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Challenges for a Sustainable Chemicals and Materials Policy

The Need for Transformation in the Global Context

Abstract from the position paper of Friends of the Earth Germany (BUND) National Working Group on Environmental Chemicals and Toxicology

INTRODUCTION

Chemicals and materials policy is more than policy on chemical substances! Limiting the use of toxic chemicals to the lowest level possible and reducing risks associated with chemical substances in general are still important goals. But extracting the raw materials needed for the manufacture of chemicals also affects and pollutes the environment. Products such as polymers that we use daily eventually end up as waste in the environment. The persistence of chemicals is a key threat. For, even when they are not toxic, persistent substances can often do irreparable damage to human beings and ecosystems.

An ecological chemicals and materials policy that takes account of the entire life cycle of chemicals – from raw materials, via chemicals, all the way to products and waste is missing. Boundaries must be set for the consumption of material resources. Such chemicals and materials policy would involve practical climate protection, for a high level of energy consumption is required to produce and process substances. An ecological chemicals and materials policy would also protect biodiversity, as persistent and toxic substances as well as large-scale landscape changes through mining, industrial agriculture or urban planning endanger them. Like climate change or biodiversity loss, substances thus threaten the ecological balance of the entire planet.

This process must be stopped in order to drastically minimize pollution caused by materials, politics and policy as well as the economy and society must change. This requires a fundamental reorientation of chemicals and materials policy, not only in Germany or Europe, but worldwide. A global approach with the goal of setting limits for the consumption of material resources is necessary. This is demonstrated in detail and substantiated in the paper "Challenges for a Sustainable Chemicals Policy" prepared by Friends of the Earth (FoE) Germany's National Working Group on Environmental Chemicals and Toxicology.
(www.bund.net/chemicals-policy)

FoE Germany sees three strategies to be combined: Efficiently using energy and resources, working towards closed substance cycles ("consistency"), and reducing the use of materials and products through new patterns of consumption and new lifestyles ("sufficiency"). Chemicals and materials policy must focus on the precautionary principle and the fundamental approach of sustainability. The United Nations Sustainable Development Goals form an important basis for this.

FROM THE CHEMICALS DEBATE TO THE DEBATE ON MATERIALS

In the mid-20th century the permeation of our life and ecosystems with chemicals was still just beginning. Essentially, there was no chemicals policy discussion. Since then, many laws for protection against chemicals have been adopted, but the exposure to chemicals continues to be too high. Chemical analysis is detecting more and more new types of chemical substances in humans and the environment. This includes substances which impair the endocrine system, are present in the environment for extended periods of time, or accumulate in living organisms.

In addition, the material complexity of consumer products is increasing, while transparency about what they consist of remains poor. This applies, for example, to electronic goods and vehicles. This makes recycling difficult or even impossible. Many valuable raw materials cannot be re-used for new products.

CHEMICALS AND MATERIALS POLICY IS A GLOBAL ISSUE

In 2019, the United Nations Environment Programme published the second edition of its "Global Chemicals Outlook" (GCO II), a comprehensive report on the global production and use of chemicals and their negative impact on humans and the environment. Especially alarming: Improper handling of chemicals still costs at least 1.6 million human lives worldwide each year. At the same time, the production of materials is steadily increasing. In 2017 the worldwide chemicals industry was worth US$5 trillion, or in other words: US$5,000 billion. This amount may double again by 2030.

Chemicals policy today goes far beyond national issues. The interconnectedness of global trade and the threats to the Earth system through global warming, loss of biodiversity, and the growing volume of synthetic chemicals demonstrate the need for a sustainable chemicals and materials policy at an international level.

In addition, EU chemical companies have opened production facilities in countries of the Global South and East and in this way are exporting the related risks. The same is true for waste: Large quantities are exported from Europe and the US (often illegally) to the countries of the global South or East. They are processed and "disposed of" there under in part very poor environmental and working conditions.

Chemicals companies and industrialized countries are thus directly or indirectly responsible for many environmental and health problems, including those in emerging and developing countries. They must not shirk their responsibility for these problems. The polluter-pays principle must apply here.

THE GUIDING PRINCIPLES: PRECAUTION AND SUSTAINABILITY

The precautionary principle has been a central guiding principle in environmental protection since the mid-1980s. Sustainability was added in the early 1990s. Both principles can be found in numerous international documents – including Agenda 21 at the 1992 Conference on Environment and Development in Rio de Janeiro.

The precautionary principle requires action to be taken whenever there are good reasons for concern. FoE Germany sees this situation as given when, for example, pollution by non-natural persistent (long-lived) substances is high. However, this principle is too rarely applied effectively. Sustainability means meeting the needs of today's generation without compromising the opportunities of future generations. Many people in politics and business talk about sustainability without acting in accordance with it. Current global developments blatantly contradict the requirements for sustainable development.

In its two studies "Sustainable Germany" FoE Germany has shown what fundamental course must be set by a sustainability policy. In practical politics and in business, however, sustainability is still under the preservation that economic growth must not be compromised. The erroneous belief in achieving "green growth" solely through efficiency gains continues to prevail.

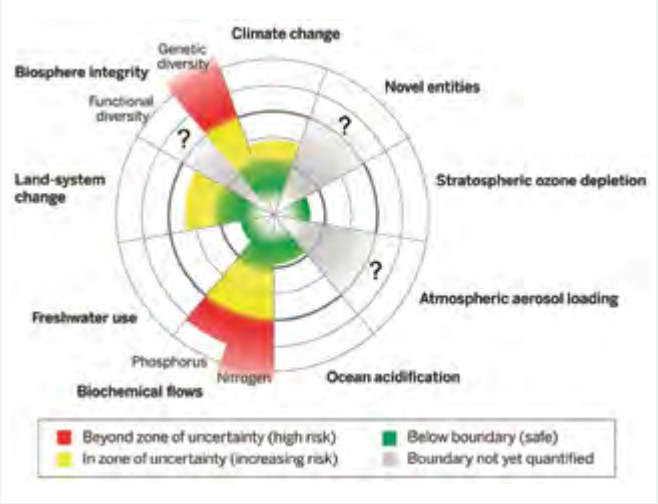
In 2015, the UN General Assembly adopted seventeen goals to be achieved by 2030, called Sustainable Development Goals (SDGs). These include several environmental targets related to clean water, climate or the protection of terrestrial and marine ecosystems and also encompass the protection of humans and the environment from hazardous chemicals. The twelfth SDG on sustainable production and consumption is particularly relevant for international chemicals policy.

Sustainability and precautionary action largely cover the same issues in their orientation, with sustainability focusing more on global and long-term effects, and precaution being more focused on knowledge deficits. Without optimal environmental precautions, sustainable development is not possible. In terms of chemicals and materials policy, precaution and sustainability mean above all avoiding irreversible damage to the ecosystem and human health.

PLANETARY BOUNDARIES: A NEW APPROACH TO EVALUATION

Through the influence of human beings, a new geological age has begun called the Anthropocene. Our current economic systems and present-day lifestyles are not sustainable and have global implications. Current trends indicate that growth in the consumption of natural resources and energy is accelerating around the world. No reversal of the trend is in sight. Humanity has already left the safe operating space.

In 2009 and 2015 scientists introduced the concept of planetary boundaries. These boundaries define nine areas in which the earth system is endangered by human action; seven of them involve resource use and the use or release of substances. These include greenhouse gases that cause climate change as well as substances that over-fertilize or acidify ecosystems, in this way endangering biodiversity, and health-threatening aerosols, i.e., extremely fine liquid droplets or solid particles in the air. Areas with a global impact also include "novel entities" (see illustration). Among other things, scientists include substances that humans release into the environment that were not previously there, as well as genetically modified organisms. The analyses show: the safe operating space of four boundary categories has already been exceeded due to excessive emissions of



Planetary boundaries for nine global processes

greenhouse gases, nitrogen and phosphorus compounds, land use change, and loss of biodiversity. It is important to bear in mind that the individual boundaries are not independent of each other. Increased chemical production and use can lead to more greenhouse gases, increased release of phosphorus and reactive nitrogen into the environment and accelerate species extinction.

So far, scientists have not been able to quantify the planetary boundary for "novel entities." This is also due to the variety of substances with different effects. We are only gradually learning what consequences this wide range of inputs into the environment is having on, for example, sensitive ecosystems. Many of these substances have been stable for centuries. Chlorofluorocarbons (CFCs) and plastics are good examples of how substances and materials originally assumed not to be dangerous can also cause major long-term problems. Practical approaches to quantification of chemical pollution are currently being developed and discussed by scientists.

INTERNATIONAL ACTIVITIES

In view of the ever-increasing production of substances and the international spread of hazardous substances and waste, chemicals and materials policy today requires a global approach so that planetary boundaries are not exceeded. So far, international agreements have brought improvements in reduction of risks deriving from particularly hazardous chemicals and waste. This is true of other initiatives as well: The Strategic Approach to International Chemicals Management (SAICM) of the United Nations and the Chemicals Program of the Organization for Economic Co-operation and Development (OECD) are contributing to a common international understanding of risks posed by substances.

However, at the current pace, problems will grow faster than measures can counteract them. More and more planetary boundaries are being exceeded.

What has to happen? It is necessary that industrialized countries and companies commit greater financial support to implementing the measures to countries of the structurally weak Global South and East. For there is a close link between poverty and the lack of opportunities for implementing effective management. Agreements need to be more binding; indicators need to developed for verifying the achievement of goals. For example, global action plans to reduce environmental inputs are necessary in connection with exceeding planetary boundaries on phosphorus and reactive nitrogen, as well as consistent implementation and tightening of fertilizer regulations at the national and EU level.

THE APPROACH OF THE EU: THE REACH REGULATION

With the REACH Chemicals Regulation from late 2006 the EU agreed on the most advanced chemicals law in the world. Thus, the EU decisively strengthened the precautionary principle: According to REACH, manufacturers and importers are required to demonstrate that their substances and mixtures can be used without risk to health and the environment in order to be permitted to market them. They must submit safety data in the form of registration dossiers. The marketing of chemicals is subject to the principle "no data, no market." Substances with particularly critical properties are to be gradually replaced by less harmful substances or processes and may only continue to be used with special permission.

The REACH Regulation is a major step forward, but it needs to be implemented more effectively and improved. A central point is the poor data quality of the registration dossiers that are submitted. Although a high percentage of them do not meet the legal requirements, substances may nevertheless still be marketed. Stricter requirements and tougher sanctions are needed here. In addition, the traditional approach of assessing each chemical individually is not adequate for assessing chemical risks. Information transfer in the product chain also needs to be improved, as many companies often fail to pass on important safety-related information to their customers.

If product waste contains substances with particularly critical properties, these are passed on to the secondary products via recycling and thus continue to pose a risk. More transparency on problematic ingredients is therefore just as urgent as significantly harmonizing chemicals, waste and product legislation.

PERSISTENCE AND OTHER CRITICAL PROPERTIES

Substances that cause problems worldwide are often long-lasting (persistent). **Persistence** is thus a key property that leads to substances posing risks to human beings and the environment. Such substances are beyond the scope of conventional chemical

risk assessment, since they accumulate in the environment, can spread widely, and can have effects in remote regions that are only felt after long delays. If adverse effects for human beings or the environment are only detected at a later stage, the substance can no longer be removed from the environment and it is often also difficult to identify the source. Even without (as yet undetected) negative effects, persistent chemicals thus have a high hazard potential. The examples of chlorofluorocarbons (CFCs) and (micro)plastics demonstrate this impressively. Perfluorinated and polyfluorinated chemicals (PFCs), which are used in textiles, fire extinguishing foams, and coatings, as well as in processes such as electroplating, are extremely persistent. Such PFCs are now widely used across the globe. In many cases, high levels of toxicity have been detected. The use of this entire substance group must be abandoned to the highest possible extent

Persistent substances that **bioaccumulate** should be viewed very critically. They are usually scarcely soluble in water and accumulate – often because of their lipid solubility – in living organisms. They are now found everywhere in alarmingly high concentrations in animals such as seals and birds of prey or in humans. Classical examples are highly chlorinated compounds such as polychlorinated biphenyls (PCBs) and brominated diphenyl ethers (PBDEs), which have long been used as flame retardants.

Other persistent substances are water-soluble, seep away easily, and are carried over long distances in groundwater. If groundwater or bank filtrate is used for drinking water, water treatment can scarcely remove such persistent mobile substances by means of activated carbon adsorption. Substances with such properties should thus be added to the candidate list of substances of very high concern (SVHC) under the REACH Regulation.

Particularly problematic are **substances having endocrine disrupting properties**. These so-called endocrine disruptors (ED) act on the hormonal systems of humans and animals even in very small quantities. They simulate or block hormones or influence their action, formation, transport and degradation. The timing of their action is often decisive, as they affect the development of organs and metabolic processes, especially in the embryonic and fetal phases of life. For example, EDs are associated with low fertility, dramatically decreasing sperm counts, genital abnormalities, increased incidence of hormone-dependent cancers such as breast and prostate cancer, immunodeficiency, diabetes and learning and behavioral disorders. Production and use of such substances are still insufficiently regulated.

Due to their tiny size and associated properties **nanomaterials** are making new technological applications possible. Because of their small size, they can also enter living cells. Their effects and behavior in the human organism and in the environment thus depend not only on their chemical composition, but also on physical-chemical properties such as particle size, surface chemistry or surface charge. New testing strategies are needed to assess the risks posed by nanomaterials.

Conventional chemical assessment has even more shortcomings: Toxicologists usually determine the effects of individual substances. However, humans and the environment are exposed to many substances simultaneously or in succession. They thus often underestimate the risks of combined effects. This shows that the precautionary principle must be increasingly included in risk assessment and management. Combined effects are also one of the reasons why a large number of micropollutants in waters lead to more damaging effects than predicted by laboratory tests.

In addition, classic risk assessment often underestimates **indirect effects**. Examples include:

- Herbicides that are eliminating wild herbs. In this way, insects and, as a result, also birds, are deprived of their means of survival. This is one reason why insect and bird life is dying off in agricultural ecosystems.

- Reactive nitrogen compounds such as ammonia and nitrate influence biochemical and geochemical cycles in a variety of ways: Water and soil are overfertilized. Nitrous oxide contributes to the greenhouse effect.

In order to cope with the diversity of substances and their adverse effects, chemicals should be used sparingly and only when it is of benefit to society. One approach is **sustainable chemistry**. This means that the production, use and disposal of substances have to be in line with the rules of sustainability. Often non-chemical alternatives also offer advantages – for example wood or paper instead of plastic.

Since many ingredients of products intentionally or unintentionally enter the environment during their use phase and are detected in waters, soils and (indoor) air, chemical substances must also be as sustainable as possible, i.e., they need an "ecological molecular design." They should not have any negative effects, should not accumulate in the environment and should not be persistent. Once released, they should degrade into harmless substances as quickly as possible.

Conclusion: Consequently, persistence deserves special attention as it has been shown that many long-lived substances lead to later damage in the environment that was not anticipated when

these substances were introduced. Furthermore, particular attention should also be paid to indirect effects, combination effects and the evaluation of nanomaterials and endocrine disruptors.

MANAGE MATERIAL FLOWS ECOLOGICALLY!

Forms of **ecological material flows management** based on the principles of precaution and sustainability are needed. Such material flows management includes, for example, the circular economy, in which waste is avoided, reused and recycled, and substance cycles and technical solutions taken from nature (keyword: bionics), which are characterized by the fact that they interact with locally available substances in a spatially and temporally limited manner and with a high degree of effectiveness and efficiency.

Consumption of resources must decrease. It is essential to keep substances and material flows as low and their constituent components as simple as possible.

The fact that modern products often have a complex structure is contributing to the increase in material flows. One example is plastics used for weight reduction in the automotive industry. They contain additives and often consist of several polymers. Films or foils for food packaging sometimes are also made of complex multilayered plastics with additives. It is usually not possible to recycle such products. Many other products are short-lived. Often components are glued together and not interchangeable. Disposable packaging as well as Internet retail trade are leading to ever-growing waste streams. This shows that, in addition to measures to increase efficiency and recycling, in particular reduced consumption (sufficiency) is a crucial approach to reducing material flows and making them environmentally compatible.

Material cycles start with the extraction and processing of raw materials and pass through the product and waste phase to reuse or recycling. Sustainable materials management also involves **requirements for product design** – keywords are recyclability, easily separable material mixtures and separable components – as well as for **process design**, for example, through a combination of high-quality materials and energy flows with appropriate downstream processes. Material flows should be maintained at a high level of purity as long as possible. Even minor impurities can often only be removed with considerable effort. The more material flows are mixed, the fewer ways of recycling are available.

The use of raw materials has increased dramatically over the past century and will continue to increase over the coming decades. Reaching or exceeding planetary boundaries is foreseeable. An international agreement on the capping of raw materials use – analogous to the Paris Climate Agreement on the Reduction of Greenhouse Gas Emissions – is thus required.

At present, fossil resources (especially oil and gas) predominate, accounting for around 90 percent of the organic raw materials (feedstock) in chemical production. This is not sustainable. Biomass and synthetic raw materials from carbon dioxide and hydrogen obtained using renewable energy are possible alternative sources of raw materials. Because of limited resources and food competition, biomass has a limited extent and synthetic chemical raw materials require large amounts of energy. This shows that there is no way around resource efficiency, recycling and reducing the amount of useless products – in other words, sufficiency – if a sustainable chemicals and materials policy is to be achieved.

STEMMING THE FLOOD OF PLASTICS

Until recently, if anything, plastics in the environment were considered an aesthetic problem. That has changed. Plastics are extremely persistent. Some also contain toxic additives that can be released. Today plastics are found in all environmental media: in the sea, in rivers and lakes, in soils, compost and sewage sludge, and also in humans and animals.

Plastics challenge the circular economy: More than 25 million tons of plastic waste are produced in the EU every year, of which only a small proportion is recycled into new plastic. Much of the plastic collected is exported. The decision of the Basel Convention of May 2019 will in future restrict such exports to clean, sorted (unmixed) plastic waste. The European Commission's 2016 plastic strategy shows ways to reduce the environmental impact of plastics and increase the recycling rate. A directive also bans some plastic articles and extends labeling and obligations to accept returned materials. These requirements will not be sufficient. To significantly reduce the amount of plastic waste, a further group of measures is called for. In particular, the use of disposable plastic packaging must be drastically reduced through bans as well as imposed deposits and levies. Recycling into the highest quality products possible must be expanded. This requires improved and effective collection and sorting systems and – where possible – the elimination of multi-component plastics, so-called composite plastics.

However, the flood of plastics is not merely a waste problem. On the contrary, significant reductions in production and consumption are needed. A change in consumption is necessary. Plastic is a worldwide problem. That is why, in order to combat the global plastics pollution, the EU should propose a legally binding international convention.

THE NEW CHEMICALS AND MATERIALS POLICY IN RESEARCH AND EDUCATION

Many findings concerning the contamination and overloading of the Earth with chemicals have resulted from scientific research in recent decades. But many questions are open, many connections unknown. There is a great need for research into the development of precautionary chemicals management and a sustainable chemicals and materials policy. Some examples: In particular, assessment criteria for the global effects of persistent substances and a more detailed design of the planetary boundary "novel entities" are needed. In addition, the many effects of substances in the environment require new methods and more accurate data. However, knowledge gaps and the need for further research are no justification for lack of action in reducing existing risks in accordance with the precautionary principle!

In terms of training and further education, it is necessary to firmly establish sustainable chemistry and material flows management in science and engineering courses. This also applies to courses offered in training and further education, information offers for members of the public and teaching materials for schoolchildren.

SUMMARY

In order to reduce the exposure of humans and the environment to chemicals in a significant way, a sustainable chemicals and materials policy is needed for

- **Substances have an impact at the global level. Like climate change and the loss of biodiversity, they threaten the ecological balance of the entire planet, and**
- **The persistence of materials represents a key danger that needs to be addressed systematically. It also causes long-term problems like greenhouse gases or radioactive waste generated by nuclear energy.**

Key guiding principles for a sustainable chemicals and materials policy are the precautionary principle and sustainable material flows management with an emphasis on sufficiency. This policy must increasingly focus on the flow of substances from their first application to reuse, and must thus focus on the following four guiding principles:

- **Chemicals and materials policy must generally focus on the principles of precaution and sustainability.**
- **Today, it must have the global goal of not exceeding planetary boundaries.**
- **Material flows must be slowed down and reduced both regionally and globally.**
- **A sustainable chemicals and materials policy must link chemicals policy, product policy and the circular economy.**

The implementation of these principles would thus also help to protect biodiversity and combat climate change.

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Friends of the Earth (FoE) Germany calls for sustainable chemistry as well as consistent implementation of a sustainable resource and chemicals policy, with special emphasis on the precautionary principle.

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The full version of this FoE Germany position paper with further supportive arguments, detailed demands, and full documentation can be downloaded at
www.bund.net/chemicals-policy
www.bund.net/chemicals-policy-abstract