# Managing chemicals for sustainable development

## Introduction

SEI research on chemicals spans international chemicals policy, strategies to manage chemicals at the national level, and local effects on ecosystem services, drawing on both natural and social science. This brief highlights some key insights from SEI's work in recent years and outlines ideas for future research.

Global chemical production is growing rapidly. From 2000 to 2010 total chemical production is estimated to have increased by over 50%, driven by growing demand especially in developing countries and countries with economies in transition. Looking ahead, continued significant increases in production and use are predicted (UNEP 2013b). The benefits to society from the wide variety of chemicals used in products of different kinds are indisputable, as are the risks to human health and ecosystems associated with exposure to hazardous substances, which also result in heavy economic costs to society (UNEP 2013a). The risks arise from direct exposure in connection with use and emissions of chemicals, and indirect exposure from long-range transport and accumulation in the food web.

Poverty is a risk factor for chemical exposure and there is a significant gap in chemical safety between developed and developing countries. Weak institutions, inadequate legislation, lack of enforcement of regulations and lack of human and financial resources are some of the obstacles to sound management of chemicals encountered by developing countries. In all countries, people are exposed to chemical mixtures in their daily lives of which the full health impact is unknown (Pruss-Ustun et al. 2011). Chemicals accumulate in a person's body over a lifetime, and socioeconomic circumstances have been found to correlate to patterns of chemical burdens in the body (Nelson et al. 2012; Tyrrell et al. 2013), highlighting that chemical risks are unequally distributed not only between countries but also within countries.

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An agricultural worker in Thailand applying pesticides to crops – a task that is often carried out with little or no safety procedures or precautions.

### The scope of this brief

In this brief the term chemicals refers to chemical products such as feedstock chemicals for industrial processes, pesticides, paints, household chemicals, and chemicals in products like flame retardants, preservatives or biocides. By chemical pollution we mean the emissions of these chemicals to the wider environment, either directly from production, during use, or from the chemical waste or waste products containing chemicals. SEI's large portfolio of research and policy advice on air pollution from combustion sources, including strategies for low-emission development, is not included in this brief (for more information visit: www.sei-international.org/managing-environmental-systems).

Society is faced with the challenge of reducing chemical risks while at the same time allowing for the safe use of chemicals. This challenge involves decisions not only on which chemicals to ban and restrict, but also on how to manage all chemicals safely through their entire life cycle in order to reduce risks for everybody. It also involves strategies to substitute hazardous chemicals for less hazardous ones, and to design new substances while taking appropriate precautions. Addressing the current deficits in national chemicals management demands the involvement and effort of stakeholders that represent all of the many sectors where chemicals are produced and used.

## Key insights

### Large gains can be achieved by targeting the informal sector

Many countries have large informal sectors (ILO 2014), and where inspections and law enforcement are lacking it is especially challenging to practice proper handling and use of chemicals. For adults and children who make their living in informal sectors, training on chemical safety precautions and use of personal protection equipment for handling hazardous substances are luxuries that are usually unavailable. The use of chemicals in small-scale mining and production industries as well as in smallholder agriculture is often far from being in line with regulated safety measures (e.g. Rother 2010). Thus, large gains in terms of occupational and public health can be made if the informal sector is specifically targeted as part of national risk reducing efforts and chemicals management strategies (Senyagwa and Persson 2014; Pruss-Ustun et al. 2011).

### Pollution can undermine crop production and livelihoods

Some degree of pollution is caused by all kinds of production and livelihood activity. The challenge for society is to curb and mitigate emissions in order to satisfy the demands of a growing population while safeguarding the natural resource base and the ecosystems on which we all depend. In spite of decades of increased pollution prevention, emissions still persist and in some cases are on the increase (UNEP 2012). Moreover, new chemicals are added every day in production and use. Pollution can have direct health effects (WHO 2013), or indirect impacts on ecosystems (Persson, Arvidson, et al. 2010; Persson, Phirun, et al. 2010). For example, it has been found that current levels of ground-level ozone can reduce crop productivity (e.g. of wheat and soy bean), and certain countries, such as China and India, are forecast to be among the hardest hit (Van Dingenen et al. 2009).

### Knowledge gaps persist from local to planetary scales

Some effects of pollution from the production, use and waste of chemicals are well understood and mapped. However, knowledge gaps persist regarding the full range of impacts. One major issue is the increasing awareness of health risks linked to low-dose exposure and exposure to chemical mixtures (Carpenter et al. 2002), but the lack of established causal linkages in these cases makes it especially difficult to take appropriate regulatory action (Carson 2004). For many years SEI has been engaged in discussions on how to handle chemicals in cases where their effects are uncertain (Vallack et al. 1998), and, historically, human societies have at times had to pay a high price for surprise impacts caused by the use of substances that were thought to be safe (EEA 2001). In certain cases, such as the depletion of the stratospheric ozone layer, impacts have a planetary significance. The threat posed by chemicals that have potential to exceed the planetary boundary of chemical pollution (Rockstrom et al. 2009) is highly challenging for current management systems (Persson, Breitholtz, et al. 2013). In order to confront these threats, it is necessary to design new hazard assessments that specifically address chemicals from a planetary boundary perspective (MacLeod et al. 2014).

### Unintended effects of pesticides in the field: Misuse that threatens livelihoods

When pesticides are used correctly they can reduce crop and post-harvest losses. However, biological effects are inherent to pesticides, which means that they will inevitably also affect plants and organisms other than the target pests. There is a gap in knowledge about the combined effects in the field of different chemicals, in terms of the multitude of possible impacts on ecosystems and ecosystem services (Persson, Arvidson, et al. 2010). Furthermore, the current uncontrolled and/or illegal use of pesticides in low- and medium-income countries greatly increases the risks of unwanted side effects (Persson, Phirun, et al. 2010).

### International agreements can reinforce national chemicals management

There are several international conventions and agreements in the field of chemicals and waste. These can focus on single substances, such as the Minamata Convention on Mercury (UNEP 2013c), or groups of substances with certain properties, such as the Stockholm Convention on Persistent Organic Pollutants (UNEP 2001). A different approach was chosen for the Strategic Approach to International Chemicals Management (SAICM 2006), which aims to establish an overall preventive system of chemicals management at the national level.

## The 2020 goal

The 2020 goal was set by the 2002 World Summit on Sustainable Development, and the Strategic Approach to International Chemicals Management (SAICM) was created to support activities that aim at achieving it. The goal reads as follows: "To achieve the sound management of chemicals throughout their life-cycle so that, by 2020, chemicals are produced and used in ways that lead to the minimization of significant adverse effects on human health and the environment."

SEI research has shown that international agreements can assist in improving chemicals management at the national level through, for instance, leveraging political awareness at the national level and providing a vision of what sound chemicals management could look like (Senyagwa and Persson 2014; Persson, Persson, et al. 2014; Persson et al. 2007).

### In implementation, details matter

Attention to detail is crucial in implementation of international agreements. Effective implementation depends on considering a range of issues, including the extent to which countries "own" the implementation process, setting specific priorities, procedures for coordinating national policy, and formal and informal incentive structures for the desk officers that carry out the actual implementation (Persson et al. 2007; Persson, Persson, et al. 2014; Senyagwa and Noel 2014).

### A new vision of overall chemicals management – an important contribution of the Strategic Approach to International Chemicals Management

Of all international agreements on chemicals the SAICM has the broadest scope, and it has helped to create a vision for sound management of chemicals at the national level. With its focus on creating multi-sectoral solutions for all chemicals from cradle to grave, together with the seed-funding from the SAICM Quick Start Programme, it has enabled countries to set their own priorities across the spectrum of chemicals management. This has not been possible to the same extent under substance- or sector-specific agreements (Persson, Persson, et al. 2014).

### There is a need to pinpoint the main components of a basic set-up for sound management of chemicals

The definition of sound management of chemicals is so far expressed only in terms of the goal of minimizing risks to human health and the environment from the production and use of chemicals. There is currently no established or internationally agreed way to measure progress towards sound management or the 2020 goal. There are 20 indicators under the SAICM umbrella, but their character does not allow an overall assessment of progress (Persson, Persson, et al. 2013). In addition, regularly updated data for national monitoring of relevant parameters are usually scarce (Bergstrom et al. 2013). A shortlist of key components of sound management of chemicals at the national level would provide vital support to all countries when designing actions to improve chemicals management, especially for those with weak institutional structures faced with tough decisions about national budgets.

### Sound management of chemicals – a balancing act

In chemical risk reduction efforts at the national level there are both clear and unclear targets. For example, it is clear that occupational exposure to hazardous substances in excess of safety limits is unnacceptable, and that this issue needs to be

addressed. But other challenges are of a different character, with less clear targets. This is the case for instance with the controlled production and use of chemicals for crucial applications where the positive and negative effects of a specific use are partly unknown, meaning that trade-offs are unclear. One such case is the use of herbicides to reduce the need for tilling in agriculture: While tilling less saves significant amounts of fuel and sustains long-term soil fertility, the use of herbicides has (depending on the substance used and when and how it is applied) potentially short- and long-term negative effects on a field's ecosystems and its surroundings. Another example of a potentially difficult balancing act is additives in food: these may give short term benefits in terms of longer shelf life (and less food waste), but could have subtle long-term health impacts. Balancing such trade-offs is far from easy.

Yet another balancing act is the use of precaution. When the European Union adopted the precautionary principle in the early 2000s, it aimed at shifting the burden of demonstrating safety to producers of chemicals, rather than the previous mode of requiring public health experts and governments to prove harm (Carson 2004). On the one hand, the result of this paradigm shift is a more cautious approach to developing and releasing new chemicals, some fear that the process of determining risk in advance may stifle innovation. On the other hand, discovering harms only after a substance is on the market not only increases risks, it can also mean lost investment when a product is removed.

## Future research

The future research aspirations of SEI include following up on the balancing acts associated with sound management of chemicals (see above). This would link well to other SEI research areas in which balancing different needs and interests is a common denominator. Dealing with trade-offs of this kind can only be done by working across sectors and through multi-stakeholder efforts, and by better bridging the science and policy domains.

In the European Union, one response to chemical challenges has been the introduction of a common regulation, called the Registration, Evaluation and Authorisation of Chemicals (REACH). The expert committees of REACH form its primary science-to-policy interface, and how effectively these committees function will be crucial for how REACH can contribute to achieving sound management of chemicals in the European Union. SEI is following this process with interest.

The addition of chemicals in SEI's consumption and production models, especially the latest and most powerful multi-regional model, Input-Output Trade Analysis (IOTA) (SEI 2014), is also on the future agenda. Interesting aspects to introduce in these models are the shifting of chemical risks along increasingly complex supply chains, as well as embedded chemical risks in products and recycling of products that contain chemicals. Such research would respond well to growing concerns among consumers and governments who wish to minimize the negative impacts of consumption of imported products, for which current information is generally scarce and difficult to access or review.

The development of a new renewable resource base for chemicals is another important development that links to several fields of ongoing SEI research. Advancements in biosciences make it possible to develop agricultural systems that not only produce food and feed, but also, to an increasingly large extent, produce agro-industrial products for applications spanning many sectors—pharmaceutical, manufacturing industries, chemicals, and energy (Johnson and Virgin 2010; Kemp-Benedict et al. 2012).

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