Sustainable chemistry and the international sustainable chemistry collaborative centre ISC 3

Elschami, Myriam; Kümmerer, Klaus; Schneidewind, Uwe

Published in:
GAIA

DOI:
10.14512/gaia.27.2.13

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Sustainable Chemistry and the International Sustainable Chemistry Collaborative Centre (ISC_3)

The International Sustainable Chemistry Collaborative Centre aims to support the implementation of sustainable chemistry in line with ecological, economic and social development in collaboration with all stakeholders and at various levels.

Myriam Elschami, Klaus Kümmerer

Sustainable Chemistry and the International Sustainable Chemistry Collaborative Centre (ISC_3) | *GAIA* 27/2 (2018): 247–249
Keywords: green chemistry, ISC_3, SAICM, SDGs, sustainable chemistry

From International Chemicals Management to Sustainable Chemistry

The chemicals sector is producing rapidly growing numbers and amounts of chemicals for a growing number of applications, a trend becoming increasingly visible also in low and middle-income countries. While leading to an enormous increase in social and economic development, the ubiquitous use and application of chemicals was always also accompanied by adverse impacts on human health and the environment.

Addressing the global scope of chemical pollution, a number of multilateral environmental agreements, such as the *Basel, Rotterdam* and *Stockholm Conventions*[1], were established for a global sound management of chemicals and waste (SMCW). An important policy framework bundling international activities on chemicals management is the *Strategic Approach to International Chemicals Management (SAICM)*[2]. It was adopted in 2006 by the first session of the *International Conference on Chemicals Management* in Dubai with the declared goal "[...] that by 2020 chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment" (UN 2006). In the chemical industry, a similar line of efforts resulted in the global initiative *Responsible Care*[3], a voluntary commitment for continuous improvement of environmental, health and safety, and security performance. In parallel to these policy- and industry-based interventions for the handling of chemicals, the approach of "green chemistry" emerged as a framework for designing and improving products and processes with the aim to prevent chemical pollution in the first place.[4] Summarizing multiple dedicated contributions by the US Environmental Protection Agency, the European Union, the Organisation for Economic Co-operation and Development (OECD) and others (Cathcart 1990, Richtlinie 96/61/EG, OECD 1998, Linthorst 2010), green chemistry employs twelve principles for a benign design and a safe and resource and environmentally friendly manufacture of chemicals (Anastas and Warner 1998).

However, global chemical production is still progressing, and neither of the above mentioned interventions are sufficient measures to counteract the adverse environmental and health impacts this is causing. In addition, the limits of resources to cover global production volumes and ensuing political and societal conflicts urgently call for broader innovative solutions including SMCW and green chemistry, but importantly also ethics and new business models to reduce resource and product flows and their environmental impact, and to initiate a transformation towards a more sustainable use of chemistry in line with ecological, economic and social development. >

Contact authors: *Dr. Myriam Elschami* | myriam.elschami@leuphana.de

Prof. Dr. Klaus Kümmerer | klaus.kuemmerer@uni.leuphana.de

both: Leuphana University of Lüneburg | Institute for Sustainable and Environmental Chemistry *and* Research & Education Hub of the International Sustainable Chemistry Collaborative Centre | Lüneburg | Germany

Contact *NaWis*-Runde: *Prof. Dr. Uwe Schneidewind* | Wuppertal Institute for Climate, Environment and Energy | Döppersberg 19 | 42103 Wuppertal | Germany | +49 202 2492100 | uwe.schneidewind@wupperinst.org

1 *www.basel.int*, *www.pic.int*, *chm.pops.int*
2 *www.saicm.org*
3 *www.icca-chem.org/responsible-care*
4 *www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry.html*

https://doi.org/10.14512/gaia.27.2.13

The Concept of Sustainable Chemistry

The need for a comprehensive framework for chemistry in the context of sustainability resulted in the concept of "sustainable chemistry", with the OECD as well as the German Chemical Society being among the first to use the term. The OECD definition of sustainable chemistry, however, is not much different from the twelve principles of green chemistry.[5] A more integrative way of describing sustainable chemistry might be as a guiding principle for sustainable development aiming to shift the basis of added value in the chemicals sector from compound or product-centred to service- and function-oriented (Blum et al. 2016, Kümmerer 2017). Moving the function and service offered by chemical products into the centre instead of the chemical product itself allows including non-chemical approaches to secure this function. This perspective of "chemistry for what and for whom" provides the basis to include total resource, substance, materials and product flows as well as ethics and social aspects into the operations of chemical production (Kümmerer and Clark 2016, Kümmerer 2017). When a chemical approach is selected for a desired service or function, it should be pursued following the principles of green chemistry and green engineering (Kümmerer 2017).

All Dimensions of Sustainability

Importantly though, also the choice of the chemical approach requires a careful assessment, as there is no common agreement on how many principles have to be fulfilled for a molecule or a process to qualify as "green" and how different principles are to be weighed against each other. And even if a chemical meets these principles, it is not necessarily sustainable, a provocative example being chemical warfare agents manufactured in compliance with green chemistry (Klapötke and Holl 2001).

Sustainable chemistry requires a thorough analysis along all dimensions of sustainability. This may raise questions such as under which circumstances the increasing use of biomass for chemicals and biofuel production could a viable alternative to the use of fossil sources, when taking into account potential social, economic and ecological consequences of its use. Or whether the reduction of CO_2 emission achieved in cars through the use of lightweight composite materials outweighs the negative environmental impact caused by the production or future recycling of these materials. Or how, in the face of fossil fuel depletion, materials and product flows for renewable energy infrastructure might be redesigned in order to increase resource efficiency and avoid new competition for the resources required for this infrastructure.

The limits of ecosystems to cope with the adverse effects of chemical products call for broader approaches …

A New Way of Systems Thinking

One example for an approach towards sustainable chemistry is the business model of chemical leasing.[6] Customers pay in terms of a service delivered by a chemical product, rather than for the product itself. The company delivering the product, for example, a specific solvent, remains the owner and takes back any used or unused product. This way, the customers' and company's interests are aligned to reduce the amount of product exchanged, offering economic advantage for both sides while minimising the use of resources and potential adverse effects of the chemical product.

Two other examples, highlighting the potential of chemical innovations to contribute to sustainable development, are the products developed by the winners of the 2018 *Elsevier Foundation Green and Sustainable Chemistry Challenge*[7]. They utilize local natural waste products (i.e., Guava leave extracts for food preservation in Nepal, or fish bone as a source for phosphate fertilizer in Senegal) to address local problems of food security and create workplaces. Furthermore, these are examples for how local material flows can be induced instead of global ones, allowing for a better assessment of resource availability in the long run.

In 2015, the UN adopted the *2030 Agenda for Sustainable Development* with up to 14 of its 17 *Sustainable Development Goals (SDGs)* requiring an active role of chemistry for their achievement. The agenda requires a new way of systems thinking for the chemicals sector centred around the service of chemical products, in order to support SMCW, make better use of natural resources and address social and ethical issues.

The International Sustainable Chemistry Collaborative Centre (ISC_3)

The International Sustainable Chemistry Collaborative Centre (ISC_3) was established in May 2017 by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU) as a contribution to the international transformation towards sustainable chemistry[8]. As an independent institution, the ISC_3 is a catalyst for sustainable chemistry and connects stakeholders from the private sector, science and research as well as civil society and politics. It fosters sustainable innovation by promoting research, new business ideas and start-ups in developing countries and emerging markets as well as in industrialized countries. ISC_3 is headquartered in the UN City Bonn, and has an *Innovation Hub* at DECHEMA (Gesellschaft für Chemische Technik und Biotechnologie) in Frankfurt and a *Research & Education Hub* at the Leuphana University of Lüneburg.

5 For details see *www.oecd.org/chemicalsafety/risk-management/sustainablechemistry.htm*.
6 For details see *www.chemicalleasing.org*.
7 For details see *www.elsevier.com/connect/guava-leaves-as-preservatives-fish-bones-as-fertilizer-creative-ideas-for-a-sustainable-future*.
8 *www.isc3.org*

The ISC_3 Headquarters

Global policy issues which are the backbone to promote sustainable chemistry world wide are led by the ISC_3 headquarter. It cooperates closely with UNEP in advancing the global dialogue on sustainable chemistry. Moreover, in a global scenario process covering work streams such as *Sustainable Chemistry & Climate Change, Sustainable Chemistry & Buildings and Living, Sustainable Chemistry & Mobility* as well as *Circular Economy and Digitalization (Chemistry 4.0),* experts will be invited to debate on how sustainable chemistry affects our future: what kind of chemical knowledge, services, products and production processes do we need to shape a sustainable future? What are the needs and up-coming issues of different regions related to chemistry? What are the societal, economic and political implications of sustainable chemistry? In what areas are chemical innovations key to achieving the *SDGs*? These scenario-based discussions offer an opportunity for civil society to voice expectations and concerns, help industry representatives to refine strategies and investments, as well as provide input to policy makers for shaping regulatory frameworks and instruments.

The ISC_3 Innovation Hub

Innovative solutions to combat pollution in the areas of mobility, energy, urbanisation, and agriculture very often originate in the chemical sector, its research community and in start-up companies. Examples are the replacements for fossil fuels, new energy storage systems and new construction and insulation materials. However, innovative solutions involving green and sustainable chemistry do not find their way easily to the market. The *ISC_3 Innovation Hub* is therefore initiating a global start-up service and network to identify and support start-up companies in the developed as well as in the developing countries. The service will provide communication support, network events, trainings and access to investors. Starting from R&D projects, the *ISC_3 Innovation Hub* will catalyse technology transfer from science to industry and to the developing countries. Moreover, the hub will support potential entrepreneurs by evaluating innovative approaches. An international *Innovation Award* will shine the light on outstanding projects all over the world, providing both an incentive and a showcase for the best innovations in the field of sustainable chemistry.

The ISC_3 Research & Education Hub

Complementary to the work of the headquarters and the *Innovation Hub,* the *ISC_3 Research & Education Hub* aims to monitor and assess academic sustainable chemistry research. To this end it assesses new developments in science with respect to their potential, limitations and possible pitfalls for sustainable development and publishes its findings in peer-reviewed scientific journals and study reports. Academic exchange on these topics is fostered at interdisciplinary international conferences and workshops organized by the hub, such as the annual *Conference on Green and Sustainable Chemistry*[9] and the annual *Summer School on Sustainable Chemistry*[10].

Alongside its research activities, the *ISC_3 Research & Education Hub* is establishing an *International School for Sustainable Chemistry.* Study programs will conduct courses in concepts of sustainable chemistry and in green chemistry, in environmental chemistry and toxicology, circular economy and product life cycles, recycling, new business and service models, and international regulations on chemicals management. It will scale up knowhow across executives, researchers and practitioners worldwide.

... to reduce resource and product flows and initiate a transformation towards a more sustainable use of chemistry.

With joined forces, the ISC_3 has the capacity to reach out globally to all stakeholders at their individual levels of expertise, thus providing the multidimensional scale required to implement sustainable chemistry.

References

Anastas, P. T., J. C. Warner. 1998. *Green chemistry: Theory and practice.* New York: Oxford University Press.
Blum, C. et al. 2016. The concept of sustainable chemistry: Key drivers for the transition towards sustainable development. *Sustainable Chemistry and Pharmacy* 5: 94–104.
Cathcart, C. 1990. Green chemistry in the Emerald Isle. *Chemical Industries* 5: 684–687.
Klapötke, T. M., G. Holl. 2001. The greening of explosives and propellants using high-energy nitrogen chemistry. *Green Chemistry* 3: G75–G77.
Kümmerer, K. 2017. Sustainable chemistry: A future guiding principle. *Angewandte Chemie (international edition)* 56: 16420–16421.
Kümmerer, K., J. Clark. 2016. Green and sustainable chemistry. In: *Sustainability science: An introduction.* Edited by H. Heinrichs, P. Martens, G. Michelsen, A. Wiek. Dordrecht: Springer.
Linthorst, J. A. 2010. An overview: Origins and development of green chemistry. *Foundations of Chemistry* 12: 55–68.
OECD (Organisation for Economic Co-operation and Development). 1998. *Proceedings of the OECD workshop on sustainable chemistry.* www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=env/jm/mono(99)19/PART1 (accessed June 5, 2018).
Richtlinie 96/61/EG. 1996. *Richtlinie 96/61/EG des Rates vom 24. September 1996 über die integrierte Vermeidung und Verminderung der Umweltverschmutzung.* Amtsblatt der Europäischen Gemeinschaften L 257: 26–40. eur-lex.europa.eu/legal-content/DE/TXT/?uri=celex% 3A31996L0061 (accessed June 14, 2018).
UN (United Nations). 2006. *Report of the International Conference on Chemicals Management on the work of its first session.* www.saicm.org/Portals/12/documents/meetings/ICCM1/Final%20ICCM%20Report %20Eng.pdf (accessed June 4, 2018).

9 *www.elsevier.com/events/conferences/green-and-sustainable-chemistry-conference*
10 *www.leuphana.de/summer-school-s3c*