised through licensing of chemicals manufacture and registration, importation and export, and used them for monitoring and enforcement. However, this scheme has been discontinued. In further advancing the mainstreaming agenda, linkages with the SDGs could serve as an entry point to integrate chemicals and waste into sectoral policies (e.g. housing, agriculture, energy). Opportunities also exist to embed sound chemicals management in a broader environment and health agenda. [Part II, Ch. 3]

Industry involvement refers to resources for the chemicals and waste agenda generated by the involvement of industry. A number of countries have clarified responsibilities between the public and private sector; promoted extended producer responsibility and the internalization of costs by industry; and used fiscal instruments. Industry involvement has also been important in mobilizing resources and has built capacity, including through testing, material safety data sheets, information-sharing and voluntary product stewardship. However, gaps remain in increasing contributions to match responsibility and the required level of support. Further efforts are needed in many countries to adopt legislation to internalize cost, as well as to expand the use of economic instruments. Further public-private partnerships could be established to design and implement chemicals management capacity development initiatives, with adequate monitoring in place to measure results. [Part II, Ch. 3]

Dedicated external financing to support countries in implementing their legal obligation, and other commitment, to sound management of chemicals and waste has been forthcoming through various mechanisms. External funding (e.g. through the Global Environment Facility, the Special Programme, the now discontinued SAICM Quick Start Programme, and bilateral development assistance) has been significant, but has not matched the need, and demand for support, expressed by developing countries and economies in transition, for building basic chemicals and waste management systems. The creation of linkages with the implementation of the 2015 Addis Ababa Action Agenda of the Third International Conference on Financing for Development could help generate investments for chemicals and waste as a critical element in implementing the 2030 Agenda. [Part II, Ch. 3]

A global coherent results, indicator and reporting framework is lacking

The current international framework for reporting and measuring progress in the area of chemicals and waste is spread across various treaties, voluntary chemicals and waste instruments, and the 2030 Agenda. A range of different – and not always complementary – indicators and reporting schemes have been developed under various international agreements (Table 5). The combination of a fragmented indicators framework and low reporting makes it challenging to develop a global baseline, and to track progress in a systematic way. Moreover, the use of activity- or instrument-based indicators (rather than impact indicators) alone provides limited insights in assessing impacts achieved. [Part II, Ch. 2]

Reporting rates under several agreements are low, particularly among developing countries and economies in transition. In some cases reporting rates exhibit a downward trend. In 2016, full reporting compliance had been achieved by only 10 per cent of the Parties under the Basel Convention and only 22 per cent under the Stockholm Convention. Reporting rates under SAICM have also been low and show a downward trend. Among Governments, reporting rates dropped from around 40 per cent and 43 per cent in the first two rounds to 28 per cent in the third round, with data lacking particularly from the Africa region. By contrast, reporting compliance has been high or even universal under ILO Conventions C170 and C174, the Montreal Protocol and the IHR. Success factors could include: making reporting more useful for national contexts and efforts; close follow-up by, and provision of direct assistance through the Secretariats; and fostering transparency on reporting outcomes. Further efforts are needed to fully understand the reasons for significant divergences in reporting rates and to share lessons learned. [Part II, Ch. 2]

Table 5 **Diverse indicators and reporting schemes under relevant international agreements and frameworks**

Agreement / framework	Indicators and reporting schemes
2030 Agenda for Sustainable Development	Countries are invited to prepare Voluntary National Reviews, which are reviewed by the High-Level Political Forum. Custodian and partner agencies facilitate reporting on relevant SDGs.
Multilateral treaties	Under all relevant multilateral treaties, except the Rotterdam Convention, Parties are required to provide regular progress reports. These vary in frequency, scope, format and public availability.
Non-binding global policy instruments	Reporting schemes under non-binding global policy instruments have varying degree of formality, ranging from national reporting under the Code of Conduct to more ad-hoc review of implementation of the GHS.
Strategic Approach to International Chemicals Management (SAICM)	Reporting under SAICM is structured along 20 activity-based indicators grouped under the five Overarching Policy Strategy objectives. Reporting by stakeholders is voluntary and progress is reviewed by the ICCM.
Inter-Organization Programme for the Sound Management of Chemicals (IOMC) indicators	The IOMC developed a set of indicators to track progress in eight areas by analyzing data from verifiable sources and for which global data are available.

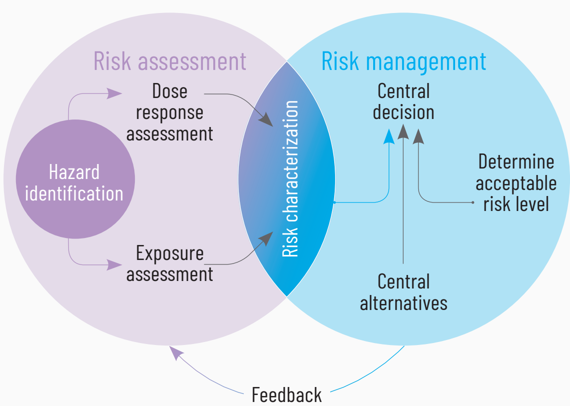
III. Advancing and sharing chemicals management tools and approaches: taking stock, looking into the future

For many years, Governments, intergovernmental organizations, industry and other stakeholders have been developing and employing a range of science-based approaches, tools, methodologies and instruments to advance sound chemicals management and implement the 2020 goal. These approaches, and the related generation of new information, serve to identify chemical hazards, assess exposure and risks of chemicals, promulgate risk management decisions and actions when necessary, and assess alternatives. Collectively, they have contributed significantly to protecting human health and the environment. At the same time, concerns have been expressed that current approaches are at times complex and slow and do not result in the progress needed. Over the past decades, valuable lessons have been learned in the practical application of these approaches, and opportunities have emerged to enhance their effectiveness, streamline their use, and employ them more systematically in all countries. Developing countries and economies in transition, in particular, stand to benefit from progress in these areas. [Part III]

Accelerating chemical hazard assessment and GHS classifications a priority

Significant progress has been made in identifying chemical hazards. Opportunities exist to share and use relevant methods and information more widely, given

Figure 17 Risk assessment and risk management decision process (adapted from US National Library of Medicine 2018)



Dedicated chapters in the GCO-II discuss a number of steps in the risk assessment and risk management process, including progress made, lessons learned, and opportunities for enhancing effectiveness and knowledge-sharing. [Part III, Ch. 1-5] that a chemical's hazard is an intrinsic property and is the same everywhere. The OECD Test Guidelines provide an internationally accepted framework to facilitate the mutual acceptance of data. Participation by additional countries in this scheme will generate further resource savings and reduce the need for animal testing. [Part III, Ch. 1]

However, data gaps remain in regard to fully understanding hazards and classifying all hazardous chemicals on the global market. For example, many dossiers submitted under the EU's REACH legislation do not meet the regulatory data and information requirements. Similarly, while hazard classification criteria have been developed through the GHS for many (albeit not all) end points, harmonized hazard classifications for individual chemicals have not been achieved. Recent research has shown that the same chemical has been classified differently by different actors due to differences in data sets and interpretation of test results. Further efforts are therefore warranted to advance a global database of assessed and classified chemicals for information sharing and promoting harmonization of classifications. This would create efficiencies for all actors and benefit, in particular, countries with limited resources. [Part III, Ch. 1]

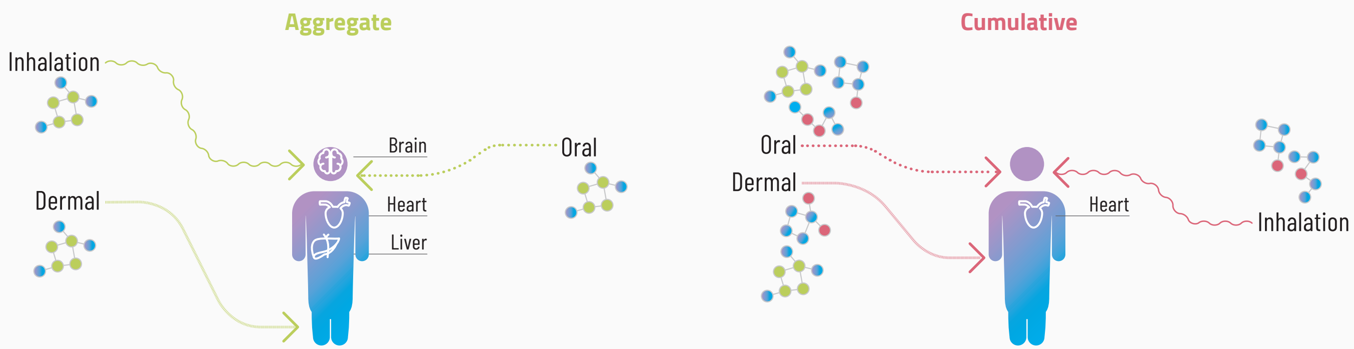
© UNITAR / Andrea Cararo, Labelling of containers in a leather chromium tanning factory

New hazard assessment approaches, such as the use of computer-based screening and grouping of chemicals, are promising developments, although further work is needed to fully replace animal testing. Beyond this, the sharing and mutual acceptance by countries or regions of hazard assessments, based on a globally agreed validation process, would create efficiencies. To facilitate knowledge sharing, mechanisms and platforms to share the growing knowledge about chemical hazards are advancing and provide valuable information, particularly for countries with limited resources. [Part III, Ch. 1]

Exposure assessment is context-specific, but can benefit from international resources

While exposure assessments are context-specific (regional, national, local), international resources to support these assessments are available. For example, generic exposure scenarios are available through the OECD. They can help obtain insights into local human and environmental chemical exposure models to estimate specific releases and exposures. Similarly, modelling-based exposure assessment approaches are being advanced that enhance knowledge about

Figure 18 The concepts of aggregate and cumulative exposure (adapted from US Environmental Protection Agency 2017b)



Aggregate exposure means exposure to the same substance from multiple sources and by multiple routes. Cumulative exposure means exposure to various chemicals and by multiple routes. [Part III, Ch. 2]

the distribution of chemicals in the environment and specific exposure situations. [Part III, Ch. 2]

However, further methodological work is needed to better understand the nature and magnitude of aggregate exposures across different sources of the same chemical, as well as cumulative exposures to various chemicals contained in one product and exposures resulting from various products. In this context, quantifying releases and exposures from chemicals in products, particularly in the indoor environment, has emerged as an important area for research. Progress in this area is often impeded by limited disclosure of chemical ingredients in products. [Part III, Ch. 2]

Refining chemical risk assessments methods to accelerate progress

A number of national, international and industry efforts have positively responded to the call of the WSSD in 2002 to advance chemical risk assessments. Legal and regulatory reform to accelerate chemical risk and safety assessment, have, for example, taken place in Australia, the EU, Canada, the Republic of South Korea and the US. In a number of countries, legislation has shifted the burden of proof from government to industry to show that – as is already the case for pesticides and pharmaceuticals in many countries – an industrial chemical is safe, rather than the regulator having to prove it has unreasonable risks. [Part III, Ch. 3]

The use of screening-level, generic risk-based approaches and grouping of chemicals with similar properties are all advancing as less complicated and more efficient chemical risk assessment approaches. To support efforts in countries with limited resources to undertake chemical risk assessments, various guidance tools are available, including for human health risks (WHO) and environmental risks (OECD). Other opportunities to improve or simplify risk assessment approaches include: [Part III, Ch. 3]

- considering weight of evidence and undertaking systematic reviews;
- defining clearly specific human and environmental protection goals;
- improving risk assessment for chemical mixtures and cumulative exposures;
- strengthening the integration of human health and environmental aspects in risk assessment;
- better linking of risk assessment and risk management;
- strengthening risk communication; and
- advancing solution-oriented approaches in risk assessment.

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Streamlining chemical risk management decision-making

While chemical risk management takes into account national and/or regional socio-economic considerations, common features of effective risk management are emerging internationally. For example, a necessary condition and first step for effective chemical risk management is to ensure that safety data sheets and chemical labels contain accurate and complete information, and that they are prepared according to the agreed GHS format. Proactive and pre-emptive risk management is particularly important in occupational settings, including in SMEs and the informal sector, which are of particular concern in developing countries and economies in transition. [Part III, Ch. 4]

Decision hierarchies are employed by risk managers in some cases, such as in occupational settings, for particularly hazardous chemicals, or in advancing risk minimization. These emphasize preventive management measures, such as substitution, taking into account the precautionary approach referred to in the 1992 Rio Declaration on Environment and Development and endorsed at WSSD in 2002. Similarly, in contexts where it is known that exposures are likely to be unacceptable (e.g. exposure of children to carcinogens through toys), regulators use science-based generic risk management decision-making to ensure adequate protection. Finally, socio-economic analysis in risk management that addresses both the costs of inaction and benefits of action is useful in decision-making. [Part III, Ch. 4, 6]

Box 7 Global knowledge-sharing and harmonization benefits all countries and saves resources

While opportunities exist to improve and further harmonize current approaches, there is great potential to share experiences and employ available chemical management tools and instruments more systematically, especially in countries with limited resources. Through a global capacity development and learning initiative, these tools and instruments could be shared more widely, including those featured in the IOMC Tool Box. All interested countries and stakeholders could be engaged to provide their context-specific experiences. For example, developing countries and economies in transition could benefit from the wealth of knowledge generated through hazard assessments undertaken and shared by more advanced countries, as well as by advancing their mutual acceptance. They could also benefit from information available through the use of generic exposure scenarios to obtain insights relevant in local exposure contexts without having to undertake full – and costly – exposure assessments themselves. [Part III]

Substitution with safer alternatives is becoming a driver for solutions and innovation

Momentum is growing to advance alternative assessment and informed substitution of chemicals of concern with safer chemical and non-chemical alternatives. Alternative assessment goes beyond conventional risk assessment and risk management, which tend to focus on reducing exposure to an acceptable level and evaluating “drop-in” replacements, often of the same chemical class and with the same hazard characteristics. Recent landmark regulations and policies promulgated in some countries or regions (e.g. the EU) include provisions for substitution. These examples could be replicated. In addition, some multilateral treaties (such as the Montreal Protocol and the Stockholm Convention) have played a critical role in driving substitution for selected chemicals of concern. Non-regulatory drivers are also providing momentum, including sustainable chemistry strategies by frontrunner retailers or coalitions of actors in chemical-intensive industry sectors such as the textile sector. However, additional and broader policies are needed to shape substitution in a direction that catalyses broader innovations, rather than merely providing a tool for replacing individual chemicals. [Part III, Ch. 5]

Box 8 Replacing highly hazardous pesticides through integrated pest management and non-chemical alternatives

A number of countries have undertaken successful initiatives to reduce the use of highly hazardous pesticides by relying on integrated pest management, an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides, including through the use of non-chemical alternatives. One success story is Cuba, which introduced changes in the management of agro-ecosystems, including use of biological agents, cultural changes, and focused application of other pesticides to phase out endosulfan. Another example is Costa Rica, where use of one or more non-chemical alternatives combined with reduced-rate application of non-HHP fungicides was found to be a feasible and affordable strategy to maintain yields while reducing use of HHPs. [Part III, Ch. 5]

© Simon Kovacic/Shutterstock, Gardening with circular planting beds, a typical feature of permaculture

Regrettable substitutions need to be avoided. These are substitutions which address risks of concern (e.g. toxicity to aquatic organisms) but cause other adverse impacts (e.g. are carcinogenic to humans). Regrettable substitution can be avoided through a functional approach which examines a range of chemical structures, technologies, product design options and non-chemical alternatives that are not restricted to finding another suitable chemical. Substitution with safer alternatives could be carried out in a stepwise process of incremental improvement, applying a number of solutions until the ultimate substitution has been achieved. [Part III, Ch. 5]

Recognizing the value of holistic sustainability assessment

Moving beyond human health and environmental aspects, life cycle assessment (LCA) tools help to foster a better understanding of broader sustainability considerations, covering all stages of the chemical and product life cycle, including social considerations. LCA approaches are increasingly used by companies to support sustainable supply chain risk management. They help avoid trade-offs, for example shifting the burden from one aspect of sustainability to another, from the present to the future, or from one stage of the life cycle

Table 6 Examples in the literature referring to regrettable substitution [Part III, Ch. 5]

Chemical of concern (function)	Hazard of chemical of concern	Substitute	Hazard of substitute
BPA (used in production of plastics)	Endocrine disruption	BPS, Bisphenol F	Endocrine activity
DEHP (plasticizer)	Endocrine disruption	Diisononyl phthalate	Carcinogenicity, possible endocrine disruption
Methylene chloride (solvent carrier in adhesives)	Acute toxicity, carcinogenicity	1-Bromopropane (nPB)	Carcinogenicity, neurotoxicity
Methylene chloride (brake cleaner)	Acute toxicity, carcinogenicity	n-Hexane	Neurotoxicity
Polybrominated diphenyl ethers (flame retardant)	Persistence, neurotoxicity, reproductive toxicity, carcinogenicity (penta and deca)	Tris (2,3-dibromopropyl) phosphate	Carcinogenicity, aquatic toxicity
Trichloroethene (metal degreasing)	Carcinogenicity	nPB	Neurotoxicity, carcinogenicity

to another. Relevant factors addressed include materials extraction; energy and water use during chemical synthesis and product manufacturing; the carbon footprint; chemicals' occurrence and behaviour in waste streams; and the prospects for recycling chemicals for renewed use. LCA approaches are therefore valuable in advancing sustainable materials management, non-toxic material flows and a circular economy. Choices about when and how to use these methods need to be made, taking into account available capacities and resources, supply chain requirements and the regulatory context, while avoiding "paralysis by analysis". [Part III, Ch. 7]

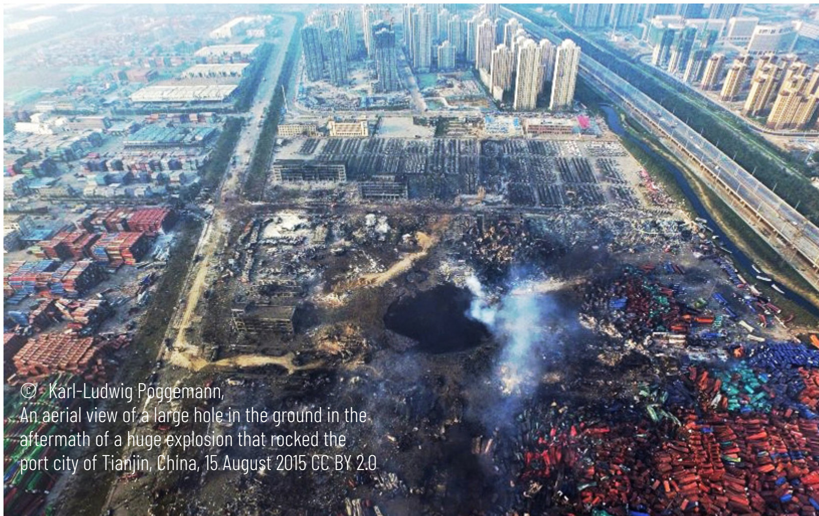
Using market-based instruments to advance substitution and innovation: getting the price right

Market-based instruments can help to correct negative externalities (i.e. unintended costs such as impairment of ecosystem services) that are caused by market failures and create incentives to reduce the use of undesired substances, fostering substitution and spurring innovation. A well-known example is the taxing of lead in gasoline, which has successfully encouraged a transformation to cleaner fuels. Examples of taxes to reduce the use of certain pesticides include one adopted in Mexico in 2013, based on the degree of acute toxicity, and a 2013 tax in Denmark based on environmental load. A number of other European countries have also implemented pesticide levies or taxes. [Part I, Ch. 8; Part IV, Ch. 6]

While the use of market-based instruments in advancing the management of hazardous chemicals and waste is still limited, it has the potential to increase. One option is to combine market-based instruments with command and control regulatory measures (such as prohibitions or restrictions) to accelerate the phase-in of alternatives until a substance is prohibited. An indirect way of correcting market failures is the use of a Sustainability Framework by the International Finance Corporation of the World Bank Group. It includes performance standards that are applied to all investments and clients whose projects undergo a credit review process. Finally, a particular challenge exists in reforming market distorting subsidy programmes that create incentives to use chemicals, for example the use of fertilizers to boost agricultural production. [Part IV, Ch. 6]

Taking preventive risk management action: chemical accidents and natural disasters

Chemical accidents in facilities and related accidental releases of hazardous substances continue to cause a large number of human fatalities, adverse effects on the environment and high economic costs. Accidents in the chemical sector, whether at fixed establishments or during off-site activities, also continue regularly both in developed and developing countries. Chemical



© Karl-Ludwig Poggemann, An aerial view of a large hole in the ground in the aftermath of a huge explosion that rocked the port city of Tianjin, China, 15 August 2015 CC BY 2.0

accidents can be caused by a range of technical and human factors, but also by natural disasters such as earthquakes, hurricanes, tsunamis, forest fires and floods, which may cause toxic chemicals to be widely disseminated in the environment and to mix with other hazardous substances. A number of these factors may be expected to increase in the light of climate change. International efforts are underway to facilitate a paradigm shift from managing chemical accidents to preventing them and integrating chemical accidents into broader emergency planning. To prevent future accidents, more systematic efforts are needed to raise awareness, strengthen oversight, share knowledge, and promote good practices. [Part I, Ch. 5, 7; Part III, Ch. 6]

Frontrunner private governance can drive risk management beyond compliance

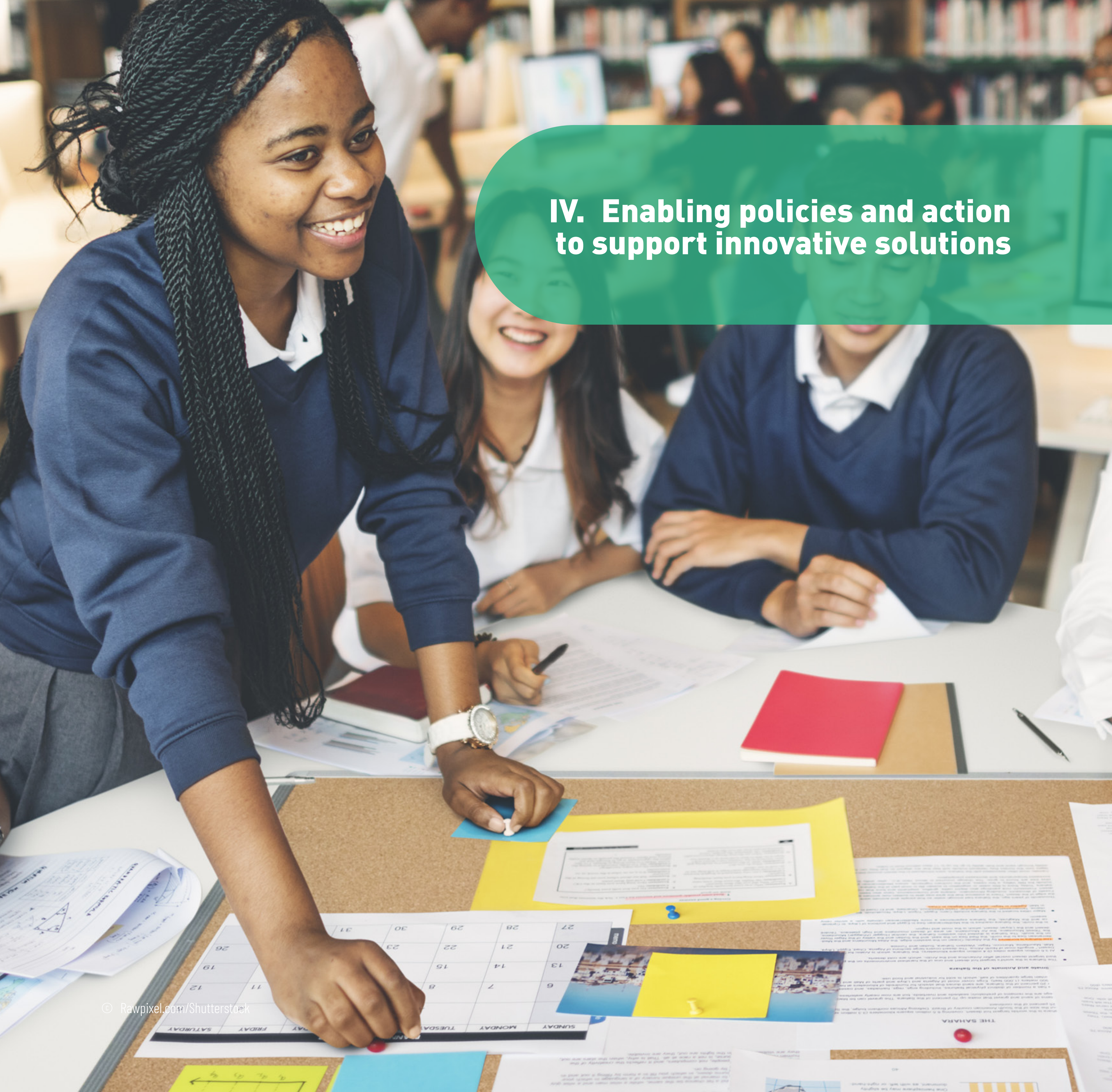
Concerted regulatory actions, non-regulatory strategies and voluntary industry initiatives beyond compliance may be mutually supportive. In many countries regulatory decision-making has stimulated companies to advance substitution, undertake sustainable innovations and become frontrunners. Given the complexity of global supply chains, and considering the limited regulatory capacity in many countries, frontrunner private sector action is important to advance sustainability globally. [Part III, Ch. 4]

Frontrunner initiatives in the private sector across the supply chain of chemicals and products may also go beyond compliance and address safety gaps, and is particularly essential when regulatory structures in countries are weak, as in many developing countries. While frontrunner initiatives and private governance are advanced through various and often specialized fora, opportunities exist to give private governance a more prominent role within a future approach on chemicals and waste management beyond 2020. Discussion in a global setting could showcase innovative initiatives, while challenging frontrunner actors by providing feedback from stakeholders. Placing these initiatives in a global policy context could enhance their legitimacy and encourage other actors to join, gradually creating a vision for universal participation. [Part III, Ch. 4; Part V, Ch. 3]

Box 9 The Greenlist™ Programme of S.C. Johnson

S.C. Johnson is a formulator of chemical-intensive products that are used in millions of households every day. The company does not produce the ingredients that go into their products. In 2001, it launched an innovative chemical classification process called Greenlist™ that rates raw materials based on their impact on the environment and human health. Greenlist™ scores are reported alongside performance and cost information in the company's chemical formulary, so that chemists can choose materials in consideration of their environmental and health properties. Using the scores, materials can be easily compared. Over time, most suppliers have embraced the protocol. Today the programme has evolved to a point where suppliers are designing new chemicals based on its criteria and proposing their chemicals to S.C. Johnson on the basis of Greenlist™ scores. [Part III, Ch. 4]

IV. Enabling policies and action to support innovative solutions



Advancing innovative solutions through enabling policies and action holds significant potential to reduce chemical pollution and exposures, thus complementing traditional action to achieve the sound management of chemicals and waste. Advancing a future chemistry that is fully sustainable requires the engagement of new actors and enabling policies and approaches, ranging from education reform, support for technology innovation and financing, to innovative business models, sustainable supply chain management and empowerment of citizens, consumers and workers through information and participation rights. [Part IV]

Imagining and shaping a future chemistry that is sustainable

A suite of innovations in chemistry have been developed, commercialized, or are on the horizon which illustrate the potential of chemistry to make a contribution to sustainable development. They range from chemistry processes that capture and transform carbon dioxide into new chemical feedstocks, to innovative building materials (e.g. transparent wood or green concrete), to catalysis innovations replacing toxic organic solvents with water solvents in pharmaceutical production. Research across the disciplines of chemistry, biology and computer science is equally promising. The 2018 Nobel Prize in Chemistry, for example, was awarded for path-breaking research on how chemists produce new enzymes, leading to new pharmaceuticals and cancer treatments and less waste. Another promising development is the use of advanced software and supercomputers to design molecules and assess properties of chemicals, including their hazards. These developments have significant potential to advance the sound management of chemicals and waste and complement other measures to achieve sustainable production and consumption. [Part IV, Ch. 1]

Yet, no matter how promising, these innovations in chemistry may cause unintended and undesirable effects. A prominent example from the past is the pesticide DDT, which has helped to fight diseases such as malaria. DDT was recognized, only years after it

Box 10 Towards a common understanding of sustainable chemistry

While the concept of "green chemistry" is elaborated through the well-known 12 principles that focus on safer and less resource intensive chemistry, "sustainable chemistry" is evolving as a more holistic complementary concept. Spearheaded originally by the OECD, recent discussions (e.g. by UNEA, the US Government Accounting Office and the International Sustainable Chemistry Collaborative Centre) have expanded the sustainable chemistry concept in a direction where chemistry is contributing to sustainable development across its three dimensions. Given the interest of stakeholders around the world in having a better understanding of this concept, further international work may be valuable to develop practical guidance on sustainable chemistry which could be widely promoted alongside green chemistry principles. Together these concepts could inspire research, policymaking and private sector action compatible with, and in support of, the 2030 Agenda for Sustainable Development. [Part IV, Ch. 1] began to be used, as a POP and probably carcinogenic to humans. It is therefore critical to screen chemistry innovations against the three dimensions of sustainable development and anticipate potential adverse impacts. Applying green and sustainable chemistry principles or considerations may be of value in driving innovation in the desired direction. [Part IV, Ch. 1]

Shifting mindsets through education in toxicology and green and sustainable chemistry

Ultimately, it will be chemists who need to come up with the inventions reaping the full potential of chemistry in supporting sustainable development. Scaling up chemistry research and innovation that integrates social,

Figure 19 **Number of papers published concerning green chemistry education or sustainable chemistry education, 1998-July 2017 (adapted from Clarivate 2018)**

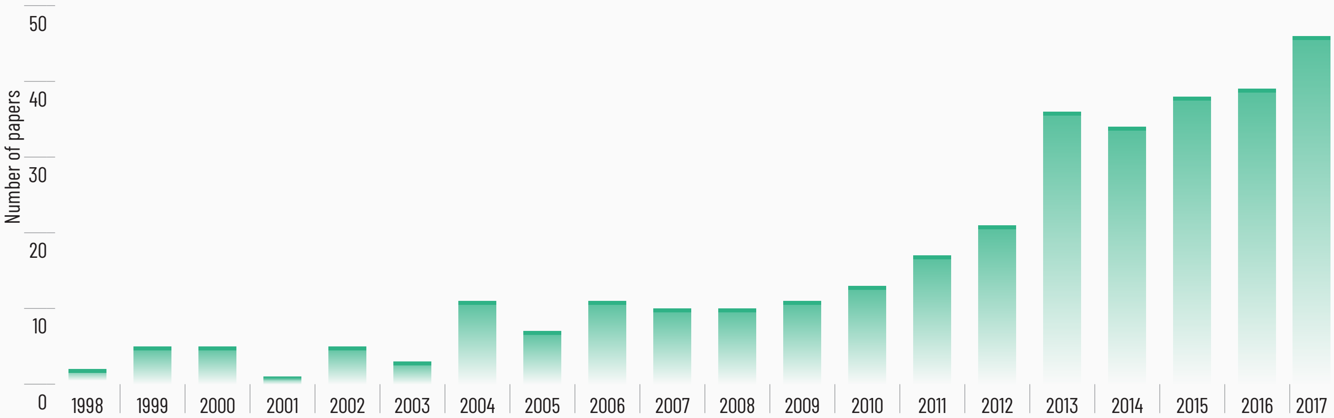
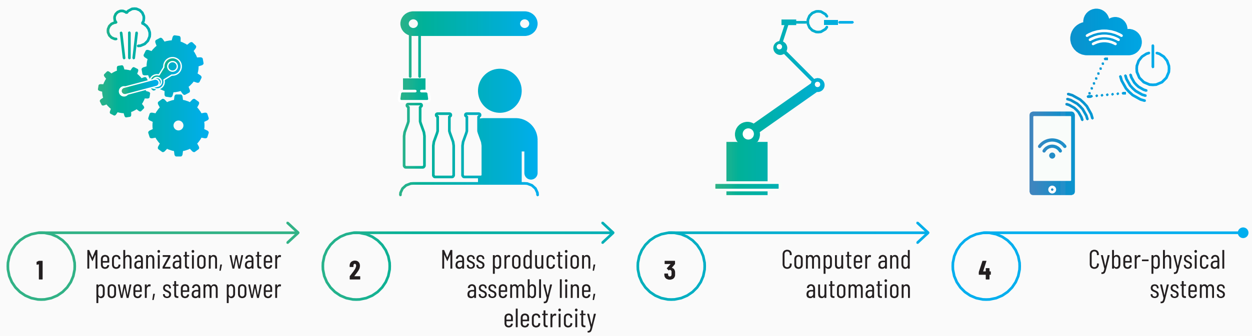


Figure 20 **The four industrial revolutions (adapted from Cisco 2017)**



The Fourth Industrial Revolution refers to a new era in the interface of industrial production, digitization and society which impacts a range of aspects of the chemical industry: how it innovates and produces; how it conducts business; how it engages with actors across supply and value chains; and its productivity and safety. While in the past there was a focus on the invention of new molecules, future innovations in chemistry, chemical safety and resource efficiency will likely be based on integrated solutions that are based on digital technologies. At the same time, digitization may also be associated with risks, such as possible cyberattacks. [Part IV, Ch. 1]

economic and environmental considerations requires the nurturing of a new generation of chemists. This can be achieved by integrating toxicology, green chemistry, sustainable chemistry and relevant topics of the 2030 Agenda for Sustainable Development in curricula at all levels, from primary education to tertiary education as well as professional education. [Part IV, Ch. 2]

To date, only a fraction of universities around the world have embraced green and sustainable chemistry education. The impact of these concepts in education is therefore still limited. However, green and sustainable chemistry is now taught in countries across all regions, creating opportunities for south-south collaboration. For example, the Indian Ministry of Education is piloting a programme in which all chemists take a one-year course in green chemistry. Such efforts could serve as an inspiration to scale up efforts in other countries. To support these efforts, an increasing number of relevant green and sustainable chemistry tools and materials are available for use at primary, secondary, tertiary and professional levels. [Part IV, Ch. 2]

Further action at all levels is needed to disseminate best practices in green and sustainable chemistry education and overcome barriers in academia and the private sector. Barriers to reform include professional and institutional resistance, professional conservatism, and lack of awareness among academic staff and policy-makers. Mainstreaming green and sustainable chemistry education therefore requires commitment and support from all stakeholder groups, including collaboration between academic institutions, chemical societies, Ministries of Education and the private sector. Existing national, regional and global networks can be used to disseminate best practices and exchange lessons learned. Building on existing initiatives, green and sustainable chemistry can be embedded as a critical element in wider efforts to integrate sustainability into education, such as the United Nations Educational, Scientific and Cultural Organization's initiative on sustainable education. [Part IV, Ch. 2]

Strengthening collaborative innovation for green and sustainable chemistry

Scaling up green and sustainable chemistry research and innovation is dependent on strengthening important elements of the innovation ecosystem. This ranges from a robust policy and regulatory framework driving innovation, to incentivizing research in chemistry that advances problem solving, to addressing sustainability challenges. Public research funding is particularly important during the early stages of the research and technology innovation process, including though blended financing mechanisms co-funded by the private sector. [Part IV, Ch. 3]

Box 11 Examples of green and sustainable chemistry start-ups

Start-ups play an important role in scaling up green and sustainable chemistry innovation across regions. Examples include the following:

- The winners of the 2018 Elsevier Foundation Green and Sustainable Chemistry Challenge, which come from Nepal and Italy, developed novel approaches to sourcing guava leaves and fish bones in order to create new preservatives and fertilizers.
- Entrepreneurs from Peru and Singapore use nanotechnology-empowered water purification filters.
- A Kenyan start-up is providing alternative building materials and products made from recycled plastics.

[Part IV, Ch. 3]

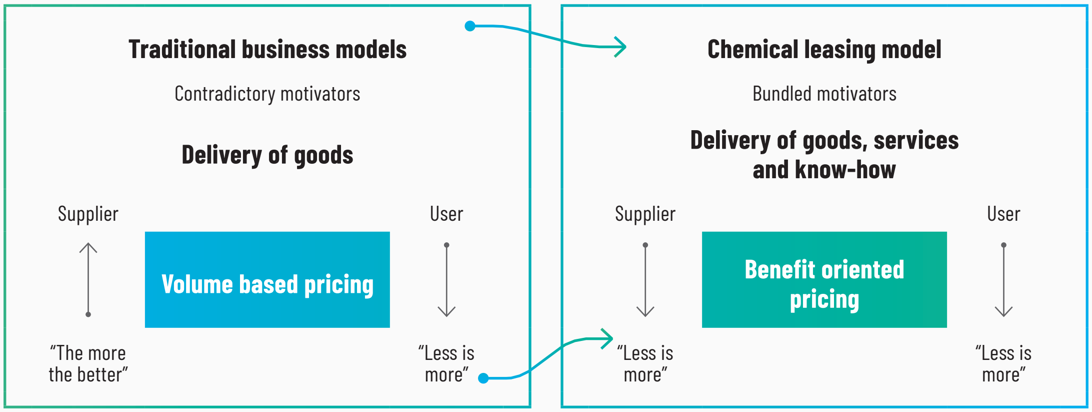
Start-up initiatives and young entrepreneurs play an important role in benefiting from the full potential of sustainable chemistry. To achieve this potential, it is important to support start-ups through various measures, ranging from university-based technology innovation offices, to providing conducive environments for start-ups in incubators and accelerators, to integrating sustainable chemistry considerations into green bonds, including those covering climate change mitigation. [Part IV, Ch. 3]

Collaborative innovation mechanisms have been shown to be effective in shaping research and innovation in a way that engages, and meets the needs of, a range of stakeholders. In designing new products in the textile sector, for example, collaborative innovation may include the chemical industry, chemistry start-up companies, designers, potential end-users, research institutes, and potential investors. Governments can support these efforts by integrating green and sustainable chemistry considerations into enabling policies, subsidy schemes or technology programmes supporting innovation consortia. [Part IV, Ch. 3]

Sustainable business models create opportunities

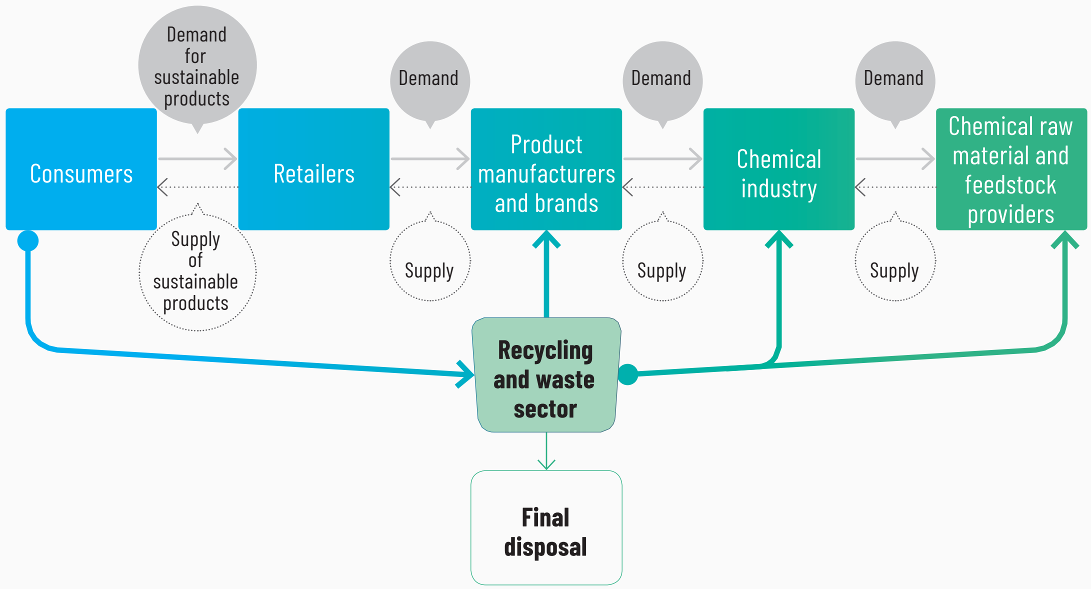
In a fast-changing world new business models emerge rapidly, with direct or indirect implications for the chemical industry and the sound management of chemicals and waste. Business models with a strong

Figure 21 Traditional business models vs. chemical leasing (adapted from Joas, Abraham and Joas 2018, p. 398)



Chemical leasing refers to a business model whereby suppliers sell services (e.g. number of cars painted) rather than chemicals, creating incentives to minimize the use of chemicals and maximize resource efficiency.

Figure 22 **Interface of demand and supply in driving the sustainability of chemicals in the supply chain**



Consumers and retailer play an important role in driving demand for safer chemicals and products. Vice versa, green and sustainable chemistry innovations can drive the development of safer chemicals and products "downstream" in the value and supply chains. Both "pull" and "push" approaches are important and can complement each other.

focus on sustainability and circularity include green product- and process-based models, waste regeneration systems, efficiency optimization, management services and industrial symbiosis models. Of specific interest for the chemical industry are industrial parks, which provide common services (e.g. energy and waste management) to various production facilities, enhancing resource efficiency and environmental performance. Joining these parks may be valuable in particular for SMEs, which could benefit from proximity to larger facilities. [Part IV, Ch. 4]

Chemical leasing (Figure 21) has been recognized as an effective service-oriented business model with the potential to advance sustainability within supply chains. Under this scheme, suppliers sell services (e.g. number of cars painted) rather than chemicals, which creates incentives to minimize the use of chemicals and maximize resource efficiency. A successful example was implemented in Colombia, where the introduction of a chemical leasing scheme in the petroleum industry in the field of water treatment resulted in a 20 per cent reduction in chemical consumption, while at the same time reducing water treatment costs by 80 per cent. At the international level, the 2016 Declaration of Intent on Chemical Leasing has been signed by Austria, Germany and Switzerland, El Salvador, Sri Lanka and Serbia. Additional countries may consider joining. [Part IV, Ch. 4]

Scaling up effective corporate governance and sustainable supply chain management

A growing number of retailers, product manufacturers and chemical companies have included sustainability objectives, sustainable supply chain management (Figure 22) and extended producer responsibility in their corporate policies. Industry action to advance the transparent flow of relevant information on chemicals and materials throughout the supply chain is also gaining momentum. Yet universal implementation of these initiatives has not been achieved. Relevant measures to be taken include: scaling up voluntary standard-setting beyond compliance; harmonizing chemical management protocols across industry sectors (e.g. on full material disclosure and labelling of products); using LCA tools, metrics and reporting to address the sustainability of products throughout their life cycle; and scaling up the design of safer and more sustainable products and production processes. Promoting the engagement of (and developing capacity in) the recycling sector is important, so that secondary raw materials going back into the circular economy are safe and sustainable. It is equally relevant to recognize the role of informal actors at various stages in the supply chain. Unless the measures described above (and others) are put in place, companies may face significant economic risks (Box 12). [Part IV, Ch. 4, 6-7]

Box 12 The benefits of thorough due diligence during mergers and acquisitions

Companies undertaking mergers and acquisitions in the chemical value chain stand to benefit from thorough due diligence that takes into account environmental and human health factors. Recent cases illustrate the risk of potential financial liabilities associated with mergers and acquisitions. A multinational consumer goods company, for example, had to pay significant fines in 2018, and set up a US dollars multi-million compensation fund, after it acquired a company whose humidifier sterilizing products were linked to lung disease cases and ca. 100 deaths. Similarly, multinational companies recently experienced heavy losses in stock values in the range of billions of US dollars, or had to pay significant compensation, following allegations of lack of diligence or unsound management practices. A comprehensive due diligence therefore helps to identify potential risks and to internalize potential costs associated with liabilities in the price of the acquisition. [Part I, Ch. 1]

Using metrics to track progress and increase accountability

The use of a variety of private sector metrics to assess the sustainability performance of companies and producers in the chemical industry and downstream sectors is gaining momentum for a range of reasons, including public demand. Examples in the chemical industry include reporting under Responsible Care® as well as by individual companies, such as Sumitomo Chemical Group. Self-assessment and reporting is also ongoing in downstream sectors, such as under the ZDHC initiative, where compliance rates are being made publicly available. Companies also choose to engage with external bodies, such as the Cradle to Cradle Product Standard and the Chemical Footprint Project. Furthermore, independent external assessments are undertaken, for example through the Mind the Store initiative. Investor interest in corporate sustainability performance is also growing. Under the Dow Jones Sustainability Index, chemical suppliers and downstream companies are requested to provide information on the percentage of their products that contain certain hazardous substances. [Part IV, Ch. 7]

Stakeholders can take further steps to increase transparency and rigour, thereby ensuring metrics meet quality standards, are fit for purpose and audience, and address all dimension of sustainability. Sustainability reporting by all chemical and downstream industries could be scaled up using harmonized methods and indicators. Opportunities exist to further (and more comprehensively) integrate chemicals and waste issues into existing and widely used private sector metrics and reporting schemes (e.g. the Global Reporting Initiative). Private sector metrics and sustainability reporting could also become an important aspect of measuring progress in a beyond 2020 framework. Bringing together relevant stakeholders to advance a common understanding of metrics, including with respect to the sustainable

Box 13 The ToxFox application, a consumer product check for harmful substances (BUND 2018)

ToxFox is a smartphone app by Friends of the Earth Germany which provides information about endocrine-disrupting chemicals in cosmetics and allows users to submit Substances of Very High Concern (SVHC) inquiries. It has a continuously growing database, in which suppliers' responses are saved. Suppliers can also enter data about the SVHC content of their articles. The AskREACH mobile app, similar to the ToxFox app, is scheduled to be launched in April 2019. It will be available throughout Europe and may be adapted for use in each EU Member State. [Part IV, Ch. 8] chemistry concept, would enhance transparency and credibility. [Part IV, Ch. 7]

Empowering workers, citizens and consumers: information and rights-based approaches

Providing enhanced access to robust information by workers, citizens and consumers, as well as fostering understanding thereof, is a prerequisite for ensuring effective public participation and informed decision-making and thus achieving the sound management of chemicals and waste. Protecting workers includes ensuring they have access to chemical hazard and safety information. Providing citizens and consumers with robust information on hazardous chemicals in products in line with the GHS allows them not only to protect themselves, but also to shape demand for safer and more sustainable products, relevant government policies, and action in the private sector.

New information tools, such as the smartphone apps ToxFox and AskReach (Box 13), are available to engage citizens in accessing, collecting, processing and sharing knowledge relevant for chemicals and waste, e.g. on high levels of occupational exposure. More efforts are needed to promote access to and understanding of this information, particularly in developing countries and economies in transition, including through campaigns and training programmes for workers. Access to information, public participation, and access to justice also allow citizens, consumers and workers to engage, e.g. by invoking the duties of states under relevant multilateral treaties, and to protect their own and future generations' rights to a healthy environment. [Part IV, Ch. 8]

Strengthening the interface of chemicals and waste management and human rights

The use of human rights-based approaches complements and provides a back-up to legislative and regulatory measures in ensuring protection and access to effective remedies. Under a number of international human rights instruments, countries have a duty to protect human rights and businesses have a responsibility to respect human rights, including those threatened by the presence of hazardous chemicals and waste. Every country has recognized one or more of the human rights that are directly or indirectly implicated by the management of chemicals and waste. For example, virtually every country has ratified the UN Convention on the Rights of the Child, which recognizes the right of the child to the highest attainable standard of health and requires that states shall take appropriate measures to combat disease and malnutrition, taking into consideration the dangers and risks of environmental pollution. [Part IV, Ch. 8]

Since 1995, the UN Commission on Human Rights and its successor, the UN Human Rights Council (HRC), have mandated a Special Rapporteur to report on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes. In 2011, the HRC affirmed "that the way hazardous substances and wastes are managed throughout their lifecycle, including manufacturing, distribution, use and final disposal, may have an adverse impact on the full enjoyment of human rights". Protecting the rights of workers, citizens and consumers, including the right-to-know and the right to have access to justice, including effective remedies, is therefore critical in protecting them and allowing them to seek remedies. [Part IV, Ch. 8]

Research recently undertaken within the mandate of the Special Rapporteur suggests that human rights violations and abuses caused by chemical pollution are still prevalent. In an August 2018 report to the HRC, the Special Rapporteur recommended that "States must ensure that legislation and other practices reflect their duty to respect, protect and fulfil human rights obligations implicated by hazardous substances and wastes [...] [and] that victims of the effects of hazardous substances and wastes have access to an effective remedy", further noting that "the right to information is critical in the context of toxics". A subsequent report in October 2018 explored opportunities to further integrate the human rights dimension of chemicals and waste into the beyond 2020 framework. [Part IV, Ch. 8]

Furthermore, in 2018 the Special Rapporteur proposed 15 principles to help Governments and businesses better protect human rights with respect to exposure to hazardous chemicals. They broadly cover the responsibilities and duties of businesses and Governments; worker access to information; and "remedies" to hold those who violate workers' rights accountable. These principles are relevant to strengthening chemicals and waste management beyond 2020. Some companies, including in the chemical industry (e.g. BASF and Merck), have already committed to respect human rights along the lines of the UN's Guiding Principles on Business and Human Rights. Other companies may consider following suit. [Part IV, Ch. 8]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V. Scaling up collaborative action under the 2030 Agenda for Sustainable Development

The period up to the conclusion of the intersessional process by 2020 provides a brief but critical window in which to develop a comprehensive global framework, featuring ambitious priorities and coherent indicators. This can be achieved by enhancing commitments by current stakeholders and increasing the engagement of new actors. The 2030 Agenda presents a range of opportunities for scaling up collaborative action to achieve the sound management of chemicals and waste, including through the integration of chemicals and waste considerations into relevant sector policies and action plans. [Part V]

Figure 23 Linkages between chemicals and waste management and the Sustainable Development Goals (based on IOMC 2018, p. 3)

The sound management of chemicals and waste can provide practical solutions to achieve a number of Sustainable Development Goals. [Introduction; Part V, Ch. 1-2]

Using the SDGs and targets to stimulate integrated action beyond 2020

The sound management of chemicals and waste cuts across the 17 SDGs. It is a crucial element underpinning the implementation of the 2030 Agenda, as chemicals and waste affect many aspects of development. This is reflected, directly or indirectly, in a number of goals and targets. Providing a global vision that brings together all countries and all stakeholders, the 2030 Agenda presents an opportunity for collaborative action at all levels to achieve the sound management of chemicals and waste. SDG Targets 12.4 and 3.9 are at the core of the sound management of chemicals and waste. Equally important, a number of SDGs and targets relevant for chemical-intensive sectors cannot be achieved without due consideration of the sound management of chemicals and waste, such as those concerning access to food, clean energy and safe housing. Furthermore, achieving a range of SDGs and targets is essential to establish an enabling environment for the sound management of chemicals and waste, including those concerning access to information, education and financing. [Introduction; Part V, Ch. 1-2]

The 2030 Agenda provides a renewed opportunity to mainstream chemicals and waste management in national development planning. Linkages exist with ending poverty (SDG 1); promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (SDG 8); climate action (SDG 13); and others. Such linkages can facilitate the inclusion of chemicals and waste management considerations in national and sub-national budgeting and the allocation of national financial resources, in line with the integrated approach to financing. Equally important is the integration of chemicals and waste management considerations in international development assistance and capacity building (SDG Targets 17.6 and 17.8). [Part V, Ch. 1-2]

Strengthening chemicals and waste management programmes

Although significant progress has already been made, major gaps remain with respect to implementation of the 2020 goal. SDG Targets 12.4 and 3.9 are at the core of the sound management of chemicals and waste, and are the drivers for developing and implementing effective and integrated systems and programmes for the sound management of chemicals and waste covering all stages of the life cycle. The development of basic legislation and institutional capacity, in line with the overall orientation and guidance and its 11 basic elements, have been recognized under SAICM as critical at the national and regional levels to the attainment of sound chemicals and waste management. The elements range from the establishment of legal frameworks that address the life cycle of chemicals and waste, to industry participation and defined responsibility across the life cycle, to the development and promotion of environmentally sound and safer alternatives, to mention only some. [Parts I-II; Part V, Ch. 2]

Integrating chemicals and waste in sector policies and actions

The 2030 Agenda provides a renewed opportunity to strengthen inter-ministerial coordination mechanisms and integrate chemicals and waste considerations into

Table 7 **Integrating chemicals and waste management, and green and sustainable chemistry innovation, in relevant sectors: some opportunities [Part V, Ch. 2]**

Sectors	SDG targets	Examples of opportunities for management and innovation
Agriculture and food	Target 2.4: sustainable food production	Scale up IPM and agro-ecological approaches, including development and use of non-chemical alternatives and other good agricultural practices
Health	Target 3.8: safe medicines and vaccines	Sound management of pharmaceuticals and disinfectants that contribute to antimicrobial resistance
Energy	Target 7.a: clean energy research and technologies	Improve technologies using resource-efficient, sustainable materials when decarbonizing the energy sector
Infrastructure	Target 9.1: sustainable infrastructures	Reduce raw material use and waste generation via advanced materials without creating future legacies
Industry	Target 9.2: sustainable industrialization	Ensure that chemical-intensive industries rely on best available techniques and best environmental practices
Housing	Target 11.1: safe housing	Reduce indoor air pollution through safer insulation and replace building materials of concern (e.g. asbestos)
Transport	Target 11.2: sustainable transport systems	Advance clean mobility, for example based on sustainable chemistry solutions for batteries
Tourism	Target 8.9: sustainable tourism	Adopt practices to reduce the chemical footprint of tourism services
Mining	Target 12.2: Sustainable use of natural resources	Ensure environmentally sound management of tailings
Labour	Target 8.8: safe working environments	Enhance risk assessment of chemicals of concern while promoting investment in green and sustainable chemistry to reduce hazardous occupational exposures
Education	Target 4.7: education for sustainable development	Mainstream green and sustainable chemistry into relevant curricula
Finance	Target 17.3: financial resources from multiple sources	Enhance use of green and sustainable chemistry metrics as criteria in investment

The list of opportunities, targets and sectors in this table is not exhaustive. Other relevant sectors include (but are not limited to) technology and innovation, trade, development cooperation, and justice.

relevant sectors, including enabling policies and actions, such as education (SDG Target 4.7), innovation (e.g. SDG Target 9.5) and financing (SDG Target 17.3). In developing effective sectoral policies and actions, relevant Ministries may benefit from considering linkages with relevant international agreements on chemicals and waste. The IOMC participating organizations can also play a valuable role in facilitating the development of sectoral strategies, as well as establishing and strengthening communication channels. [Part V, Ch. 2]

Concerned Ministries, working closely with respective policy communities, may consider initiating a structured approach which could include the following considerations, among others: [Part V, Ch. 2]

› Identify industry sectors where chemicals and waste issues cause concern, including hot spots.

› Engage concerned industry sectors, associations and groups to initiate a dialogue.

› Ensure hazard and risk communication according to the GHS. Identify risk management approaches and opportunities for safer alternatives.

› Consider sectoral policy reform and standards to encourage sustainable chemistry innovation.

A coherent and results-oriented global indicators and reporting framework is needed

The development of a framework for chemicals and waste beyond 2020 provides an opportunity to create linkages across all relevant agreements and initiatives related to chemicals and waste management. Of particular value would be a comprehensive framework bringing together and complementing chemicals and waste multilateral treaties and other relevant instruments and initiatives, without interfering in matters addressed though these specialized instruments. An overarching common vision, strategic goals (or strategic objectives), targets and indicators to achieve sound management of chemicals and waste could provide a common agenda, guiding actions towards a desirable future in line with the 2030 Agenda. Valuable lessons can be learned from the development of the Aichi Targets and the Strategic Plan for Biodiversity 2011-2020, which created an integrated and coherent international framework endorsed by all stakeholders in the biodiversity cluster. Private sector metrics and sustainability reporting could add further value and become an important aspect of measuring progress. [Part II, Ch. 2; Part IV, Ch. 7; Part V, Ch. 2]

Linked to national initiatives, reporting schemes can become simpler, country-driven and linked to global targets and milestones. Making reporting more meaningful could be achieved by using reporting data more systematically to monitor progress over time and across countries, identify best practices, and inform capacity-building measures. Useful examples include the WHO IHR model, reflecting progress with core capacities over time, and the Aichi Targets, which provide a reference point for developing National Biodiversity

Table 8 Example of a results chain to minimize adverse impacts [Part V, Ch. 2]

Activities →	Outputs →	Outcomes →	Impact
› Develop GHS awareness-raising and capacity-building material › Prepare an implementation strategy for the GHS in key sectors	› GHS standards and regulation developed › Key stakeholders trained and have capacity to implement the GHS	› GHS labels and safety data sheets available at the workplace › Companies and workers take precautionary measures	› Reduced number of deaths and illnesses among workers and minimized impacts on the environment

Implementation of the GHS is a necessary but in many cases not sufficient measure for reducing the number of deaths and illnesses among workers and minimizing impacts on the environment.

Action Plans. Consolidating reporting mechanisms and data from various instruments, focusing on a limited number of indicators and making data available at the global level, as is done, for example, in the case of the Global Health Observatory, would help to ensure accountability, track progress, engage stakeholders and identify good practices. [Part II, Ch. 2; Part V, Ch. 2]

A coherent framework would benefit from distinguishing between outputs (e.g. adoption of legislation) and impacts (e.g. reduction of adverse impacts from hazardous chemicals), where possible using impact indicators as the ultimate benchmark to determine whether interventions are successful. Most indicators currently used to monitor progress under international chemicals and waste agreements are output-, activity- or instrument-based, making it difficult to assess progress in protecting human health and the environment from the adverse effects of chemicals and waste. In developing the framework, consideration also needs to be given to impact-focused targets in the 2030 Agenda. Concerning activity and output indicators, work under SAICM could serve as a starting point. Table 8 provides an example of indicators distinguishing between activities, outputs, outcomes and impacts to illustrate such a results chain. Further thinking could explore a comprehensive framework at the national level, as well as the interface of such a framework with tracking of progress at the global level. [Part II, Ch. 2; Part V, Ch. 2]

Engaging key sectors and actors will be crucial in chemicals and waste management beyond 2020

The 2030 Agenda is built on the premise that sustainable development can only be achieved by bringing together all countries and stakeholders. SDG 17, calling on the global community to revitalize the global partnership for sustainable development, provides a framework for facilitating the engagement and ownership of actors beyond the chemicals and waste community (including actors in key economic and enabling sectors), some of which have so far not been sufficiently engaged, both nationally and at the international level. [Part V, Ch. 1-3]

To advance ambitious and concerted commitment, a global framework to stimulate collaborative action for the sound management of chemicals and waste would need to create mechanisms and incentives to foster commitment, engagement and collaborative action of key actor groups, including: [Part V, Ch. 3]

- **key economic and enabling sectors**, for example by developing national sectoral strategies in close collaboration with relevant Ministries, embedded in a global framework featuring overarching international sectoral strategies, e.g. with a yearly focus;
- **companies, industry groups, and trade associations**, for example by creating a platform for frontrunner retailers and downstream manufacturers excelling through innovative action to showcase achievements and stimulate a race to the top;
- **workers' organizations**, for example by promoting discussion and the exchange of good practices related to training and hazard identification, as well as on potential strategies towards the promotion of green jobs and decent work in the sector;
- **civil society groups**, for example by reaching out to organizations active at the local, national, regional and global level that have not traditionally been engaged on chemicals and waste but can offer capacities and work on topics with strong linkages;
- **the academic and research community**, for example by ensuring that concrete reward structures are in place for scientists to provide targeted and tailor-made input for chemicals and waste policy-making or by inviting scientists to speak at relevant fora more systematically;
- **the donor, investor and financial community**, for example by exploring and communicating linkages of chemicals and waste with other priority topics of national and international donors (e.g. climate change and biodiversity) and by mobilizing new business angels and investors to consider green and sustainable chemistry in their investment criteria; and
- **leaders in the media and the general public**, for example by providing journalists with key messages in simple language and of interest to a broad audience, or by implementing social media campaigns.

Results-based stakeholder action plans, roadmaps and accountability beyond 2020

To facilitate commitment, ownership, mutual accountability and collective tracking of progress to achieve the sound management of chemicals and waste, countries and all relevant stakeholders could develop, implement and share, internationally, results-based action plans and roadmaps to accelerate progress towards achieving the sound management of chemicals and waste. Within the framework of a beyond 2020 mechanism, action plans and roadmaps could be prepared in a collaborative manner by countries, industry sectors (e.g. the chemical industry, chemical-intensive downstream sectors, retailers, the recycling industry), civil society organizations, the IOMC, academia and others. They could also be prepared at the thematic level and involve several stakeholders (e.g. for an initiative to fill data gaps to understand the hazard potential of chemicals). [Part V, Ch. 3]

Stakeholders could pledge and showcase their action plans and roadmaps within the beyond 2020 framework and benefit from the input of other stakeholders (which might take different forms, such as peer review). Pledges could be reviewed globally against agreed goals and targets, with adjustments made as appropriate. Collectively, these action plans and roadmaps would provide an indication of commitments and allow assessing the extent collaborative action succeeds in making the needed progress to achieve the sound management of chemicals and waste. There are examples of road maps already prepared addressing the sound management of chemicals and waste management, or certain aspects of it, which could serve as a source of inspiration. Examples include the World Business Council for Sustainable Development Chemical Sector SDG Roadmap or the WHO Chemicals Road Map. This proposed "roadmap" approach would be compatible with, and also take into account experience gained in other international fora, such as climate change. Those have evolved to include a more flexible, yet results-oriented and mutually accountable approach to compile commitments and action taken, with international tracking of progress and adjusting of ambition, as appropriate. [Part V, Ch. 3]

Box 14 Strengthening engagement of scientists and the science-policy interface

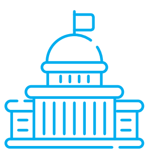
Opportunities exist to provide better and more coherent scientific information for policy-making. This can be achieved, for example, by taking steps towards cost-effective harmonization of data generation and collection, and respective research protocols (e.g. on releases and biomonitoring), strengthening monitoring and surveillance capacities (including those of medical professionals), and sharing data more systematically at all levels. Industry has a critical role and responsibility in regard to generating and disseminating relevant data. Further approaches and mechanisms could be developed to strengthen two-way communication, support collaboration between the scientific community and policy-makers, and develop a problem-solving oriented research agenda and protocols on priority topics.

Stakeholders could find value in further exploring methodologies that facilitate more systematic and science-based identification of future priorities at the international level, for example by using information on health and environmental impacts and harm caused, and by drawing on information from risk assessments. Improved science-policy interaction can also help identify issues early on; set priorities; and determine the corresponding specific and measurable targets that guide their implementation. [Part I, Ch. 1, 5-9; Part II, Ch. 1, 3-4; Part III, Ch. 2-3; Part V, Ch. 3]

Annex: actions up to and beyond 2020 identified through the GCO-II

As a contribution to strengthening the implementation of the sound management of chemicals and waste and minimizing their adverse impacts, the GCO-II identified the following actions, grouped under ten topics. They were derived based on a review of the implementation of the 2020 goal to date, and responding to the UNEA mandate to provide options for implementation of actions to reach relevant SDGs and targets up to and beyond 2020.

1. Develop effective management systems



Address prevailing capacity gaps across countries, strengthen national and regional legislation using a life cycle approach, and further strengthen institutions and programmes by:

- promulgating, aligning and enforcing legislation and policies, including full implementation of the GHS, promulgating legislation for industrial and consumer products, and taking measure to address illegal international traffic; and
- integrating chemicals and waste considerations into national and sectoral policies (e.g. agriculture, housing, transport and energy) to implement specific SDG targets.

Main actors: *Governments, IOMC, international and regional economic integration organizations*

Relevant chapters include: Part II, Ch. 3, 6; Part III, Ch. 1; Part V, Ch. 2

2. Mobilize resources

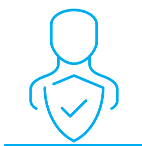
Scale up adequate resources and innovative financing for effective legislation, implementation and enforcement, particularly in developing countries and economies in transition, by:

- scaling up efforts to integrate chemicals and waste management into national and sectoral budgets;
- facilitating adequate external technical assistance, financial support and technology transfer to address issues causing greatest harm, including through new and innovative financing (e.g. fiscal incentives, cost recovery instruments, green bonds, venture capital); and
- strengthening the integrated approach to financing through assessing its effectiveness and renewed commitment across all three components (mainstreaming, industry involvement, and dedicated external financing).

Main actors: *Governments, the private sector, civil society, the financial sector and investors*

Relevant chapters include: Part II, Ch. 3, 6; Part IV, Ch. 3, 5; Part V, Ch. 2

3. Assess and communicate hazards



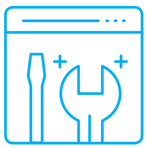
Fill global data and knowledge gaps, and enhance international collaboration to advance chemical hazard assessments, classifications and communication by:

- sharing existing hazard data and assessments globally, and increasing the mutual acceptance of testing data and hazard assessments across countries based on accepted methods and scientific criteria;
- developing a global database of assessed and classified chemicals for information-sharing and promoting harmonization of classifications; and
- setting targets to fill data gaps to fully understand globally the hazards of substances in commerce, and assessing progress.

Main actors: *Governments, the private sector, IOMC, international and regional organizations, academia*

Relevant chapters include: Part II, Ch. 3, 6 Part III, Ch. 2

4. Assess and manage risks



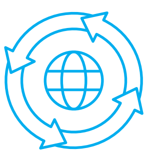
Refine and share chemical risk assessment and risk management approaches globally to promote safe and sustainable use of chemicals and address emerging issues throughout the life cycle by:

- sharing knowledge on existing risk assessment and management approaches and tools (e.g. exposure scenarios) more widely;
- further developing and refining exposure, risk assessment and LCA methods; and
- taking into account and benefiting from opportunities for accelerated and effective risk management, such as placing the burden of proof on producers, advancing informed and non-regrettable substitution of chemicals of high concern, and using generic risk-based approaches, when possible.

Main actors: *National and regional agencies, IOMC, academia, the private sector*

Relevant chapters include: Part II, Ch. 3-6; Part III, Ch. 1-7

5. Use life cycle approaches



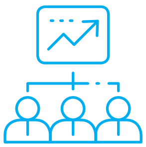
Advance widespread implementation of sustainable supply chain management, full material disclosure, transparency and sustainable product design by:

- promoting wide implementation of corporate sustainability and sustainable procurement policies;
- developing harmonized approaches across sectors to share chemical information and to advance full material disclosure across supply chains, including chemical-intensive industry sectors and the recycling/waste sector;
- strengthening collaboration by all actors in the supply chain in designing and using safer chemicals and sustainable products; and
- promoting the integration of chemicals and waste considerations into corporate sustainability metrics and reporting.

Main actors: *The private sector, Governments, IOMC, international organizations*

Relevant chapters include: Part I, Ch. 4; Part II, Ch. 4; Part IV, Ch. 6-7

6. Strengthen corporate governance



Enable and strengthen chemicals and waste management aspects of corporate sustainability policies, sustainable business models, and reporting by:

- encouraging private sector frontrunner action to further develop voluntary standards that exceed basic compliance, and reviewing their effectiveness through interested stakeholders;
- promoting sustainable business models, such as chemical leasing and eco-industrial parks; and
- enhancing systematic use by investors of corporate sustainability and chemical footprint reporting, covering chemicals and waste management performance.

Main actors: *The private sector, Governments, international organizations, the financial sector and investors*

Relevant chapters include: Part II, Ch. 3-4, 6; Part III, Ch. 4; Part IV, Ch. 4, 7

7. Educate and innovate

Integrate green and sustainable chemistry in education, research, and innovation policies and programs by:

- reforming chemistry curricula in tertiary, secondary, primary and professional education;
- scaling up research initiatives, and technology innovation policies and programmes, that advance green and sustainable chemistry, particularly for start-up companies; and
- facilitating a better global understanding of green and sustainable chemistry concepts.

Main actors: *Governments, academia, international organizations, green and sustainable chemistry networks, the financial sector and investors, civil society, the private sector*

Relevant chapters include: Part IV, Ch. 1-3

8. Foster transparency

Empower workers, consumers and citizens to protect themselves and the environment by:

- disclosing robust and understandable information about hazardous chemicals in the supply chain to workers, consumers, citizens and communities;
- scaling up innovative programmes and technology applications to facilitate a better understanding by individuals of chemical and waste risks, and engaging citizens in data collection through citizen science;
- promoting and supporting meaningful and active participation by all actors of civil society, particularly women, workers and indigenous communities, in regulatory and other decision-making processes that relate to chemical safety; and
- taking action so that citizens have ready access to justice.

Main actors: *Governments, the private sector, civil society, citizens, workers, consumers*

Relevant chapters include: Part I, Ch. 4; Part II, Ch. 4; Part III, Ch. 1, 6; Part IV, Ch. 8

9. Bring knowledge to decision-makers

Strengthen the science-policy interface and use of science in monitoring progress, priority setting (e.g. for emerging issues), and policy making throughout the life cycle of chemicals and waste by:

- taking steps to harmonize scientific research protocols (e.g. for biomonitoring);
- developing science-based criteria to identify emerging issues at the international level, taking into account harm (e.g. using health impact information) and monitoring their implementation;
- providing research funding to fill identified gaps and priorities;
- developing a study on the global costs of inaction, and benefits of action, on chemicals and waste management, comparable to the Stern Review on the Economics of Climate Change; and
- developing and improving institutional mechanisms to improve knowledge generation and management.

Main actors: *Governments, academia, IOMC, international organizations*

Relevant chapters include: Part I, Ch. 1-8; Part II, Ch. 3, 6

10. Enhance global commitment

Establish an ambitious and comprehensive global framework for chemicals and waste beyond 2020, scale up collaborative action, and track progress by:

- developing an aspirational, overarching and widely owned global framework that encourages engagement by all relevant stakeholders; developing global targets, milestones and indicators that distinguish between outputs and impacts;
- providing opportunities for sharing internationally, and for input or peer reviews, action plans and roadmaps by stakeholders under a beyond 2020 framework;
- considering how corporate sustainability metrics and reporting can play a stronger role in measuring progress in a beyond 2020 framework; and
- monitoring, tracking and reviewing collective action and progress and making adjustments in regard to ambition, as needed.

Main actors: *All stakeholders participating in the intersessional process on beyond 2020*

Relevant chapters include: Part II, Ch. 2; Part IV, Ch. 7; Part V, Ch. 1-3

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