Knowledge Gaps and Opportunities to improve the Situation of Chemical Pollution, Exposure and Risks in LAMICS

In this report, we have described the current knowledge on chemical pollution and effects thereof on human- and environmental health in LAMICs. Despite the fact that information is rather scarce and/or fragmented, it is safe to conclude that the situation is alarming and that there is a trend that this situation is getting worse. In all the sectors evaluated, significant amounts of a large variety of chemical compounds are used, which enter the environment in often uncontrolled manner and can have negative impacts on environmental health. The negative effects of chemical pollution on human health, either caused by direct exposure, or indirectly, e.g. via the environment or food, are also significant. Because of the lack of data, the real threat for humans and the environment can only be estimated, with high probability that it could be more severe. Continuous exposures of the environment and humans to a large variety of chemical compounds, sometimes even to high concentrations, is a long term experiment with high risks. We hence believe that serious attention must be given to this risk. With the description of knowledge gaps and opportunities for action for specific fields we aim to improve the knowledge-base of chemical pollution and effects thereof in LAMICs, and help to develop mitigation options for the future.

1) Data availability and data collection

More comprehensive data, including the complete chemical life cycle, assessments of effects on environmental and human health, and comprehensive risk assessments, are needed on various scales. Data at global scale are needed to support international policy development as well as international conventions and protocols. Increasing international attention will also help national policy makers to make chemical pollution a priority topic. Country-level evidence is crucial for the development of national policies. Finally, since mitigation actions are implemented at local/catchment scale, more detailed information, with significant spatial and temporal resolution, is needed at this level. Our report shows that some data are available on the global and/or country scale, though this data is still scarce and often incomplete. Data at catchment scale are largely missing or not available at all.

As a way forward, as a first step, we suggest that existing data could/should be made publicly available. Such data includes figures of chemical production, import, export, use and chemical waste management. This sharing should also include all available data on exposure routes, concentrations and evidence of impacts on human and environmental health. Although this issue of data sharing might sound trivial, in particular in cases where data was collected with public/tax money, unresolved issues around data property and the willingness to be transparent and the subsequent ethical responsibility are major barriers. Reality shows that even existing data are seldom made publicly available, and this is not only true for LAMICs, but also holds for HICs.

Access to existing data with respective analysis would allow an identification of specific regional, or even country-wise risk hotspots. For a more detailed assessment, more data on exposure routes and exposure concentrations with higher spatio-temporal resolution, e.g. within countries, or within catchments, is needed. Finally, to complete the picture, such data would need to be complemented by surveys assessing human and environmental health as well as institutional settings, handling practices, and chemical waste management. All this contributes to the identification of the most hazardous pollutants, processes with major risks, lacking awareness, limited human capacity and knowledge, bad handling practices or even missing legislation.

2) Development of concepts and tools for monitoring and data collection

Most concepts and tools for monitoring and data collection have been developed with available expertise and resources for local settings and conditions in and for HICs. Such concepts and tools need to be adapted or newly developed for LAMICs, so that evidence on exposure routes, environmental concentrations, and effects of chemical pollutants can be collected. Adaptation of concepts and tools need to consider i) functionality under the respective climatic situation, ii) efficiency and cost-effectiveness, iii) feasibility of use by local people with limited technical skills and expertise, iv) applicability for all relevant spheres (air, soil, water and anthoposphere), v) the ability to capture both exposure and effect assessments, and vi) the ability to allow the development of locally relevant risk maps and mitigation options.

3) Development of mitigation options

Despite the fact that chemical pollution is of global importance and influenced by global trends, local mitigation measures are key to improving the situation for human and environmental health. There are no „one size fits all" solutions. A wide portfolio of mitigation options must be developed and it must be evaluated which option fits best to the specific local situation. Ideally, finding and implementing mitigation solutions is a process taking place not in isolation but by including boundary conditions and local challenges and using a base of solid and detailed knowledge about the local situation.

4) Raise awareness in society, private sector and industry, politics and regulatory authorities as well as support the development and implementation of legislation and management tools

Awareness of the existing problem or the risk of the issue becoming a problem is a precondition for change. This report shows that chemical pollution is already a problem in many countries and is a problem which will increase in the years to come. The outcome of chronic chemical exposure on environmental and human health is difficult to predict and if, then only with limited reliability. Society, including policy makers, regulatory authorities, producing industries and the private sector must be better informed with clearer messages. In this regard, scientists and research play an important role as they can provide facts in an unbiased and neutral way. Furthermore, scientists can also support decision making under uncertainty.

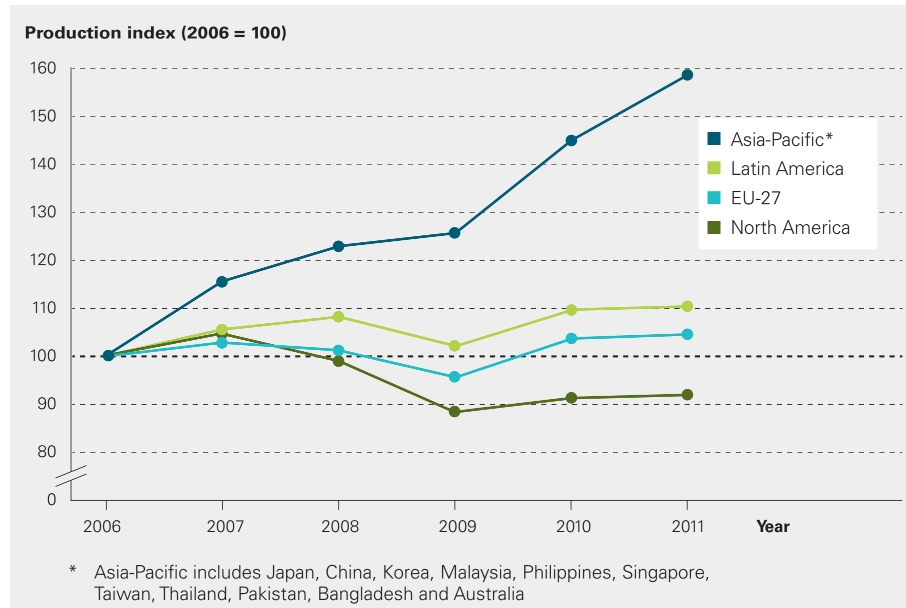
Interdisciplinary research is a necessity for the issues of chemical pollution in LAMICs. Such research includes technical, social and natural sciences while involving a wide range of stakeholders at an early stage so that research results are taken up by policy makers and practitioners and can effectively tackle the problem of chemical pollution. Including relevant stakeholders in the research process assures that the critical questions can be voiced and tackled by researchers, the necessary and required data can be collected in a focused, practical manner, mitigation and management tools can be developed in a concerted action, and evidence can support and drive policy and legislation.

Appendix

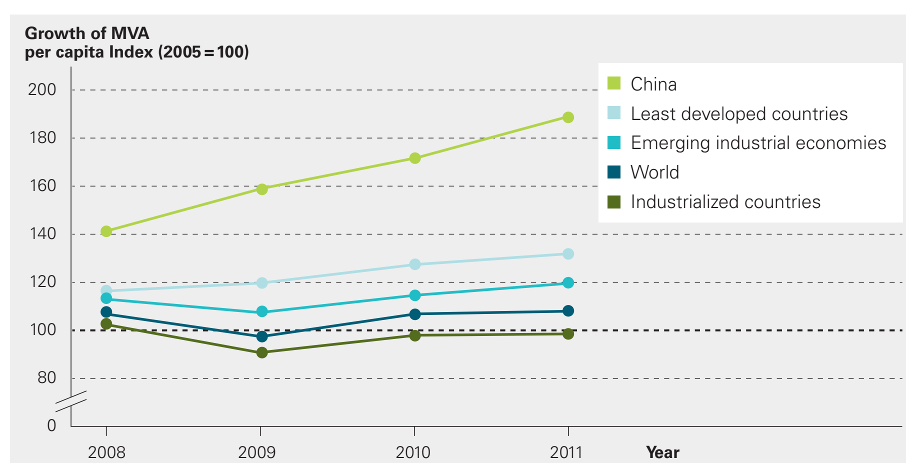
Appendix Figure 1 shows the trend in chemical production of the European Chemical Industry Council (Cefic) from 2006 to 2011 (European Chemical Industry Council, 2013). These data confirm that chemical production in almost all regions of the world has reduced. There are negative growth rates in 2008/09 that helped give rise to the economic recession in 2009. North America was the region most affected, followed by Europe and Latin America. Production in the Asia-Pacific region continued to show persistent growth over time with only a small deceleration during the recession (European Chemical Industry Council, 2013). In 2009, world chemicals production declined by 4.8% compared to 2008. This represented the largest recorded decline in world chemical production over the last 23 years. However, in 2010, global chemical production recovered in all regions, showing an increased growth rate of 10% compared to 2009. This was followed by a 4.5% increase in 2011 compared to the prior year. The growing rate of the production was headed by the Asia-Pacific region followed by production in the Latin American region. Over the last years, chemical production in Latin America and the Asia-Pacific region has far exceeded the production growth rates of Europe and the North America (European Chemical Industry Council, 2013).

World data on the growth of and distribution trends in manufacturing presented by UNIDO (United Nations Industrial Development Organization) in its International Yearbook of Industrial Statistics 2013 (United Nations Industrial Development Organization, 2013) and data presented by the Cefic (European Chemical Industry Council, 2013) are both in agreement with the data of the Global Chemicals Outlook Towards Sound Management of Chemicals from UNEP (United Nations Environment Programme, 2013c).

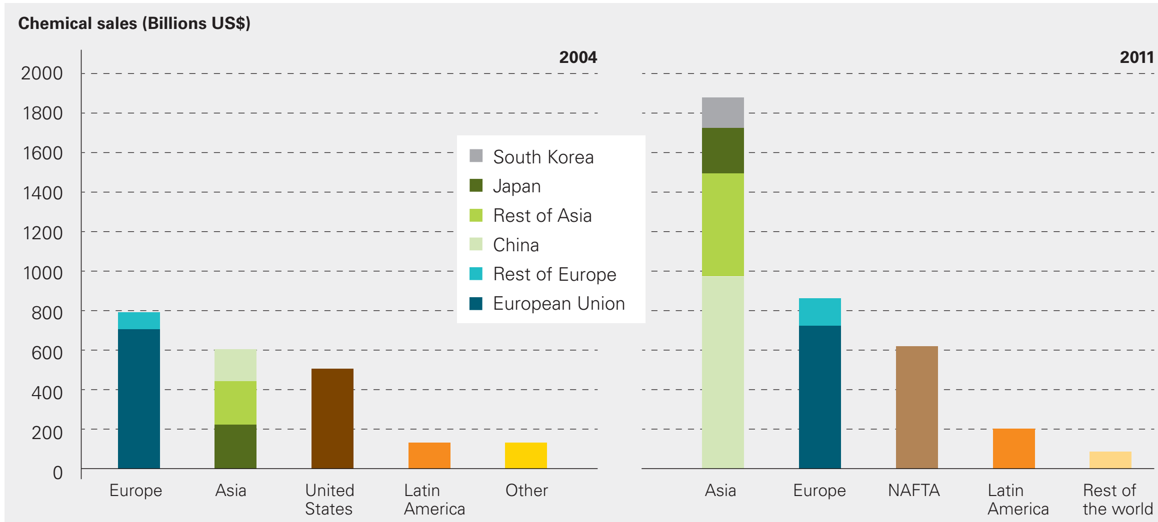
The data of the Yearbook of Industrial Statistics 2013 indicate that in addition to China, there was constant growth in industrial production and manufacturing output in the least developed countries (Appendix Figure 2). (This includes primary production of the basic chemical and secondary industrial sectors – pharmaceutical and pesticide production – and the production of electronic devices, clothes, household products, etc.) This growth in the least developed countries is shown by the growth in the manufacturing value added (MVA) in this region. In contrast, the manufacturing growth of the industrialized countries (the European Union and the United States) was strongly affected by the economic recession of 2009. By 2012, the MVA of the industrial economics had still not reached the level of the period before the financial crisis. The MVA was determined under the terms of the national accounting concept, which represents



Appendix Figure 1: *Long-term trend of chemical production. Growth rates and index numbers (2006 = 100; European Chemical Industry Council, 2013)*



Appendix Figure 2: *Major trends in the growth and distribution of manufacturing value added (MVA). Growth rates and index numbers (2005 = 100) per capita. MVA for the latest year 2011 for individual economies and for selected country groups. Data referring to country groups were based on cross-country aggregates of MVA in constant 2005 US$ (United Nations Industrial Development Organization, 2013).*

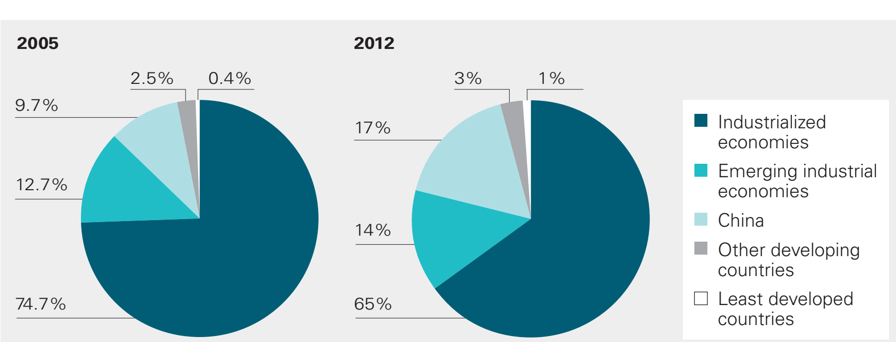


Appendix Figure 3: *World chemical production 2004 (left) and 2011 (right; African Ministerial Conference on Environment and United Nations Environment Programme, 2004; European Chemical Industry Council, 2013).*

the net contribution of the manufacturing sector to the gross domestic product (GDP; United Nations Industrial Development Organization, 2013)

The worldwide sales of chemicals for the period 2004 to 2011 in US$ billion are presented in Appendix Figure 3 (African Ministerial Conference on Environment and United Nations Environment Programme, 2004; European Chemical Industry Council, 2013). The sales figures of 2011 show that the Asian chemical production outstrips those of the other regions, posting sales of US$1890 billion in 2011. This represents 51.8% of the world's chemicals sales. In 2004, European chemical sales were constituting US$793 billion compared to Asian chemical sales of US$612 billion.

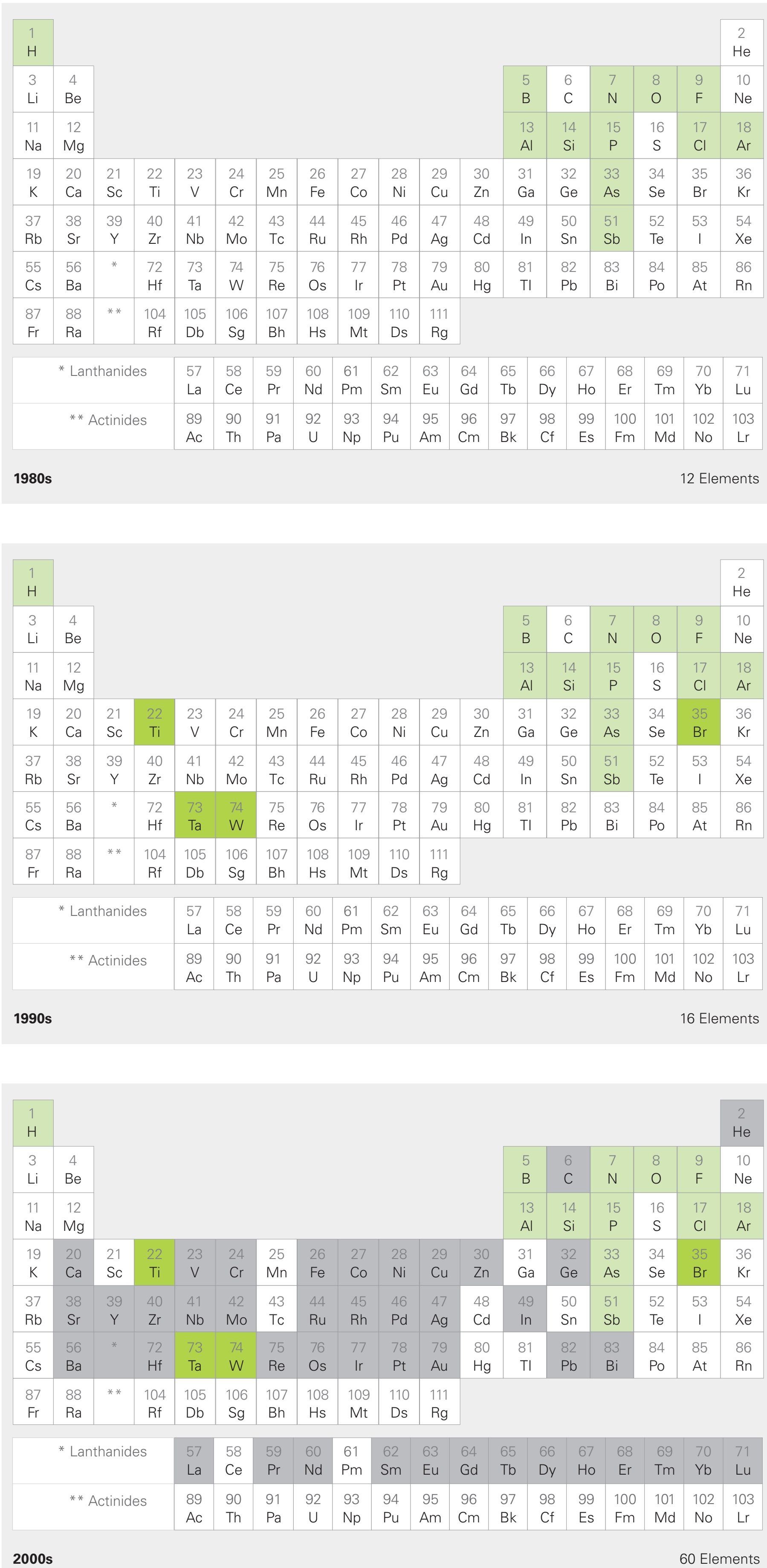
The dark blue column in Appendix Figure 3 represents the countries of the European Union; the light blue column represents the rest of Europe. The light green bar represents China; the darker green bar shows sales for rest of Asia; the olive column represents the data for Japan; and the grey bar indicates the values for South Korea. The dark brown bar represents the sales for the United States. The light brown bar combines the sales of the countries of the North American Free Trade Agreement (NAFTA: Canada, United States and Mexico). The orange bar shows the value for Latin America. The yellow bar shows the value for Canada, Mexico, Africa and Oceania together. The light orange bar illustrates the amounts of sales that are not included in the other columns. In summary, worldwide chemical sales were US$2141 billion in 2004 and US$3649 billion in 2011 (African Ministerial Conference on Environment and United Nations Environment Programme, 2004; European Chemical Industry Council, 2013)



Appendix Figure 4: *Distribution of world manufacturing value added (MVA; United Nations Industrial Development Organization, 2013). [%]*

Appendix Figure 4 shows that despite the financial crisis, the industrial economies were still at the top of total manufacturing production, although the proportion of MVA had decreased by approximately 10%. However, the proportions of the MVAs of the developing countries and the emerging industrial economies, especially China, had increased (United Nations Industrial Development Organization, 2013).

These pie charts present the shares of selected groups of economic activities (e.g. basic chemical, leather, textile, and pharmaceutical production) in world MVA for different industrialized economies. China belongs to the group of emerging industrial economies. However, because of the large size of its economy, China is presented separately (United Nations Industrial Development Organization, 2013)



Appendix Figure 5: *Growing diversity in the materials used in the semiconductor industry from 1980 to 2000 (Theis, 2007).*