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Global Chemicals Outlook

Towards Sound Management of Chemicals

Trends and changes

Economic implications

Policy responses

Health and environmental effects

Synthesis Report for Decision-Makers

Disclaimer

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Glossary

ACC	American Chemistry Council
BRIICS	Brazil, Russia, India, Indonesia, China, South Africa
CEFIC	European Chemicals Industry Council
DALY	Disability Adjusted Life Year
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
ICCA	International Council of Chemical Associations
ILO	International Labour Office
IPEN	International POPs Elimination Network
MEA	Multilateral Environment Agreement
NGO	Non Governmental Organization
ODA	Overseas Development Assistance
OECD	Organization for Economic Cooperation and Development
PCBs	Polychlorinated Biphenyls
POPs	Persistent Organic Pollutants
PRTR	Pollutant Release and Transfer Register
REACH	Registration, Evaluation and Authorization of Chemicals
SAICM	Strategic Approach to International Chemicals Management
SME	Small and Medium-sized Enterprise
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Programme
UNITAR	United Nations Institute for Training and Research
VOC	Volatile Organic Compound
WHO	World Health Organization
WSSD	World Summit on Sustainable Development

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The Global Chemicals Outlook synthesis report was coordinated by Kaj Madsen and Pierre Quiblier, Chemicals Branch, UNEP, under the guidance of Sylvie Lemmet, Director, Division of Technology, Industry and Economics, UNEP; Tim Kasten, Head, Chemicals Branch, UNEP; Per Bakken, UNEP (retired); Fatoumata Keita-Ouane, Head, Assessment Branch, Division of Early Warning and Assessment (DEWA), UNEP; and Ludgarde Coppens, Programme Officer, DEWA, UNEP. This report is the product of a stakeholder convening process in which Steering Committee members developed framing papers to highlight key questions. Rachel Massey coordinated the activities of the Steering Committee in this first phase of the project. The editing and the publication were coordinated by Cyrille-Lazare Siewe, with the administrative guidance of Ardeshir Zamani both from Chemicals Branch, UNEP. UNEP wishes to thank the Governments of Norway and Sweden for their funding and the following individuals whose efforts made this synthesis report possible.

[1] The Steering Committee met five times over two years. Its mandate was to review the detailed work plan, provide substantive input, and ensure the coherence, consistency and comprehensiveness of the report.

Authors and Co-authors of the Three Chapters:

Chapter I: Trends and Indicators
Rachel Massey* and Molly Jacobs**

* Massachusetts Toxics Use Reduction Institute, University of Massachusetts Lowell
** Lowell Center for Sustainable Production, University of Massachusetts Lowell

Chapter II: Economic Implications of Trends in Chemicals Production, Trade and Use
Louise A. Gallagher

Independent consultant for UNEP Chemicals Branch, DTIE

Contribution to Chapter II from a financial and insurance perspectives: Risks to the Financial Sector from Chemicals
Dr Andrew Dlugolecki

Principal, Andlug Consulting, assisted by Dr Laura Cochran, Deveron Cochran Ltd

Chapter III: Instruments and Approaches for the Sound Management of Chemicals
Ken Geiser+ and Sally Edwards++

+ Department of Work Environment and Lowell Center for Sustainable Production, University of Massachusetts Lowell
++ Lowell Center for Sustainable Production, University of Massachusetts Lowell

Participants in the meetings of the Steering Committee

Governments

Ms. Ingela ANDERSSON, Director of International Programme, Swedish Chemicals Agency (KemI).
Mr. Christopher BLUM, Scientific Officer, German Federal Environment Agency, International Chemicals Management.
Ms. Maria DELVIN, Senior Advisor, Swedish Chemical Agency (KemI).
Mr. Lars DRAKE, Ph.D., Scientific Advisor, Swedish Chemicals Agency (KemI).
Mr. Idunn EIDHEIM, Director General, Norwegian Ministry of Environment.
Mr. Atle FRETHEIM, Deputy Director General, Norwegian Ministry of the Environment.
Ms. Johanna LISSINGER PEITZ, Policy Assistant, Swedish Ministry of the Environment (KemI).
Ms. Monika LUXEM-FRITSCH, Deputy Head, German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety.
Ms. Abiola OLANIPEKUN, Assistant Director, Nigerian Federal Ministry of Environment.
Mr. Long RHITIRAK, Deputy Director General, Cambodian Ministry of Environment.
Ms. Sezaneh SEYMOUR, Division Director, U.S. Department of State, Division of Air Pollution and Chemicals.

Inter-Organization Programme for the Sound Management of Chemicals (IOMC)

Mr. Pavan BAICHOO, Technical Officer, International Labor Office (ILO).

Mr. Mark DAVIS, Programme Coordinator and Chief Technical Advisor, Food and Agriculture Organization (FAO).

Ms. Nathalie DELRUE, Test Guideline Programme, Administrator, Organization for Economic Co-operation and Development (OECD).

Mr. Sebastian GIL, Delegated Representative, European Commission.

Mr. John HAINES, Ph.D., Senior Special Fellow, United Nations for Training and Research (UNITAR).

Mr. Dadan Wardhana HASANUDDIN, Programme Officer, Secretariat of the Basel Convention, United Nations Environment Programme (UNEP).

Mr. Jonathan KRUEGER, Programme Officer, Programmes in Chemicals, Waste and Environmental Governance, United Nations Institute for Training and Research (UNITAR).

Mr. Heinz LEUENBERGER, Director, Energy and Cleaner Production Branch, United Nations Industrial Development Organization (UNIDO).

Ms. Katarina MAGULOVA, Programme Officer, Secretariat of the Stockholm Convention, United Nations Environment Programme (UNEP).

Mr. Tomas MARQUES, Associate Programme Officer, United Nations Environment Programme (UNEP), Business and Industry Unit, Sustainable Consumption and production Branch, DTIE.

Ms. Helen MCCARTHY, Delegated Representative, European Commission.

Mr. Michihiro OI, Administrator, Organization for Economic Co-operation and Development (OECD).

Ms. Annette PRUSS-ÜSTUN, Scientist, World Health Organisation (WHO).

Ms. Carolyn VICKERS, Team Leader, Chemical Safety Evidence and Policy on Environmental Health, World Health Organisation (WHO).

Mr. Ron WITT, GRID Manager, United Nations Environment Programme (UNEP) Division of Early Warning and Assessment (DEWA) Global Resource Information Database (GRID), DTIE.

Private Sector

Ms. Birgit ENGELHARDT, Representative to the UN, International Council of Chemical Associations (ICCA).

Mr. Arthur FONG, Program Manager, Chemical Management and Senior Scientist, IBM Corporation.

Ms. Véronique GARNY, Director, Product Stewardship, European Chemicals Industry Council (CEFIC).

Mr. Michael GRIBBLE, Scientific Officer, Science Industries Switzerland (SCGI Chemie Pharma Schweiz), representing ICCA.

Mr. Thomas JACOB, Principal, T.R. Jacobs & Associates, International Council of Chemical Associations (ICCA) and American Chemistry Council (ACC).

Ms. Lena PERENIUS, Executive Director, Product Stewardship, International Council of Chemical Associations (ICCA).

Non Governmental Organizations (NGOs)

Ms. Judith CARRERAS GARCIA, Project Coordinator, Sustainlabour International Labour Foundation for Sustainable Development.

Mr. Joseph DIGANGI, Ph.D., Senior Science and Technical Advisor, International POPs Elimination Network (IPEN).

Mr. David HANHARAN, Ph.D., Director of Global Operations, Blacksmith Institute.

Ms. Lora VERHEECKE, Policy Assistant, International Trade Union Confederation (ITUC).

Academia

Mr. Babajide ALO, Ph.D., Director, Centre for Environmental Human Resources Development.

Mr. Ricardo BARRA, Ph.D., University of Concepción.

Mr. Hendrik BOUWMAN, Ph.D., Scientific and Technical Advisory Panel of the GEF, School of Environment Sciences and Development
North-West University.

Mr. Richard CLAPP, Ph.D., Professor, Boston University School of Public Health.

Mr. Leonardo TRASANDE, Ph.D., Faculty Member in Pediatrics and Environmental Medicine and Health Policy, New York University.

Consultants

Mr. Thomas CONWAY, Ph.D., President, Resource Future International.

Mr. Andrew DLUGOLECKI, Ph.D., Principal, Andlug Consulting.

Ms. Louise A. GALLAGHER, PhD., Consultant, Chemicals Branch, DTIE, United Nations Environment Programme (UNEP).

Mr. Kenneth GEISER, Ph.D., Co-director Lowell Center for Sustainable Production and Professor of Work Environment, University of Massachusetts Lowell.

Ms. Khanam JAUHAN, Consultant, Chemicals Branch, DTIE, United Nations Environment Programme (UNEP).

Ms. Sharon KHAN, Consultant, Chemicals Branch, DTIE, United Nations Environment Programme, (UNEP).

Ms. Rachel MASSEY, MPA, MSc, Senior Associate Director and Policy Program Manager, Toxics Use Reduction Institute, University of Massachusetts Lowell.

Mr. Armand RACINE, Consultant, Chemicals Branch, DTIE, United Nations Environment Programme (UNEP).

UNEP Secretariat

Mr. Pierre QUIBLIER, Programme Officer, Chemicals Branch, DTIE, United Nations Environment Programme (UNEP).

Mr. Kaj MADSEN, Senior Programme Officer, Chemicals Branch, DTIE, United Nations Environment Programme (UNEP).

Mr. Cyrille-Lazare SIEWE, Scientific Affairs Officer, Chemicals Branch, DTIE, United Nations Environment Programme (UNEP).

Foreword

The way the world manages chemicals will play a key role in the transition towards an inclusive Green Economy and the realization of a sustainable 21st century.

Governments across the globe recognize that chemicals are essential in areas from medicine and agriculture to consumer goods, clean technologies and overcoming poverty yet chemicals and the pollution linked with their manufacture, use, and disposal come at a cost.

There is increasing recognition among governments, non-governmental organizations and the public that human health and the environment are being compromised by the current arrangements for managing chemicals and hazardous wastes.

These concerns take on a new level of urgency as the quantity and range of new and existing chemicals grow rapidly in developing countries and economies in transition.

At the World Summit on Sustainable Development in 2002, governments agreed on "using and producing of chemicals in ways that do not lead to significant adverse effects on human health and the environment" and set a deadline of 2020 to achieve this goal. This commitment was reaffirmed at the Rio+20 Summit in Brazil in 2012.

This report, *Global Chemicals Outlook*, which was compiled by UNEP working with international experts, is designed to inform governments and industry on trends in chemicals production, use and disposal while offering policy advice aimed at meeting the 2020 goal. It focuses particularly on the challenges and opportunities facing developing nations.

The report, which also supports the work and actions of the three chemical and hazardous waste conventions— Basel, Rotterdam and Stockholm—and the Strategic Approach to International Chemicals Management, demonstrates the dramatic growth in the industry, which has seen global output climb from $171 billion in 1970 to over $4.1 trillion today.

The shift in production from developed to developing countries is underscored by China, which today is the largest consumer of textile chemicals with 42% of global consumption, and South Africa, where spending on pesticides has grown by close to 60 per cent since the late 1990s.

The Global Chemicals Outlook states that of the 5.7 million metric tonnes of pollutants released in North America (United States, Canada and Mexico), close to two million were chemicals that are persistent, able to accumulate in humans and animals and are toxic. The report also deemed toxic a further million tonnes of substances that are linked with or have suspected links with cancer.

An important aspect of this new report is the economic analysis that compares the benefits of action to the costs of inaction in terms of improved management.

2020 is fast approaching. I am sure that this report can provide some much-needed energy, focus and confidence that what was agreed in 2002 can be met, thus bringing significant benefits for the global population and the environmental services upon which each one of us depends for our lives and livelihoods.

Achim Steiner
UNEP Executive Director
United Nations Under-Secretary General

INTRODUCTION

Chemicals are an integral part of daily life in today's world. There is hardly any industry where chemicals are not used and there is no single economic sector where chemicals do not play an important role. Millions of people throughout the world lead richer, more productive and more comfortable lives because of the thousands of chemicals on the market today. These chemicals are used in a wide variety of products and processes and while they are major contributors to national and world economies, their sound management throughout their lifecycle is essential in order to avoid significant and increasingly complex risks to human health and ecosystems and substantial costs to national economies.

The exact number of chemicals on the global market is not known but under the pre-registration requirement of the European Union's chemicals regulation, REACH, 143,835 chemical substances have been pre-registered. This is a reasonable guide to the approximate number of chemicals in commerce globally.

Industries which produce and use chemicals have a significant impact on employment, trade and economic growth worldwide, but chemicals can have adverse effects on human health and the environment. A variety of global economic and regulatory forces influences changes in chemical production, transport, import and export, use and disposal over time. In response to the growing demand for chemical-based products and processes, the international chemical industry has grown dramatically since the 1970s. Global chemical output (produced and shipped) was valued at US$171 billion in 1970. By 2010, it had grown to $4.12 trillion (figures not adjusted for inflation or price changes).

The OECD's *Environmental Outlook to 2050* notes that while annual global chemical sales doubled over the period 2000 to 2009, OECD's share decreased from 77% to 63% and the share of the BRIICS countries (Brazil, Russia, India, Indonesia, China, and South Africa) increased from 13% to 28%. Figures 1 and 2 illustrate the growth of chemical industry output over time, broken out by country or region.

Many national governments have enacted laws and established institutional structures with a view to managing the hazards of this growing volume of chemicals. Leading corporations have adopted chemical management programs and there are now many international conventions and institutions for addressing these chemicals globally. However, the increasing variety and complexity of chemicals and the ever longer and more intricate chemical supply chains and waste streams exposes serious gaps, lapses and inconsistencies in government and international policies and corporate practices. Consequently, international concerns are growing over the capacity to achieve the Johannesburg Plan of Implementation goal that, by 2020, chemicals will be produced and used in ways that minimize significant adverse effects on the environment and human health.

These concerns are important to all countries, but are particularly salient in industrializing economies that face pressing needs to achieve development, national security and poverty eradication objectives. One obstacle to integrating the sound management of chemicals into the broader sustainable development agenda is the tendency to address and consider chemicals on a case-by-case basis separate from the economic development agenda. To protect human health and the environment and to fully benefit from the value that chemicals can yield, all countries must include in their economic and social development priorities the means to manage chemicals soundly.

This synthesis report for decision-makers highlights the main findings and conclusions of the full report: Global Chemicals Outlook: Towards Sound Management of Chemicals. The Global Chemicals Outlook report assembles scientific, technical and socio-economic information on the sound management of chemicals. It is targeted to decision makers in order to build capacity and to implement policy change to protect the environment and human health. As such, the Global Chemicals Outlook covers three broad inter-linked areas building upon the findings of existing and concurrent studies:

1. Trends and indicators for chemical production, transport, use and disposal, and associated health and environment impacts;
2. Economic implications of these trends including costs of inaction and the benefits of action; and
3. Instruments and approaches for sound management of chemicals, including promotion of safer alternatives and guidance to accelerate the achievement of SAICM goals by 2020.

Figure 1. Chemical Industry Output: Developed Regions*

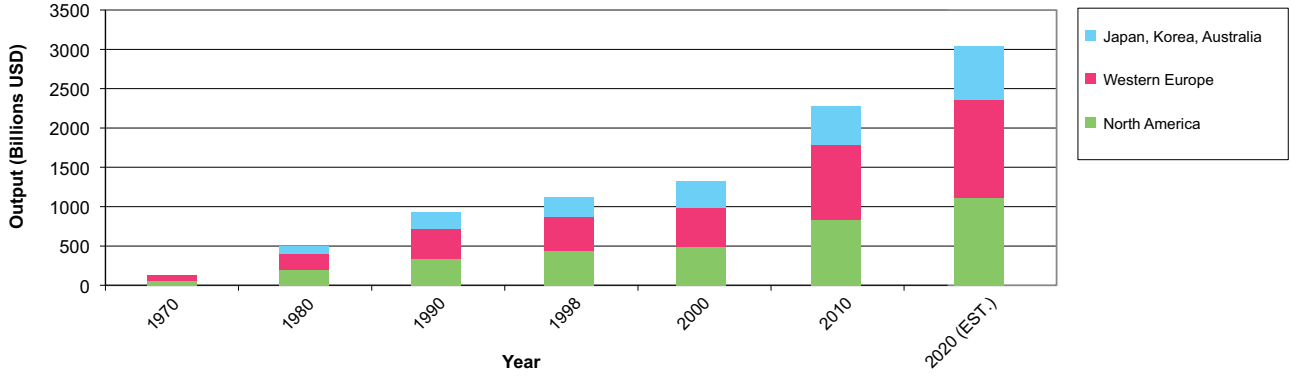
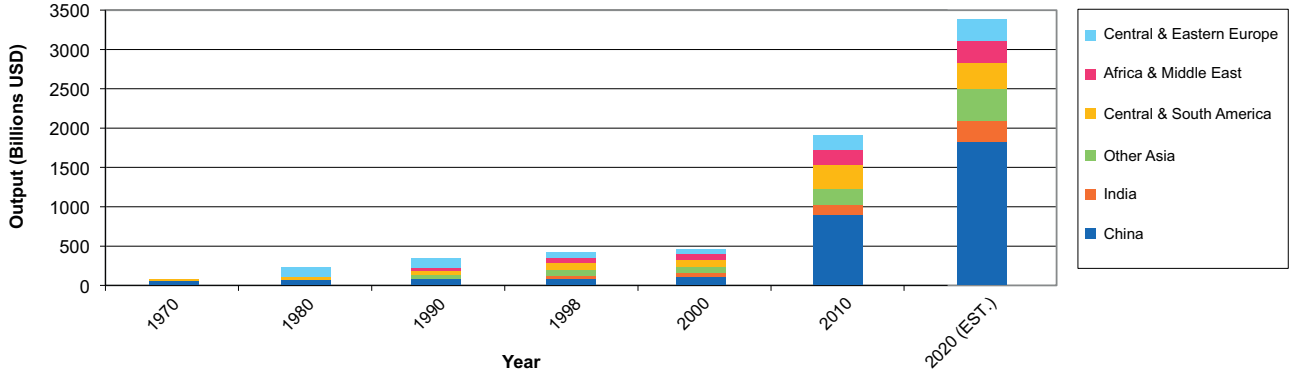


Figure 2. Chemical Industry Output: Developing Regions* & Countries with Economies in Transition



*As categorized by UN Statistics Division, http://unstats.un.org/unsd/methods/m49/m49regin.htm, accessed 24 November, 2011, with the exception of the Republic of Korea. *1970-1990 Source:* Organization for Economic Development (OECD). (2001.) *OECD Environmental Outlook for the Chemicals Industry.* Paris: OECD Environment Directorate. *2000-2010 Source:* American Chemistry Council (2011). "Global Business of Chemistry: Global Chemical Shipments by Country/Region (billions of dollars)." Retrieved from: http://www.americanchemistry.com/Jobs/EconomicStatistics/Industry-Profile/Global-Business-of-Chemistry. Accessed: 11 August, 2011. *2020 Estimation Source:* American Chemistry Council, *Mid-Year 2011 Situation & Outlook*, June 2011. Figures shown here are not adjusted to reflect price changes or inflation.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I - GLOBAL PRODUCTION, TRADE, USE AND DISPOSAL OF CHEMICALS AND THEIR HEALTH AND ENVIRONMENTAL EFFECTS: AN INCREASING CHEMICAL INTENSIFICATION[2] OF THE ECONOMY

Both the continuous growth trends and the changes in global production, trade and use of chemicals point toward an increasing chemical intensification of the economy. This trend affects all countries but will particularly exert an added chemicals management requirement on developing countries and countries with economies in transition that often have limited capacities to deal with such complex challenges.

This chemical intensification of the economy derives largely from three factors: 1) the increased volume and a shift of production and use from highly industrialized countries to developing countries and countries in economic transition; 2) the penetration of chemical intensive products into national economies through globalization of sales and use; 3) the increased chemical emissions resulting from major economic development sectors.

1) Increased volume of chemical production and imports and shift of chemical production and use from highly industrialized to developing countries

Studies, projecting trends to 2050, forecast that global chemical sales will grow about 3% per year to 2050. However as chemical production, trade, use and disposal continue to expand worldwide, this expansion is not evenly distributed geographically. Chemical manufacturing and processing activities, once largely located in the highly industrialized countries, are now steadily expanding into developing countries and countries with economies in transition. Chemical use in developing countries is influenced both by countries' needs for additional production domestically, and by production related to trade. Factors influencing the location of growth of chemical use in manufacturing include proximity to raw materials, proximity to final markets and a suite of other factors. The worldwide expansion of the chemicals industry has been driven in large part by the emergence of multinational chemical companies as OECD-based companies invested in production facilities in non-OECD countries.

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[2] Chemical intensification of economy is used in this report as an analytical framework to better capture the trends and changes in the volume of chemicals produced, used and disposed throughout their lifecycle and the penetration of chemical intensive products into national economies.
Chemical intensification includes:

1. Products of the chemical industry that are increasingly replacing natural materials in both industrial and commercial products. Thus, petrochemical lubricants, coatings, adhesives, inks, dyes, creams, gels, soaps, detergents, fragrances and plastics are replacing conventional plant, animal and ceramic based products.
2. Industries and research institutions which are increasingly developing sophisticated and novel nanoscale chemicals and synthetic halogenated compounds that are creating new functions such as durable, non-stick, stain resistant, fire retardant, water-resistant, non-corrosive surfaces, and metallic, conductive compounds that are central to integrated circuits used in cars, cell phones, and computers.

Chemical intensification is not just a measure of the chemical production and use but reflects changes in functions of chemicals and the importance of chemicals in all aspects of economic development. It also incorporates the increased complexity of chemicals themselves and the ever lengthening and more intricate chemical supply chain. The potential for negative effects on environment and human health of the chemical intensification of the economy if unregulated shows the importance of advancing the sound management of chemicals now. The concept of chemical intensification, possible indicators and ways to measure it, is still under development.

OECD member countries as a group still account for the bulk of world chemical production, but developing countries and countries with economies in transition are increasingly significant. Over the last decade, chemical production in the BRICS countries has far exceeded the growth rates of the OECD countries (Figures 1 and 2). For example, from 2000 to 2010, chemical production in China and India grew at an average annual rate of 24% and 14%, respectively, whereas the growth rate in the United States, Japan and Germany was between 5 and 8%.

In 2001, the OECD issued projections that by 2020, developing countries would be home to 31% of global chemical production, and 33% of global chemical consumption. Recent forecasts from the American Chemistry Council (ACC) also predict significant growth in chemical production in developing countries in the period to 2021 and more modest growth in developed countries (Table 1).

Table 1. Chemical Production: Predicted Growth, 2012-2020

		Percent change, 2012-2020	
North America		25%	
	United States		25%
	Canada		27%
	Mexico		28%
Latin America		33%	
	Brazil		35%
	Other		31%
Western Europe		24%	
Emerging Europe		35%	
	Russia		34%
	Other		36%
Africa & Middle East		40%	
Asia-Pacific		46%	
	Japan		22%
	China		66%
	India		59%
	Australia		23%
	Korea		35%
	Singapore		35%
	Other		44%

Source: Percentages calculated based on projections for the regions and for selected countries by Swift, Thomas Kevin et al., (June 2011). "Mid-Year 2011 Situation & Outlook,» American Chemistry Council.

2) Penetration of chemical intensive products into national economies

Many countries are primarily importers of chemicals and are not significant producers. Agricultural chemicals and pesticides used in farming were among the first synthetic chemicals to be actively exported to developing countries.

Today, as consumption of a wide range of products increases over time, these products themselves become a significant vehicle increasing the presence of chemicals in developing and transition economies (Table 2). These include liquid chemical personal care products for sale directly to consumers; paints, adhesives and lubricants; as well as chemically complex articles ranging from textiles and electronics, to building materials and toys. Emissions from products pose different management challenges from those associated with manufacturing, as they are diffused throughout the economy, rather than being concentrated at manufacturing facilities.

Increasingly, articles are important vehicles of the global transport of chemicals with potentially significant impacts at every stage of the product life cycle. For example, trade in articles has been identified as a significant driver of global transport of lead, cadmium, mercury and brominated flame retardants. In some instances, the most significant human and environmental exposures occur through product use and disposal, and are added to those occurring during manufacturing.

It is often the case that electrical and electronic equipment, which contain hazardous or toxic substances, are purchased in developed countries before being disposed of or recycled in unsafe and unprotected conditions in developing or countries with economies in transition. Products such as cell phones and laptops are being purchased and used in regions of the world recently thought to be too remote. Increasing consumer demand for electrical/electronic goods and materials, along with rapid technology change and the high obsolescence rate of these items have led to the increasing generation of large quantities of obsolete and near end of life electronic products. These trends contribute to global electronic waste generation estimated at 40 million tons per year. These trends are expected to rise with the increased use and disposal of electronic products by developing countries and countries with economies in transition.

During just the first quarter of 2010, worldwide shipments of personal computers were estimated to total 84.3 million units, an increase of 27% from the first quarter in 2009.

Worldwide sales of mobile phones were estimated to total 314.7 million units in the first quarter of 2010, a 17% increase from the same period in 2009.

Table 2. Examples of Toxic Substances in Articles

Article	Chemical & health effects	Pathways of Exposure
Automobiles		
Automotive switches	Mercury. Effects include neurotoxicity, including developmental neurotoxicity (methyl mercury) as well as organ damage.	Mercury can be released when automobiles with mercury-containing switches are crushed or shredded. Elemental mercury can be transformed into methylmercury, which is bioaccumulative. Humans can be exposed through consumption of contaminated fish and other routes.
Tires	Polycyclic aromatic hydrocarbons (PAHs); 1,3-butadiene. Effects include the following: some PAHs are carcinogenic, and 1,3-butadiene is a known human carcinogen.	Highly aromatic oils containing PAHs are used to make the rubber polymer easier to work and to make the tire tread soft. Rubber particles containing PAHs can wear off tires over time, dispersing PAHs into the environment.
Wheel weights	Lead. Effects include neurotoxicity, including developmental neurotoxicity; high blood pressure; organ damage.	Lead wheel balancing weights fall off car wheels, then are run over by other cars and dispersed into the environment.
Electronic Products		
Electronic products	Lead, mercury, cadmium, brominated flame retardants. Effects of cadmium include carcinogenicity; possible damage to fertility; possible fetal damage; organ damage. Effects of brominated flame retardants include neurotoxicity; thyroid disorders. Effects of lead and mercury are listed above.	Heavy metals and brominated flame retardants are released during disposal or recycling of electronic wastes. Developing countries and countries with economies in transition bear a particularly large burden from unsafe disposal and recycling of these articles.
Batteries	Lead. Effects of lead are listed above.	The major use for lead globally is in lead-acid batteries. In many countries, recycling of batteries/car batteries is a common source of human and environmental exposure to lead.
Children's products		
Toys	Lead, cadmium, phthalates. Effects of some phthalates include endocrine disruption, effects on fertility, and possible effects on sexual development. Some phthalates are possible carcinogens. Effects of lead and cadmium are listed above.	Toys and children's jewelry can contain lead in the form of lead paint and metal clasps, chains or charms. Lead is also used as a stabilizer in some toys and other children's items made from PVC plastics. Lead can leach out of these products during use. Phthalates are used as plasticizers (i.e., chemical agents that make plastics soft and flexible) in toys made of polyvinyl chloride (PVC) plastics. These substances leach out of toys during use.

Adapted from: Massey, R., Becker, M., Hutchins, J. (2008). *Toxic Substances in Articles: The Need for Information*. Swedish Chemicals Agency.

3) Increased chemical emissions resulting from major economic development sectors

Individual industries that are users of chemicals or that emit significant amounts of chemicals as unintentional by-products also contribute to the chemical intensification of national economies. As developing countries and those in economic transition increase their economic production, related chemical releases have raised concerns over adverse human and environmental effects. Chemical contamination and waste associated with industrial sectors of importance in developing countries include pesticides from agricultural runoff; heavy metals associated with cement production; dioxin associated with electronics recycling; mercury and other heavy metals associated with mining and coal combustion; butyl tins, heavy metals, and asbestos released during ship breaking; heavy metals associated with tanneries; mutagenic dyes, heavy metals and other pollutants associated with textile production; and toxic metals, solvents, polymers, and flame retardants used in electronics manufacturing. An added concern includes the direct exposure resulting from the long range transport of many chemicals through environmental media that deliver chemical pollutants which originate from sources thousands of kilometres away.

Total pesticide expenditures in South Africa rose 59% over the period 1999 to 2009, and are projected to rise another 55% in the period 2009 to 2019.

Economic forecasts in these sectors suggest that emissions will continue to increase. In many developing countries, agriculture is the largest economic sector, and accounts for the most significant releases of chemicals in the economy. Agricultural chemicals, including fertilizers and pesticides, are among some of the largest volume uses of chemicals worldwide. World consumption of fertilizers is estimated to grow 2.6% per year in the period 2010 to 2014. While over 500 different chemicals are used in electronics manufacture, electronic production has grown globally and is expected to continue to grow with an increasing percentage in developing countries and those with economies in transition. China is the largest consumer of textile chemicals with 42% of global consumption, and its consumption of textile chemicals - along with other Asian countries (excluding Japan) - is expected to increase 5% per year over the period 2010 to 2015. Global consumption of cement is anticipated to increase 4% per year to 3.5 billion metric tons in 2013. Sixty-nine percent of world cement consumption in 2013 is predicted to be in China and India. Africa and the Middle East are predicted to be the next largest consumers, accounting for 12% of global demand in 2013.


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HEALTH AND ENVIRONMENTAL EFFECTS OF CHEMICAL EXPOSURES: AN INCREASINGLY COMPLEX CHALLENGE

The release of chemicals continues to affect all aspects of natural resources including the atmosphere, water, soil and wildlife. Chemicals released to the air can act as air pollutants as well as greenhouse gases and ozone depleters and contribute to acid rain formation. Chemicals can contaminate water resources through direct discharges to bodies of water, or via deposition of air contaminants to water. This contamination can have adverse effects on aquatic organisms, including fish, and on the availability of water resources for drinking, bathing, and other activities.

It is common for soil pollution to be a direct result of atmospheric deposition, dumping of waste, spills from industrial or waste facilities, mining activities, contaminated water, or pesticides. Soil contamination impacts include loss of agricultural productivity, contamination of food crops grown on polluted soil, adverse effects on soil microorganisms, and human exposure either through food or through direct exposure to contaminated soil or dust.

Persistent and bioaccumulative chemicals are found as widespread contaminants in wildlife, especially those that are high in the food chain. Some of these chemicals cause cancers, immune system dysfunction, and reproductive disorders in wildlife. Dioxins and polychlorinated biphenyls (PCBs) are among the chemicals that have been documented at high levels in wildlife. As measures have been taken to reduce the presence of these contaminants in the environment, others have taken their place. For example, while levels of dioxins and PCBs in wildlife have gradually decreased in most areas, levels of brominated flame retardants and perfluorinated compounds have increased.

Some halogenated organic compounds have been identified as Persistent Organic Pollutants (POPs) under the Stockholm Convention on Persistent Organic Pollutants. The first chemicals listed as POPs under the Stockholm Convention were aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, PCBs, and polychlorinated dibenzo-p-furans and polychlorinated dibenzofurans (PCDD/PCDF). Additional chemicals were added to the list more recently: alphahexachlorocyclohexane; beta hexachlorocyclohexane; chlordecone; technical endosulfan and its related isomers; hexabromobiphenyl; hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octabromodiphenyl ether); lindane; pentachlorobenzene; perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride; and tetrabromodiphenyl ether and pentabromodiphenyl ether (commercial pentabromodiphenyl ether).

Of the 5.7 million metric tons of pollutants released or disposed of in North America in 2006, 1.8 million metric tons were of chemicals considered persistent, bioaccumulative or toxic, 970,000 metric tons were known or suspected carcinogens and 857,000 metric tons were of chemicals that are considered reproductive or developmental toxicants.

Environmental effects of the chemical intensification of the national economies are furthermore compounded by the trans-boundary movement of chemicals through the air or water. In some countries this occurs because they lie downriver or downwind from the polluting industries of neighbouring countries. In other countries, the runoff of pesticides and fertilizers from agricultural fields or the use of chemicals in mining in neighbouring countries, may leach into ground water, or run into estuaries shared across national boundaries. Throughout the globe, atmospheric air currents deliver chemical pollutants which originate from sources some thousands of kilometres away.

Whilst each chemical-intensification factor contributes to a small share of the environmental burden of each country and nation

state, when combined, these together can form an increasingly significant and complex overall mix of chemicals not present fifty years ago. As this chemical intensity increases, the prospects for widespread and multifaceted exposures of humans and the environment to chemicals of high and unknown concern also arise.

Of the tens of thousands of chemicals on the market, only a fraction has been thoroughly evaluated to determine their effects on human health and the environment. Even as progress is being made to develop better information on the effects of chemicals, for example through data submission under the European Union's REACH programme, United States Toxic Substances Control Act (TSCA), Canada's Chemicals Management Plan (CMP) and the Japanese Chemical Substances Control Law, this data remains limited to individual chemicals. Real-life exposures are rarely limited to a single chemical and very little information is available on the health and environmental effects of chemical mixtures.

Nevertheless, many of these chemicals in widespread use have been associated with well-established risks to human health and the environment. Exposure to toxic chemicals can cause or contribute to a broad range of health outcomes. These include eye, skin, and respiratory irritation; damage to organs such as the brain, lungs, liver or kidneys; damage to the immune, respiratory, cardiovascular, nervous, reproductive or endocrine systems; and birth defects and chronic diseases, such as cancer, asthma, or diabetes. The vulnerability and effects of exposure are much greater for children, pregnant women and other vulnerable groups.

Workers in industries using chemicals are especially vulnerable through exposure to toxic chemicals and related health effects. These include an increased cancer rate in workers in electronics facilities; high blood lead levels among workers at lead-acid battery manufacturing and recycling plants; flame retardant exposures among workers in electronic waste recycling; mercury poisoning in small-scale gold miners; asbestosis among workers employed in asbestos mining and milling; and acute and chronic pesticide poisoning among workers in agriculture in many countries.

Toxicological research has also revealed that for a range of chemicals, very low levels of exposure can influence disease risk and that both dose and timing of exposure are important. For example, human exposure to certain chemical toxicants at low levels during periods of rapid growth and cell differentiation (e.g., foetal life through puberty) can be important factors that influence disease risk. Individuals living in poverty are particularly vulnerable, both because their exposures may be particularly high, and because poor nutrition and other risk factors can increase susceptibility to the effects of toxic exposures. Due to their size, children's responses to small doses of toxic chemicals are disproportionately large compared to adults. Because their metabolic pathways are immature, children are also slower to detoxify and excrete many environmental chemicals and thus toxins may remain active in their bodies for longer periods of time (table 3). Research has also made clear that the elderly are among those particularly susceptible to health effects from a range of chemical contaminants.

CHEMICAL IMPACTS ON FISHERIES

Fisheries, an important source of protein and of economic value for populations around the world, can be severely affected by chemicals. Persistent organic pollutants can accumulate in fish, especially those high in the food chain. As a result, the value of this otherwise excellent protein source is diminished or lost completely.

Industrial and agricultural run-off can lead to large-scale fish kills, and lower-level chemical contamination of water bodies can decimate fish populations over time. Chemical contamination is also associated with disease in fish populations, including cancers and increased vulnerability to infectious agents.

Table 3. Studies of Reproductive & Developmental Health Effects Associated with Chemicals: Examples from Developing & Countries in Economic Transition

Conception, pregnancy and foetal and child development are complex processes that research has shown can be adversely affected by industrial chemicals. This table provides a sampling of a few examples from developing countries and countries with economies in transition.

Health Outcome	Country	Example
Reproductive effects	China	Reduced sperm concentration was significantly associated with the urine phthalate metabolite, monomethyl phthalate among a cohort of Chinese men from Chongqing exposed to phthalates in the general environment.
	China	In rural China, elevated placental concentrations of several persistent organic pollutants, including o,p'-DDT and metabolites, ∝-HCH, and PAHs were associated with increased risks of neural tube defects. Strong associations were observed for exposure to PAHs—placental concentrations above the median were associated with a 4.5 fold increased risk for any neural tube defect.
	Sudan	In central Sudan, hospital-and community-based case control studies revealed a consistent and significant two-fold elevated risk of perinatal mortality associated with pesticide exposure. The risk was over three-fold among women engaged in farming.
Developmental Disorders	Mexico	A group of children exposed to high levels of pesticides in an agricultural area showed neurodevelopmental deficits (diminished short-term memory, hand-eye coordination, and drawing ability) compared with children living in otherwise similar communities but with low or no pesticide exposure.
	Ecuador	Ecuadorean school children whose mothers were exposed to organophosphates and other pesticides during pregnancy demonstrated visuospatial deficits compared with their unexposed peers.
	Ecuador	Families living in La Victoria are involved in producing ceramic roof tiles or ceramic objects glazed with lead salts made from melting batteries. Children as young as 6 years of age are engaged in the trade. A small study found very high blood levels in children aged 6-15 years (23 µg/dl to 124 µg/dl, with a mean of 70 µg/dl). Half of the children had repeated one or more years of school.

Note: There is a vast literature on all these health endpoints. Much of the evidence comes from developed countries. For a recent review of the literature see: Stillerman, K.P., Mattison, D.R., Giudice, L.C., et al., (2008). Environmental exposures and adverse pregnancy outcomes: a review of the science. *Reproductive Sciences*.15, 631-650.

Research undertaken recently in developed countries has indeed led to some detailed information concerning the presence of industrial chemicals in the human body. Less research of this kind has been conducted in developing countries, but it is reasonable to conclude that to the extent that people are exposed to the same chemicals, the results will be similar. A 2009 study by the United States Centers for Disease Control (CDC) found that of 212 chemicals studied, all were detected in some portion of the US population. Findings from the report indicate widespread exposure to some industrial chemicals; 90 to 100%" of samples assessed had detectable levels of toxic substances including perchlorate, mercury, bisphenol-A, acrylamide, multiple perfluorinated chemicals, and the flame retardant polybrominated diphenyl ether-47 (BDE-47).

Despite ubiquitous exposure to chemicals in both developed and developing nations, little is known about the total disease burden attributable to chemicals. In 2011, the World Health Organization (WHO) reported that globally, 4.9 million deaths (8.3% of total) and 86 million Disability-Adjusted Life Years (DALYs) (5.7% of total) were attributable to environmental exposure and management of selected chemicals in 2004 for which data were available. This figure includes indoor smoke from solid fuel use, outdoor air pollution and second-hand smoke, with 2.0, 1.2 and 0.6 million deaths/year. These are followed by occupational particulates, chemicals involved in acute poisonings, and pesticides involved in self-poisonings, with 375,000, 240,000 and 186,000 deaths/year respectively.

Estimates for selected chemicals (including pesticides) involved in unintentional acute and occupational poisonings, a limited number of occupational carcinogens and particulates and lead, correspond to a total of 964,000 deaths and 20,986,153 DALYs, corresponding to 1.6% of the total deaths and 1.4% of the total burden of disease worldwide.

To compare, among the global top ten leading causes of death in 2004, HIV/AIDS caused 2 million deaths, tuberculosis caused 1.5 million deaths, road traffic accidents caused 1.27 million deaths, and malaria caused 0.9 million deaths (WHO, 2008).

This global estimate is an underestimate of the real burden attributable to chemicals. Only a small number of chemicals were included in the WHO analysis due to limitations in data availability. Critical chemicals not incorporated in the analysis due to data gaps include mercury, dioxins, organic chlorinated solvents, PCBs, and chronic pesticide exposures as well as health impacts from exposure to local toxic waste sites.


Matt_Roe

II - ECONOMIC AND FINANCIAL IMPLICATIONS: UNRECOGNIZED AND SUBSTANTIAL COSTS AND BENEFITS

The financial cost of chemical exposure on national economies and the public are often unrecognized and substantial. Efforts to overcome the challenging task of quantification indicate that risks associated with a poorly resourced, fragmented and ineffective approach to policy are considerable.

Debates about resource allocations have frequently posited a trade-off between the economic gains associated with industrial development, on the one hand, and the costs imposed by regulation on the other. What is lost in this formulation is recognition that sound chemicals management can yield significant benefits in terms of economic development, poverty reduction, human health and environmental quality. Conversely, the absence of sound chemicals management can impose large economic costs. Preventive approaches to chemical risk management can also create additional benefits beyond 'avoided costs' in the form of improved production and resource efficiencies, trade and investment, innovation and employment impacts.

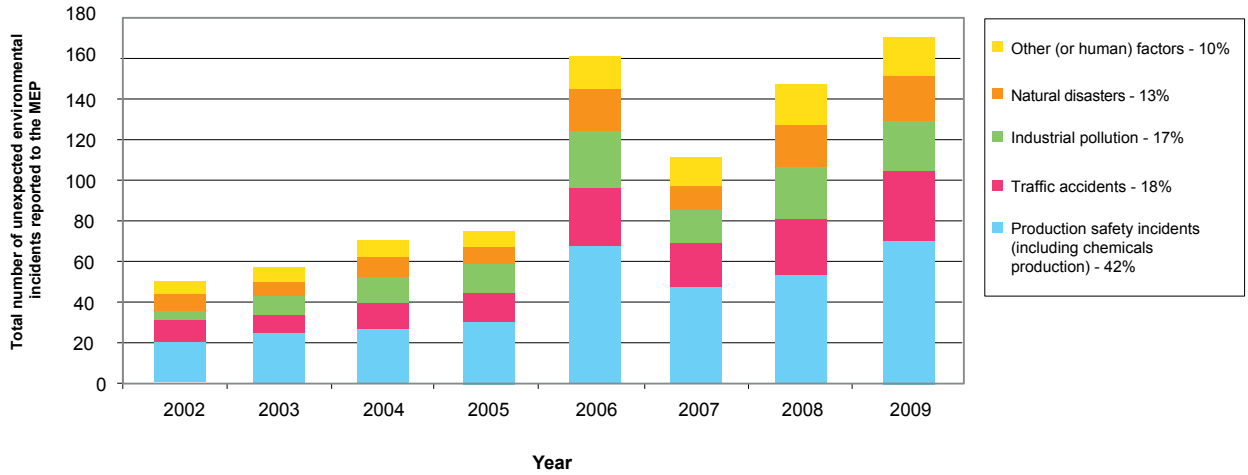
Many countries have the fundamentals of law to manage chemicals; but the implementation is poorly resourced and often fragmented and ineffective. Moreover, weak chemical regulation in developing countries and countries with economies in transition occurs while greater expansion of chemical production and/or use is taking place. Many chemical risks of concern in developing countries exist in developed countries though most are managed more effectively due to greater regulatory infrastructure, financial resources, and techniques learned over time. What is needed is to facilitate the exchange of experience and lessons learned in managing chemical risks between countries. As such, policy responses to keep up with the pace of economic development and related trends in chemical production, transport, import, export, consumption and disposal require further investment in policy development and implementation; and transfer of relevant management experience.

Financial costs to the chemicals and related industries: Higher insurance costs, loss of productivity, reputation impacts

A report from the United Nations Environment Programme, Risks to the Financial Sector from Chemicals, 2012; explores the way in which the financial sector (insurance, banking and asset management) interacts with the chemical sector. The study concludes that poor management of chemicals across lifecycles contributes to inefficiencies in the chemicals industry, with increased risks leading to higher insurance costs, loss of productivity and significant reputation impacts. It also stresses the following implications related to the chemical intensification of developing countries economies. With no progress in policies and regulations, financial risks may increase even further:

a) The scope for unintended incidents is growing rapidly (figure 3); this is compounded by the introduction of numerous novel compounds, e.g., nano-scaled and genetically synthesized chemicals which may, by themselves, or in combination with others, generate new risks. While it is not possible to give an economic estimate of the global chemical risks to the finance sector, the costs incurred in a few specific cases demonstrate that they can be significant. Examples include asbestos (over $100 billion globally), contaminated dry wall ($25 billion), the Bhopal disaster ($3.5 billion), RC2 toys ($500 million).

Figure 3. Growing incidence of environmental accidents as reported to the Ministry of Environmental Protection (MEP) of the People's Republic of China (2002-2009)



Note: Generated based on data contained in two presentations by Professor Zhao Jinsong, Department of Chemical Engineering, Tsinghua University Research Center of Accident Prevention and Emergency in Chemical Process i) "Analysis on Hazard and Operability", UNEP SCP APELL Workshop 26-27 April, 2010, Zhangjiagang. The Office of Emergency Command Leading Group at the Ministry of Environmental Protection compiled the underlying data in 2008 and 2009. The percentages relate to data for 2008 that was used as the baseline for all years; and ii) "Process Safety and HAZOP" UNEP's Global APELL 25th Anniversary Forum held in Beijing, China on 14-18 November 2011.

Three examples of the cost of industrial accidents in the EU and US

- Pasadena, Texas October 1989. A series of explosions at the Phillips Houston Chemical Complex (HCC) killed 23 and injured 314 others. It cost an estimated US$1,5 million in 1996 US dollar terms. A large portion of these costs are attributed to additional business disruption.
- Toulouse, France 21 September 2001. An explosion of ammonium nitrate causing 30 fatalities and an estimated 10,000 injuries. Estimated damage costs of approximately €1.5 billion (US$1.8 billion in 2011 terms).
- Buncefield, United Kingdom December 2005. The Buncefield oil storage depot incident was the biggest explosion and fire in peace-time Europe. 200 people required immediate medical attention and 3,408 litigants subsequently demanding damages. The total cost of the incident was estimated at £1 billion (US$1.5 billion in 2011 dollar terms). A four month trial concluded in July 2010, with five companies being found guilty and ordered to pay a total of £9.5 million (US$14.6 million) in fines and costs.

Note: Fewtrell and Hirst (1998)
Note: http://www.grida.no/publications/et/ep3/page/2607.aspx
Note: British Government website on the Buncefield disaster: http://www.buncefieldinvestigation.gov.uk/index.htm; Hiles (2010)

b) Disastrous incidents make the headlines, but the true costs of chemical mismanagement are dispersed and hidden throughout the population and over time. Such costs are typically carried by a nation's social welfare system and individuals.

c) The chemical intensification of developing country economies has the potential to make this situation worse. The supply chain is now longer and therefore harder to manage; products are more likely to fail to meet standards, and recourse from those parties originally responsible for failure is more difficult to obtain, thus necessitating remediation from those who are 'downstream', or from public bodies in the end-markets. Producers or importers/exporters may be held legally liable for harm caused by poor quality products and services, but in many cases it is their reputation value amongst consumers and investors that is at stake.

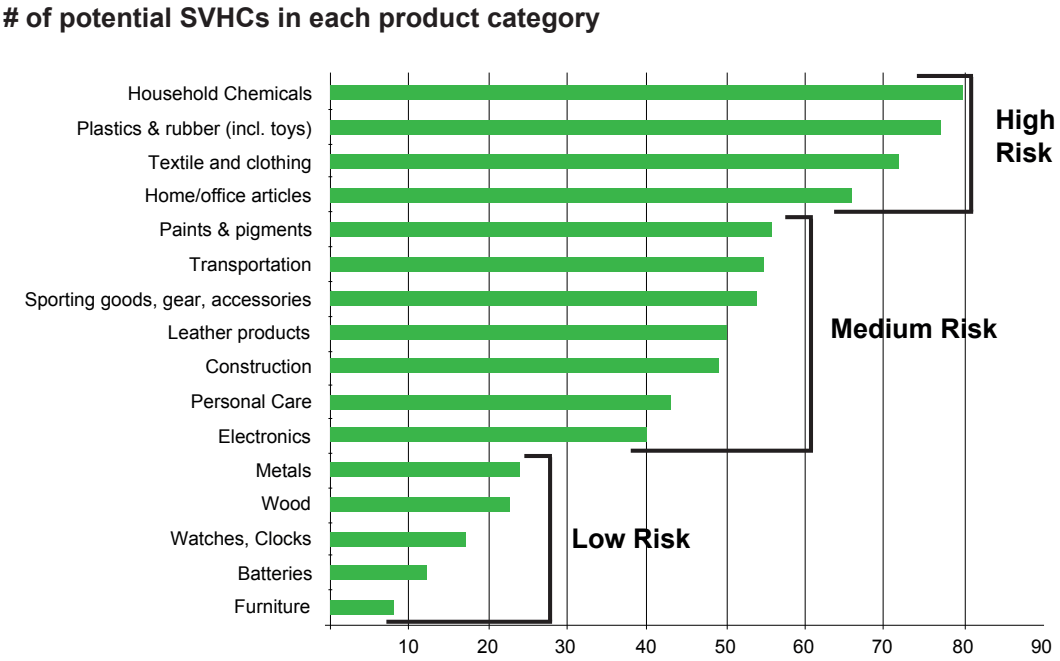
COSTS OF ACCIDENTS

US$ 19 million reported profit made by Trafigura for the 2006 ship leased "Probo Koala" with a shipment of coker gasoline. Total costs paid out by Trafigura to date for waste dumping incident equal approximately **US$ 250 million.**

US$ 600 million to date: treatment of contaminated sludge from the Minamata mercury pollution incident; Over **47,600** people likely to be compensated in the legal process.

d) The insurance sector has been working with the public sector to develop 'safety nets' in the sphere of financial support for large segments of society, through innovative products and services for health care, income replacement, and death-related compensations, but so far these are not seen as part of the solution for handling externalities due to chemical mismanagement. In terms of direct risk transfer, insurers are cautious about involvement with ill-defined risks with potential for major costs. However, shares in chemical companies are a significant element of global stock markets, and therefore movements in their value are of major concern to institutional investors. Further, it is becoming clear that chemical risks affect a much broader range of companies than simply the chemical sector. In recent years, there have been approaches by socially responsible investments (SRI) actors in alliance with NGOs, to policymakers seeking to create a more comprehensive regulatory framework for chemicals of high concern.

Figure 4. Substances of Very High Concern (SVHC) risk profiles for quoted companies



Source: MSCI ESG Research, ChemSec's SIN List 2.0 (May 2011)

Insurance and environmental liability benefits of improved environmental management

The steadily rising cost and impact of environmental risk liability are related to several factors, including past operational activities, current operational activities, business transactions, and financial and reporting obligations. Many private companies and public agencies have found that a sound environmental/chemical management system, such as ISO 14000, is an effective tool for managing their environmental liabilities. Although the primary purpose for the adoption of environmental/chemical management systems is improving environmental performance, insurance companies such as Swiss Re note that such practices can result in substantial economic benefits in terms of insurance. These insurance benefits include the securing of insurability (ability to acquire insurance coverage), lower deductibles, higher limits insured, broader coverage, and more favorable premium rates. For example, following the development and implementation of a pilot environmental management system program, the Port of Houston Authority benefited from a 20% reduction in insurance cost.

Source: Swiss Re. (1998). Environmental management systems and environmental impairment liability insurance. http://www.swissre.com/resources/c63dd180455c7cfeb76cbf80a45d76a0-environmental_eng.Paras.0006.File.pdf.; Kruse, C.J. (2005). Environmental management systems at ports – a new initiative. In Proceedings of the 14th Biennial Coastal Zone Conference. New Orleans, Louisiana, USA, Jul 17-21, 2005.

External implications and cost of inaction for human health and environment: large with heavy burden on individual and public budgets

The UNEP *Cost of Inaction* Report (2012) gathered and examined available primary data containing relevant monetized or quantified external cost information related to chemical mismanagement. The vast majority of human health costs linked to chemical production, consumption and disposal are not borne by chemical producers, or shared down the value-chain.

a) Poor management of chemicals across their lifecycles comes with a price paid for by individuals, important economic sectors and public budgets, including through poor health and degraded ecosystem health and productivity. For example, one study suggests that the major economic and environmental losses due to the use of pesticides in the United States amounted to USD $1.5 billion in pesticides resistance and USD $1.4 billion in crop losses, and USD $2.2 billion in bird losses, amongst other costs. Another study in China cites the effect of acute water pollution incidents on commercial fisheries which has been estimated at approximately USD $634 million (4 billion Yuan) for one year.

US$2.1billion: Disability-Adjusted Life Years (DALYs) costs of children's exposures to lead in Africa, Latin America and South East Asia;

US$108 billion: IQ-based lost economic productivity due to childhood lead exposures in the same regions.

US$ 236.3 billion: global environmental external costs from 'global human activity' producing VOCs;

US$ 22 billion: global environmental external costs from mercury emissions.

b) Health care in many low- and middle-income countries is hospital-centered and focused on patients who have reached the point of acute stress or have long-term complications. Given the rising chemical intensity in these countries and the epidemic of chronic diseases, especially in children, that emerged contemporaneously with increasing use of chemicals in the developed countries, this is liable to be an increasingly expensive approach to public health administration in the future. New evidence on health costs from pesticides in sub-Saharan Africa gives an indication of just how large. UNEP *Cost of Inaction* Report (2012) used available data to make a conservative estimate for pesticide users on smallholdings in sub-Saharan Africa. It reveals that the costs of injury (lost work days, outpatient medical treatment, and inpatient hospitalization) from pesticide poisonings, in this region alone, amounted to USD $4.4 billion in 2005. This is an underestimate as it does not include the costs of lost livelihoods and lives, environmental health effects, and effects of other chemicals. In 2009, Overseas Development Assistance (ODA) to health in sub-Saharan Africa amounted to USD $10.3 billion. Excluding HIV/AIDS, total assistance to basic health services approximated USD $4.8 billion.

US$ 90 billion: Projected total costs of illness and injury for pesticides users in the sub-Saharan African region from 2015 to 2020.

A conservative projection of the 2005 estimate to 2009 shows costs of injury due to pesticide poisoning in sub-Saharan Africa to be **USD $6.2 billion.** This suggests that the total ODA to general healthcare is exceeded by costs of inaction related to current pesticide use alone.

Uncompensated harm to human health and the environment are market failures that need correction. The study indicates that these 'spillover' costs of inaction on chemicals policies are large and draws the following conclusions:

c) The costs of public environmental management are set to rise in the developing and emerging economies experiencing the most rapid increase in chemical intensification. For example, the Africa Stockpiles Programme calculates that to clean up the 50,000 tonnes of obsolete pesticides in Africa will cost around US $150-170 million. At the same time, production underpinned by ecosystem services – typically key in these types of economies – is likely to be undermined if the transition to increased chemical production, transport, importation, exportation, consumption and disposal is not well managed.

The benefits of action: above cost savings, sound management of chemicals policies for national development paves the way for a thriving green economy

This 'costs of inaction' data demonstrates a broad pattern of costs that can be avoided through improved chemical management efforts. In addition, sound management of chemicals will benefit countries and regions beyond cost savings alone. *UNEP's Green Economy Report (2011)*, makes the economic and social case for investing just 2% of global Gross Domestic Product (GDP), or around USD $1.3 trillion, in greening ten central economic sectors resulting in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities".

The production, transport, import, export, consumption and disposal of chemicals are important factors in six of the ten central economic sectors - agriculture, water, energy (efficiency and supply), fisheries, waste, and industry. The chemical sector contributes to economic development mainly through the value of products and products containing chemicals (technological contribution) and direct employment. Sound management principles and action help to maximize this contribution, paving the way for a green economy to emerge.

Examining the potential effect of sound management of chemicals on national development the UNEP *Cost of Inaction* Report (2012) concludes that investment in improved management of chemical production, import, export, use and disposal, equates to investment in industrial development, health, education and other priority areas while poor management detracts from making progress on these fronts and more. The following tangible and potential economic benefits have been reported:

a) Sound chemicals management approaches and strategies can enable greater resource productivity through chemical recycling, recovery of valuable materials from the waste stream, energy supply and other innovations gains. Chemical leasing is an innovative service-oriented approach to reduce ineffective use and overconsumption of chemicals and helps companies to enhance their economic performance. It includes value-oriented, instead of volume-oriented, pricing and decouples the payment from the consumption of chemicals. This results in better chemicals management and encourages innovation. UNIDO has launched a global programme and promotes the application of chemical leasing in industry in 10 developing countries and countries with economies in transition in close cooperation with the respective Cleaner Production Centres.

Increased potato yields from integrated pest management in Ecuador

Pesticides were introduced in the northern highlands of Ecuador in the 1940s, boosting yields and incomes. However, subsequently the region suffers from one of the highest pesticide poisoning rates in the world.

Farmers use highly hazardous pesticides such as carbofuran and methamidophos. Implementation of integrated pest management (IPM) techniques reduced the number of pesticide applications from 12 (in conventional plots) to 7 (in plots that used IPM techniques). The IPM fields yielded as many or more potatoes, but production costs decreased from USD$104 to USD$80.

Researchers attribute the success of the project to capacity building of an expanded repertoire of farming techniques as well as a decrease in neurological effects among farmers which illustrated the link between health and agricultural productivity.

Note: Full version of this case study is available at: http://web.idrc.ca/en/ev-29128-201-1-DO_TOPIC.html.
Note: Further information of economic impacts of integrated pest management in developing countries are available at: http://scholar.lib.vt.edu/theses/available/etd-05252009-231519/unrestricted/Hristovska_Masters_Thesis.pdf

b) The global chemical industry supports some types of regulation and voluntary measures that seek to stabilize markets and set harmonized standards. The ICCA Global Product Strategy (GPS) (2011) commits global companies to promote the safe use of chemical products and enhance product stewardship throughout the value chain – and is particularly aimed at Small and Medium Sized Enterprises (SMEs) in developing countries. The strengthening of environmental regulations has been shown to stimulate innovation in firms. Green chemistry, recognized as an important approach to achieving sustainability in the design of chemical compounds and processes, encompasses the principle of substitution in sound management of chemicals.

UNIDO Chemicals Leasing and Solvents in Egypt

The Egypt National Cleaner Production Centre (ENCPC), coordinates chemical leasing activities in Egypt under the Technology Transfer and Innovation Council (TTICs) of the Ministry of Industry and Foreign Trade. The ENCPC aims to enhance competitiveness and productivity of Egypt's industry through Cleaner Production. Egypt's industrial sector accounts for 35% of national GDP and employs approximately 25% of the national workforce. There are eight main industrial sectors: food, chemical, textile, metal, engineering, wood, pharmaceutical and non-metallic minerals. About 270,000 companies (95%) are classified as small and medium sized enterprises.

The hydrocarbon solvent supplier supervises the application of the solvent in the process of cleaning equipment at General Motors Egypt and receives payment per vehicle produced instead of solvents sold. When the cleaning process is completed, the supplier takes back the solvent waste for recycling at its plant. This model has achieved cost reductions of 15% related to reduction of solvent consumption from 1.5 L per vehicle to 0.85 L per vehicle. Part of this reduction was achieved from preventing using the hydrocarbon solvent for purposes other than that of cleaning of equipment (e.g., washing worker hands, cloths). Other aspects of cost savings include avoided costs for solvent waste disposal. Other economic benefits cited by partners include sharing liability and benefits and the creation of a long term business relationship.

Source: UNIDO case studies available at http://www.chemicalleasing.com/index.htm.

US$120,000: initial capital investment in mercury-free gold processing in Mongolia.

- **US$14,070:** current price value for 250g of gold produced on a daily basis
- **US$35:** potential return to miners per day.

c) Sound management of chemicals is not a 'no-cost' proposition; but outlays are likely to be far less than the benefits of progressing on chemical management. Benefits from eliminating lead in gasoline on a global scale have been estimated to range from USD $1 to $6 trillion per year with a best estimate of USD $2.45 trillion per year, or 4% of global GDP. With such large social benefits, the removal of lead from gasoline is a highly cost-effective measure. In the United States alone, the benefits of phasing out lead were estimated to outweigh the costs more than ten times.

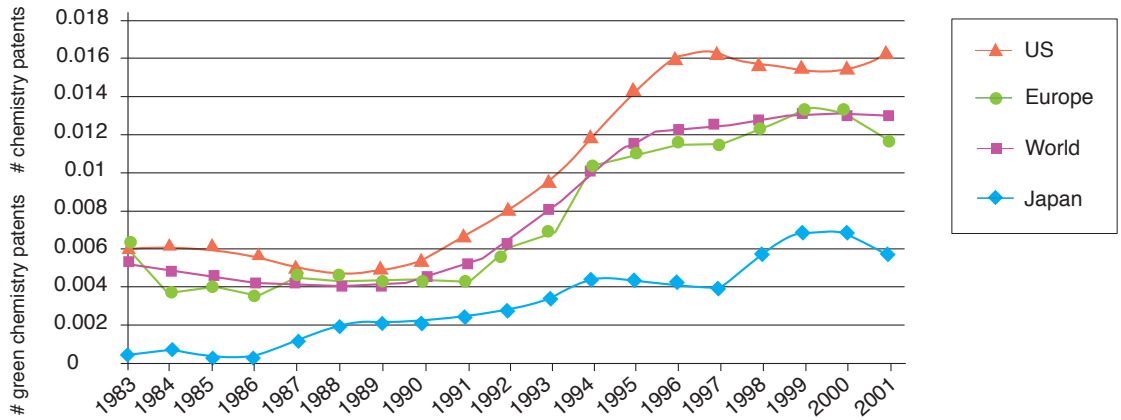
The economic benefits from sound management of chemicals will vary from country to country depending upon volume of production and import, the level of economic development, the character of chemical use and exposure, and how well chemical policies are implemented and enforced (Figure 5). However, the economies of all countries are becoming more chemically intensive and all would benefit from improved chemical management.

Demonstrating the economic benefits of sound chemicals management proves that this is as valid an area for investment as education, transport infrastructure, direct health care services and other essential public services and could foster the creation of many green, decent and healthy jobs and livelihoods for developed and developing countries. Effective long-term management of chemicals and wastes lays the foundations for a thriving Green Economy and a fairer distribution of development benefits across societies.

US$100 billion: estimated value of the global green chemistry market in 2020

45%: increase in revenue per unit from recycling desktop computers achieved using best practice recycling technologies in Ghana.

Figure 5. A regional analysis of green chemistry patents



Source: Nameroff et al., (2004) cited in Oltra et al., (2008)


LEGEND
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III - INSTRUMENTS AND APPROACHES FOR THE SOUND MANAGEMENT OF CHEMICALS: A CALL FOR A COMPREHENSIVE, MULTI-STAKEHOLDER AND PREVENTIVE STRATEGY

Many nations throughout the world have created legal structures and competent authorities for managing chemicals in their different forms as commodities, constituents of products, environmental pollutants, occupational and public health hazards and wastes. Many businesses and NGOs have developed new methods and tools to further strengthen these efforts. The Strategic Approach to International Chemicals Management (SAICM) and the chemicals related multilateral agreements now provide voluntary and legally binding frameworks for promoting the sound management of chemicals and many industrialized countries have adopted a range of legal, economic, technical and voluntary instruments and approaches for managing chemicals. Significant progress has been made, particularly over the past forty years, in developing international, national, and local capacities for managing chemicals safely and soundly (Table 4).

A broad survey of government, business and civil society initiatives demonstrates the wide range of instruments and approaches as well as methods and tools that are now available for promoting sound chemicals management. Developing countries and countries in economic transition, faced limited resources while confronting a steady increase of chemical intensity of their national

Table 4: National instruments and Programs for the Sound Management of Chemicals

Goal of instrument	Timeframe	Legal	Technical	Voluntary
Controlling Chemical Pollution				
Air quality and emission control	1970s+	X		
Ambient water protection and waste water control		X		
Drinking water protection		X		
Remediating Contaminated Sites and Managing Waste Chemicals				
Emergency response and spill management programs		X		
Hazardous waste site remediation		X		
Hazardous and municipal waste management	1970s+	X		
Legacy chemicals and stockpile management		X		
Controlling Dangerous Chemicals				
Food and drug safety		X		
Pesticide regulation and management	1970s+	X		
Workplace health and safety		X		
Chemical regulation and restriction		X		
Preventing Chemical Pollution				
Pollution prevention and waste reduction		X	X	X
Cleaner production programs	1980s+	X	X	X
Chemical accident prevention programs		X	X	X
Sustainable agriculture and Integrated Pest/Vector Management			X	X
Managing Chemical Information				
Chemical testing programs		X	X	
Hazard communication and Right-to-Know	1980s+	X	X	
Product ingredient disclosure/Product declaration			X	X
Pollutant Release and Transfer Inventories (PRTRs)		X		
National Chemical Profiles			X	X
Globally Harmonized System for Classification and Labeling		X	X	X
Managing Chemicals in Products				
Eco-labeling programs			X	X
Eco-design programs			X	X
Product safety (Cosmetics, Biocide, Toys) directives		X		
Product Stewardship/Extended Producer	1990s+	X		X
Responsibility (EPR) Programmes				
Environmentally Preferred Purchasing Programmes		X		X
Generating Safer Chemicals and encouraging resource efficiency				
Green and sustainable chemistry programs	2000s+		X	X
Green engineering programs			X	X
Chemicals Leasing			X	X

Source: Global Chemicals Outlook: Towards Sound Chemicals Management. Chapter III: Instruments and Approaches for the Sound Management of Chemicals. Ken Geiser and Sally Edwards, UNEP. 2012

economies have to be strategically discerning and clear on goals and objectives in selecting appropriate instruments and approaches.

Despite the progress made, more work must be done by governments, corporations and civil society to develop comprehensive, multi-stakeholder and preventive policies that address chemical management across chemicals and through the product life cycle.

Comprehensive chemical policies need to be closely linked with national, social and economic policies and programmes

A comprehensive chemical strategy addresses all chemicals across their lifecycle and must not focus solely on chemicals. Because chemicals are fundamental to national economies there is a strong relationship between safe chemical management and sustainable social and economic development. A comprehensive strategy assumes that the most effective means of reducing the risks of dangerous chemicals is to design an economy that promotes the value of safer chemicals while reducing the risks and inappropriate uses of harmful chemicals.

Countries with emerging or transitional economies have an opportunity to leapfrog the fragmented sector-by-sector chemical management approaches (in workplaces, emissions, wastes, products, etc.) that have characterized conventional chemical policies in developed countries. Adopting a more comprehensive strategy allows governments to integrate and coordinate legal regimes and institutional structures so as to address chemicals more holistically.

Multi-stakeholder approaches to coordinate government policies and instruments with corporate and civil society's skills and resources

The limited attention to chemical safety in national planning derives in part from the lack of coherent risk reduction strategies among the various government authorities responsible for chemicals and wastes. To develop more coherent risk management strategies, cross sector coordination is needed on chemical management among these agencies. In addition, it is important to ensure clear roles for both government and the private sector. In many countries corporations have good information on chemicals and wastes management and the technical capacity to launch effective strategies. Many global corporations actively propagate effective chemical strategies and techniques along their value chain and within related industries. By making chemicals and product manufacturers and importers the first line of sound chemicals management, the responsibility and costs for social and economic development are more effectively shared between private and public sectors (Table 5).

Table 5: Responsibilities of National Governments and Enterprises in Promoting the Sound Management of Chemicals

Responsibilities of Enterprises
- assessing the hazards, potential exposures and risks of chemicals to be marketed and used
- providing chemical information and safe practices to customers, governments and the public
- assuring safe use, storage, and transport and appropriate disposal of chemicals

Responsibilities of Governments
- enacting laws, policies and regulations on the sound management of chemicals
- collecting and verifying information and setting standards and priorities
- negotiating permits, licenses and agreements on chemical management
- monitoring and inspecting enterprises to assure compliance

Source: Global Chemicals Outlook: Towards Sound Chemicals Management. Chapter III: Instruments and Approaches for the Sound Management of Chemicals. Ken Geiser and Sally Edwards, UNEP. 2012

An integrated and multi-stakeholder spectrum approach to chemicals management is inherently inclusive, knitting together and coordinating government policies and instruments with industry and its stakeholders (from investors to retailers) skills and resources and linking in the participation of civil society and non-governmental organizations.

Preventive, proactive policies which anticipate risk, and promote safer alternatives

The governments of developing countries and countries with economies in transition can develop proactive and preventive policies anticipating risks, promoting safer alternatives and adopting measures to prevent accidents and unintended outcomes. These policies can be designed first to prevent, rather than control or remediate risks. Therein lies the critical opportunity for demonstrating how joint actions on environment and health within the broader development context can promote economic and social benefits. Thus, laws regulating chemicals use can be paired with programmes for clean technology transfer, programmes to reduce industrial chemical exposure can be aligned with programs for preventing workplace injury and disease, and programmes for managing pesticides can be partnered with supports for sustainable agriculture. Cleaner production programmes can be integrated into industrial development strategies and tailored to meet the needs of industrial parks and economic development zones. Systems for providing public information on chemical releases and transfers can be aligned with requirements for product labeling and public information and education.

National capacity building: Strengthening the economic arguments

In many countries a full range of government institutions has not been established, important legal instruments have not been adopted, and sufficient financial resources have not been allocated. Capacity development needs to be seen in the context of national economic development goals and must have regard to the stability of government institutions, the rule of law, an effective judicial system, the promotion of a culture of transparency and accountability, the development of trained and qualified professionals, the cooperation of the business community, the encouragement of civil society organizations, and the development of stable and sufficient financial resources.

National budgets provide the most conventional sources of funding for national authorities. However, countries may augment these resources with the use of economic instruments. A clear allocation of responsibilities between public and private actors is also essential for the division of the costs. Economic instruments can be used to internalize the costs of chemicals management and create financial incentives to improve chemical safety. If these instruments are well crafted they may reduce the public cost and also generate public revenues needed to fund agency programmes (Table 6).

Governments in developing countries and countries with economies in transition have a range of opportunities for cost recovery and revenue generation in managing chemicals. However, for many countries the use of economic instruments alone will not provide the necessary revenues to cover the costs. Financial assistance from developed countries and international agencies and donors will still be needed to fully seize the opportunity to generate tangible and long term results.

Governments in developing countries and countries with economies in transition need to promote innovation and the use of safer chemicals in order to attract and retain private investments. A comprehensive chemical strategy linking chemical innovation to economic development can attract the private capital that generates employment opportunities and reduces worker injury and lost productivity. Chemical leasing and chemical management services offer innovative avenues for assuring commercial and technical accountability for chemical use. Chemical innovation can support the development of new enterprises and new "greener" export oriented products and services.

Case Study: Mainstreaming in Uganda

With funding from the Quick Start Programme (QSP) and support from the UNDP/UNEP Partnership Initiative, the National Environmental Management Agency of Uganda brought together the Ministries of Environment, Health and Planning and Finance with industry and civil society organizations to integrate chemical management priorities into the new Five Year National Development Plan (NDP). Recognizing that Uganda's Poverty Eradication Action Plan (PEAP) provided the basis for the NDP, the participants broke into two efforts–one fast track team to integrate short-term chemical priorities into the PEAP, and the other team to identify needs and gaps in the current chemical management infrastructure that could be staged into the longer term NDP plans and programs.

Table 6. Economic Instruments for the Sound Management of Chemicals

Category	Instruments
Price Instruments	Fees, taxes and user charges on production inputs, emissions, outputs or consumption User-charges on natural resource inputs, i.e. water charges Removal/reduction of perverse subsidies Subsidies or environmental funds for environmentally preferable activities Tax adjustments/breaks Chemical leasing, deposit-refund systems, tax-subsidy, refunded emissions fees
Liability Instruments	Environmental fines Liability systems Extended producer responsibility (EPR)
Procurement Instruments	In-house environmentally preferable procurement (EPP) Guidelines for market preferences
Information Instruments	Labeling for market creation and product differentiation Certification for market creation and product differentiation Environmental reporting Information disclosure Eco-design and green chemistry awards

Source: Global Chemicals Outlook: Towards Sound Chemicals Management. Chapter III: Instruments and Approaches for the Sound Management of Chemicals. Ken Geiser and Sally Edwards, UNEP. 2012

Corporate and civil society organization responses

Governments are not alone in developing new instruments and approaches for the sound management of chemicals. Many enterprises and business associations incorporate sound management of chemicals in their corporate policies and practices (Table 7).

Table 7: Methods and Tools developed by Corporations for Chemical Hazard Assessment and Identification of Preferred Chemicals and Products

Name of method/tool	Developed by	Purpose
Restricted substance lists (RSLs)	Many corporations	Screen out chemicals of concern in supply chains and products
Life Cycle Assessment	Formalized by ISO 14040	Identify environmental impacts of a chemical or material across its life cycle
Greenlist™	S.C. Johnson	Screen out hazardous chemical ingredients and compare alternatives
Green WERCS™	The WERCS	Evaluate the human health and environmental hazards of chemical ingredients in products
SciVera Lens™	SciVera	Evaluate the human health and environmental hazards of chemical ingredients in products
3E GPA™	3E company	Evaluate the human health and environmental hazards of chemical ingredients in products
iSustain™	iSustain Alliance	Assessment tool for scientists in the research and development phase of a product life cycle - generates a sustainability score for chemical products and processes based on 12 Principles of Green Chemistry
Sustainability Product Assessment Tool	Boots UK	Assess product sustainability during the development process by evaluating 20 attributes across 5 life cycle stages – raw materials/sourcing, production, distribution/retail, use, end of life
Responsible Care/ Global Product Stewardship	Canadian Chemical Producers Association	Global initiative to drive continuous improvement in the chemical industry in the areas of health, safety and the environment
International Council of Chemical Associations (ICCA)	Global initiative to drive continuous improvement in the chemical industry in the areas of health, safety and the environment	Compare sustainability of products and processes - evaluates raw materials consumption, energy consumption, land use, air and water emissions and solid waste, toxicity potential, and risk potential from misuse
Eco-Efficiency Analysis Tool	BASF	Compare sustainability of products and processes - evaluates raw materials consumption, energy consumption, land use, air and water emissions and solid waste, toxicity potential, and risk potential from misuse
BASTA	Swedish building companies, NCC, Skanska, JM and Peab, in association with the Swedish Construction Federation	Help contractors and designers select building products that do not contain chemicals of concern. Suppliers determine chemical constituents of products, ensure that they meet BASTA criteria, and register products
Eco-Check	Bayer Technology Services	Holistic assessment of products and processes, considering economy, health, environment, life cycle, technology and public value
Environmental Product Declaration (EPD)	Numerous corporations	An EPD is a standardized (ISO 14025/TR) and Life Cycle Assessment based tool used to communicate the environmental performance of a product or system
Apparel Index	Sustainable Apparel Coalition	Tool to assess the environmental performance and human health and safety for textile (clothing) products

Source: Global Chemicals Outlook: Towards Sound Chemicals Management. Chapter III: Instruments and Approaches for the Sound Management of Chemicals. Ken Geiser and Sally Edwards, UNEP. 2012

Similarly, many civil society organizations have developed methods and tools to assist government, enterprises and the public in chemical management (Table 8). A broad survey of these initiatives demonstrates the enormous range of instruments and approaches as well as methods and tools that are now available for promoting sound chemicals management. However, the range is so broad and diverse that it diminishes the potential for cross-enterprise learning or assessment and makes it difficult for government policy-makers to integrate them into a broader strategy. In this regard, it would be useful to develop assessments of the efficacy and value of these measures that compares them in terms of potential goals and identifies strategies where some or a combination of these might be most effective.

Table 8: Methods and Tools developed by CSOs and NGOs for Chemical Hazard Assessment and Chemical and Product Prioritization

Name of method/tool	Developed by	Purpose
RISCTOX	Spanish Trade Union (ISTAS)	Provide information about risks to human health and environment from chemicals in the workplace
Trade Union Priority List	European Trade Union Confederation (ETUC)	Contribute to REACH implementation by proposing substances of very high concern (SVHC) which, from a trade union perspective, should have priority for inclusion in the candidate list and potentially in the authorization list.
Black List of Chemicals	Spanish Trade Union (ISTAS)	Identify chemicals of high concern to be avoided or strictly controlled
SIN List	ChemSec	Identify chemicals that meet the REACH criteria for SVHC and therefore may be subject to restriction currently or in the future
Green Screen	Clean Production Action	Compare chemical alternatives and identify preferred chemicals
P2OASys	Massachusetts Toxics Use Reduction Institute	Help companies conduct systematic environmental and worker health and safety analyses of pollution prevention and toxics use reduction options
Ecolabels and Certifications	Many organizations	Provide voluntary certification for a range of product groups
Pharos	Healthy Building Network	Help commercial buyers evaluate product content, certifications and other relevant data about building materials against key health, environmental and social impact benchmarks
Skin Deep cosmetics database	Environmental Working Group	Help consumers assess the chemical hazards of personal care products
GoodGuide	GoodGuide	Help consumers evaluate products for their health, safety, environmental and social impacts
CleanGredients	GreenBlue	Encourage the design of cleaning products that are safer for human health and the environment. Provide information on physical and chemical properties of ingredients

Source: Global Chemicals Outlook: Towards Sound Chemicals Management. Chapter III: Instruments and Approaches for the Sound Management of Chemicals. Ken Geiser and Sally Edwards, UNEP. 2012

International response: defining the integrated and mutually reinforcing approaches

The commitment to a comprehensive, multi-stakeholder and preventive strategy for chemical management does not apply only on the national level. As international trade and the globalization of markets drive the increasing chemical intensification of all economies, achieving sound chemicals management requires a well-coordinated international response. National governments cannot assure the sound management of chemicals alone.

Case Study: African Stockpiles Program (ASP) as Regional Partnership

The ability to address the estimated 50,000 tons of obsolete and unwanted pesticides stored across Africa is beyond the capacities of many nations. Beginning in 2005 a regional, multi-stakeholder partnership was created uniting the African Union, World Bank, FAO, CropLife and the Pesticide Action Network. With commitments for a 15 year program the ASP is working country by country to develop plans, build capacity and implement collection, treatment and disposal projects. The ASP has focused on raising community and government awareness of pesticide risks and the construction and improvement of long term storage facilities for unwanted pesticides. Recognizing that managing obsolete pesticide stockpiles would not succeed unless better pesticide management practices were developed, the ASP has helped to draft new pesticide legislation and encourage Integrated Pest Management training programs for current farmers.

The laudable efforts to better coordinate the activities and functions of the United Nations agencies responsible for chemicals needs to be further strengthened in integrating sound chemicals management into the international organizations charged with social and economic development. While several global agreements and other comprehensive programmes have been established, their implementation remains challenging. Strengthening international environment governance specifically in the field of chemicals and wastes is therefore essential. Recently, efforts have taken place among the Parties to the Basel, Rotterdam and Stockholm Conventions to pursue the advantages associated with synergies among different MEAs in this area and to bring coherence to international environmental governance. A comprehensive approach to the sound management of chemicals does not require a single strategy, but it does require that agency approaches be integrated and mutually reinforcing. The success of an international comprehensive approach will be defined by its capacity to convince international organizations, agencies for national development, multilateral aid programmes and financial partners that funding sound management of chemicals is critical to economic development and is cost effective.

CONCLUSION

Achieving the Johannesburg Plan of Implementation goal that, by 2020, chemicals will be produced and used in ways that minimize significant adverse impacts on the environment and human health will require a more concerted effort by international agencies, national and local governments, business and civil society organizations. Corporations will need to assume more responsibility for safe chemical production and sound management all along the value chain. Governments will need to adopt and more effectively implement instruments and approaches, define responsibilities and improve administrative and strategic coordination. This also requires providing developing countries and countries with economies in transition with technical assistance, technology transfer, institutional capacity building and training on the new methods and tools that are being used today by developed countries, private sector and civil society.

The absence of effective chemical management by governments, corporations and international bodies leads to market uncertainties in developing countries and countries with economies in transition. It inhibits risk aware financial institutions in the investment and banking sectors from making investment that support strong economic development. Additional financing for chemical management may come from economic instruments for cost integration and recovery within countries. Such funding has to be triggered and complemented by international financing from national and international development assistance programmes. To be effective and sufficiently funded and sustainably maintained, sound chemicals management must be comprehensively mainstreamed into national, social and economic planning and be coordinated internationally.

Sound chemicals management is a vital element that underpins each aspect of a Green Economy and should be integrated not only by investments in natural capital in the realm of agriculture, fisheries, forest and water, but also in the investment in energy and resource efficiency, manufacturing, waste management, building and urban design, tourism and transportation. Sound chemicals management must become a national and international environmental, public health and economic and business development priority.

RECOMMENDATIONS

The following recommendations are made with a view to raise the awareness and attention of policy-makers and key stakeholders in order to strengthen the implementation of SAICM and of the chemicals related conventions and accelerate the achievement of the Johannesburg Plan of Implementation goal that, by 2020, chemicals will be produced and used in ways that minimize significant adverse impacts on the environment and human health.

Two sets of recommendations emanate from the key findings and conclusions of the report. The first set provides general recommendations on institutional, economic and development policy related issues. The second set focuses on more specific, technical and managerial types of recommendations to address the main challenges raised in this report related to trends and indicators, economic implications and instruments and approaches.

General recommendations

1. Develop and implement comprehensive, multi-stakeholder and prevention-oriented chemical management strategies tailored to the economic and development needs of the developing countries and countries with economies in transition.
2. Mainstream sound chemicals management into national public health, labour, social and economic development programmes.
3. Regulate and reduce the use of chemicals of highest concern and substitute with safer alternatives.
4. Integrate and coordinate regional, international and intergovernmental chemical management programmes to promote synergies and increase effectiveness.
5. Develop and implement national, regional and international approaches to financing adequate capacity and resources to support sound chemicals management.

Specific recommendations on responses to address identified challenges include:

Trends and indicators

1. Develop coherent approaches for monitoring of chemical exposures and environmental and health effects that allow spatial assessments and establishment of time trends.
2. Include as baseline information on chemicals not only data on chemical exposure and health and environment effects but also on chemicals throughout their lifecycle.
3. Develop and strengthen global, regional and national integrated health and environment monitoring and surveillance system for chemicals to make timely and evidence-based decisions for effective information management of environmental risks to human health.

Economic implications

4. Further analyse the economic cost of chemical effects.
5. Increase the capacities of health and environment agencies to use economic analysis in the development of sound chemicals management policies.
6. Integrate sound chemicals management in social and economic development processes through greater use of decision-making economic tools and methodologies.

Instruments and approaches

a) National and regional level

7. Build capacity at national level for mainstreaming sound chemicals management into national development plans and processes.
8. Adopt and implement legal instruments that define the responsibilities of the public and private sector for chemical control and improve administrative coordination for compliance and enforcement.
9. Adopt a full policy chain of instruments and approaches that stretch across the lifecycle from the entry of chemicals onto the market to the management of chemicals at their disposal.
10. Use regional approaches to increase the efficient use of resources for risk assessment and management of chemicals and to prevent illegal trafficking.
11. Strengthen national capacity to facilitate the appropriate use of economic instruments to internalize the cost of chemical management and create financial incentives to improve chemical management strategies and promote safer alternatives.
12. Strengthen or develop a single national coordinating chemical management entity.

b) Corporate level and civil society

13. Foster the incorporation of sound management of chemicals in corporate policies and practices.
14. Involve small and medium-sized enterprises (SMEs) in the sound management of chemicals and encourage industry to cooperate with governments to fairly share the responsibility and costs for social and economic development.
15. Industry should generate and make public an appropriate baseline set of health and environmental effects for chemicals in commerce.
16. Further develop and improve chemical management programmes throughout the value chain including communication about chemical hazards and risks, both for chemicals as such and chemicals in articles.
17. Encourage industry to provide the public with all health and safety information and all but the most business sensitive chemical information to effectively reduce the related risks.
18. The financial sector should evaluate more thoroughly the chemical risks inherent in the activities and corporations which it finances, and work with other stakeholders to reduce them.
19. Encourage civil society organizations to participate in government policymaking and to develop activities to access, assess and widely communicate chemical information on chemical safety to the public.
20. Civil society organizations should participate actively and meaningfully in decision-making processes on chemical safety at all levels.
21. Civil society organizations should actively participate in the implementation, and monitoring, of chemicals and wastes regulatory policies including national, regional, and global agreements and facilitate their enforcement.

c) International level

22. Further promote synergies among Multilateral Environmental Agreements (MEAs) in terms of administrative, logistical and programmes integration.
23. Strengthen international and national chemical control activities including legislation to address gaps in current chemicals related MEAs.
24. Mainstream sound chemicals management into multilateral and bilateral economic assistance programmes.
25. Facilitate the assessment of the efficacy and value of corporate and civil society organizations' methods and tools, compare them in terms of potential goals and identify strategies where some or a combination of these might be most effective.
26. Foster public private partnerships to promote the implementation of sound chemical management policies and strategies as a contribution to economic development plans and processes.

www.unep.org
United Nations Environment Programme
P.O. Box 30552 Nairobi, 00100 Kenya
Tel: (254 20) 7621234
Fax: (254 20) 7623927
E-mail: uneppub@unep.org
web: www.unep.org

UNEP

The Global Chemicals Outlook assesses the status of health, environmental, economic and institutional factors related to the production, use, and disposal of chemicals, with a focus on issues relevant to developing countries and countries with economies in transition. Alerting Ministers and decision-makers on the most pressing challenges related to the changes and trends in the production and use of chemicals, the Global Chemicals Outlook makes a convincing economic case for investing in sound chemicals management.

Achim Steiner
UNEP Executive Director
United Nations Under-Secretary General

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