CHAPTER 11
CHEMICALS

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"The goal of balancing the economic and social benefits of chemicals with their health and environmental risks is easy to understand and agree to. But how to achieve this balance is a highly complex problem – or rather, it requires understanding and solving many complex problems. Managing the risks of chemicals is interconnected with many other issues, including wastes and pollution, global warming, resource depletion, agriculture, biotechnology, loss of biodiversity, poverty and women's rights."

UNEP 2004a

The use of chemicals has brought immense benefits to humankind, and at the same time it has had negative impacts on human health and safety, particularly for the poorest and youngest people, on the integrity of terrestrial and marine ecosystems, and on air and water quality. The unsound management and use of chemicals poses threats to human well-being at many levels: it threatens the sustainability of the environment which provides essential goods-and-services for livelihoods, it undermines human health, it threatens physical security, and it reduces the ability of communities to care for themselves and, especially, for children.

Chemicals present both known and unknown risks. Some chemicals, including heavy metals, persistent organic pollutants (POPs) and poly-chlorinated biphenyls (PCBs), present known risks. Lead and mercury, for example, have serious and irreversible impacts on the mental development of children. Over the past half-century there has been an accelerated release of artificial chemicals into the environment, many of which are long-lived and transformed into by-products whose behaviours, synergies and impacts are not well-known (MA 2006). New research indicates that many chemicals widely in use, including in household and personal care products, that are assumed to be safe by consumers and downstream users, pose significant threats to people and biodiversity (WWF 2004b). As chemical production increases globally, wildlife contamination has become even more pervasive, and troubling health threats are ever more apparent (WWF 2004a). Establishing and implementing systems for the sound management of chemicals must be a priority for Africa. A key challenge is how to account for this aspect of uncertainty.

Chemical substances, and their derivatives, are widely used in many development and economic sectors including industry, agriculture, mining, water purification, public health – particularly disease eradication – and infrastructure development. However, production, storage, transportation, and removal of these substances can pose risks to people and the environment. The challenge facing Africa is how to harness the benefits of chemicals, while minimizing the costs. While Africa has made significant progress in developing a regional framework for the management of chemicals throughout their life cycle – production, transportation, storage, use and disposal – much still needs to be done in integrating this approach into national and sub-regional systems for implementation.

Although Africa is currently neither a major consumer nor producer of chemicals in global terms, the level of risk faced by poor countries is disproportionately higher than in those with sufficient resources to effectively manage and monitor chemical use. Additionally, many poor people have weakened immune systems, making them more vulnerable to

chemical-related illness; their well-being may be further compromised by lack of access to information about the impact of chemicals, and their living conditions and work places may leave them exposed to the hazards of toxic chemicals (UNEP 2006). With economic growth, Africa is likely to grow as both a producer and consumer of chemical products, increasing the importance of this issue. There is also a trend to relocate chemical production away from the Organization for Economic Cooperation and Development (OECD) countries to developing countries (OECD 2001).

STATE-AND-TRENDS

The global chemical industry has experienced steady growth in production, consumption and trade over the last 35 years. The value of the chemical trade rose from US$171 000 million in 1970 to US$1.5 million million in 1998 (Buccini 2004). The sector is expected to continue to grow until 2020. Four broad trends are evident (Buccini 2004):

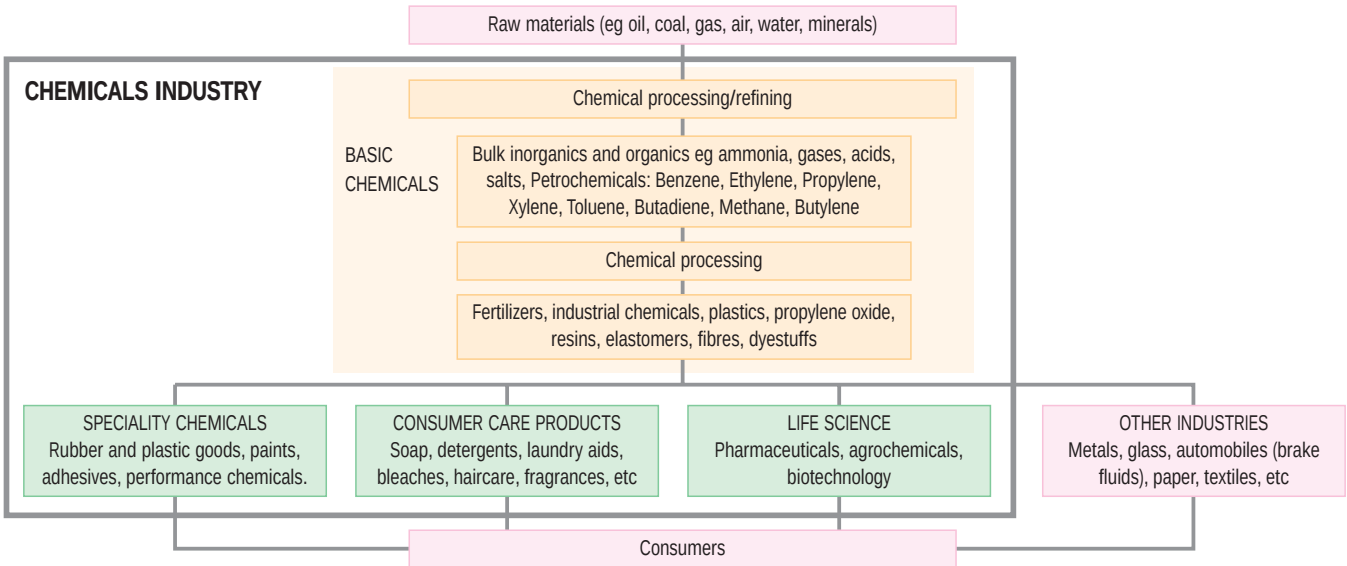
- Global chemical output will continue to rise. In 2010, it is predicted to increase by 63 per cent compared to 1996. Estimated annual growth rates for the global industry range from 2.6 to 3.5 per cent, corresponding to the predicted rate of growth for global gross domestic product (GDP). By 2020, global output is expected to increase by 85 per cent over 1995 levels.
- Globally, per capita consumption is increasing.
- There will be a shift in chemicals production from OECD countries to non-OECD countries. Nevertheless, OECD countries will remain the largest producers in 2020, but their share will decrease to 69 per cent of total world production, that is 10 per cent below 1995 levels.
- Total demand for chemicals will increase more rapidly in the developing than in the developed world. By 2020, the developing world will increase its share from 23 per cent of global chemical demand and 21 per cent of production in 1995 to 33 per cent and 31 per cent, respectively.

The global chemical industry is still concentrated in 16 countries that account for about 80 per cent of global production. These are the US, Japan, Germany, China, France, UK, Italy, Korea, Brazil, Belgium, Luxembourg, Spain, Netherlands, Taiwan, Switzerland and Russia (Buccini 2004). Key developing country producers include the Republic of Korea, India, Brazil, China, Mexico, Singapore, Argentina, Turkey, Saudi Arabia, Malaysia, Indonesia and the Philippines (OECD 2001). Figure 1 gives an overview of the chemical industry.

PRODUCTION AND CONSUMPTION PATTERNS

Although Africa's contribution to value-added production is very small, current trends suggest that its contribution to global production of chemicals will continue to grow. Between 1976 and 1996, this sector grew by 2.5 per cent per year (OECD 2001). Given that projections indicate that chemicals manufacturing will be relocated from OECD countries to developing countries in the

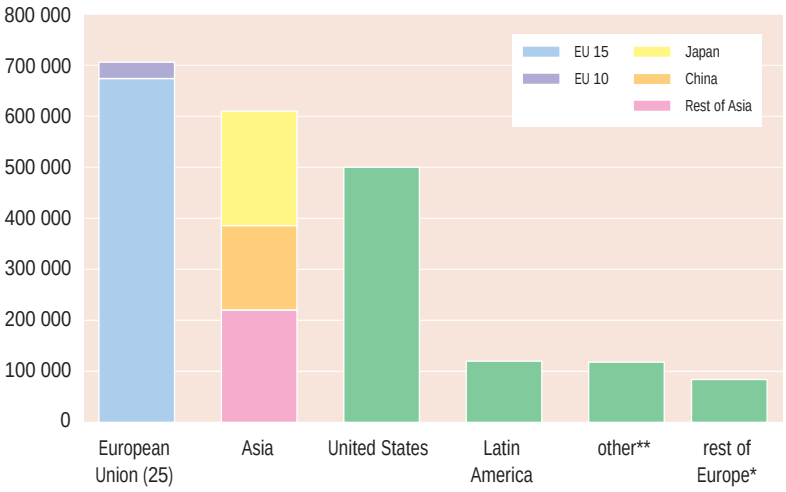
Figure 1: The general structure of the chemical industry



Source: OECD 2001

Figure 2: World chemicals production 2004

chemical sales (US$ million)



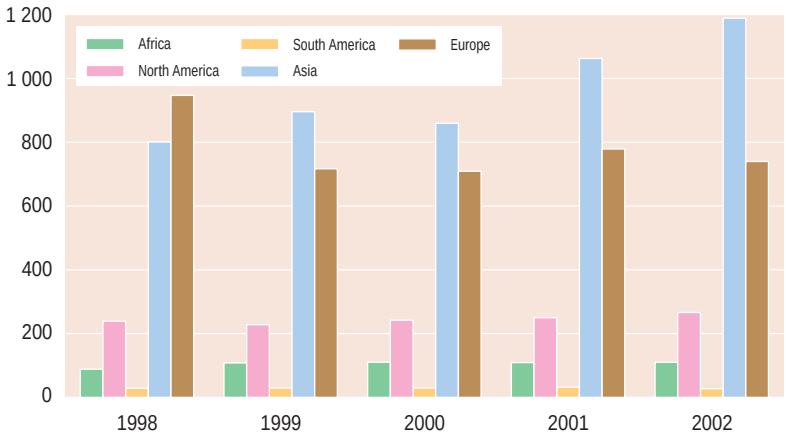
** Switzerland, Norway, and other Central & Eastern European countries (excluding the new EU 10 countries)*
*** including Canada, Mexico, Africa & Oceania*

Source: CEFIC 2005

medium term, this sector can be expected to grow. The shift in production from OECD countries to developing countries is directly related to the rise of multinational chemical companies, who have been able to relocate and invest in developing countries (Buccini 2004). This move may also be related to growing public concerns in developed countries about chemicals and the hazards they pose, as well as lower labour costs and a less regulated production environment in developing countries. Increasing consumption, directly linked to economic growth and improved levels of per capita GDP, underlies market development. There has also been an increase in international trade as tariffs and non-trade barriers have been removed in order to comply with the provisions of the World Trade Organization (WTO).

Figure 3: World production of insecticides, fungicides and disinfectants

thousand tonnes



Source: UNSTATS 2005

The most advanced chemical industries in the region are found in Northern, Western and Southern Africa. The development of chemical industries in these sub-regions has been facilitated by access to larger markets and by the presence of natural resources that can support growth in this sector, such as natural gas and oil, and well-developed infrastructure and communications. In Northern Africa, there are strong chemicals industries in Algeria, Egypt, Libya, Morocco and Tunisia (MBendi 2002). In Western African, Nigeria is the main producer and user of chemicals. In Southern Africa, the prime market and producer is South Africa. South Africa is also the only African country with a chemicals company listed among the top 30 in the world (the South African company is number 16) (CEFIC 2005). South Africa's chemical industry differs from others in the region in that energy use is largely based on coal.

Although it is relatively small by international standards, South Africa's chemical industry is the largest in Africa, contributing about 5 per cent of GDP and employing approximately 150 000 people. Annual production of primary and secondary process chemicals is in the order of 13 million tonnes, with a value of around US$2 825.75 million (UNEP 2004b).

Industry predictions are that future global growth in the chemicals industry will be led by pharmaceuticals, followed by specialty chemicals, agricultural chemicals, textile fibres and industrial chemicals (Buccini 2004). Currently, petrochemical commodities, polymers and fertilizers are the main products of the African industry (MBendi 2002). However, a number of African countries have capacity in pharmaceuticals production and many are investing in oil and gas, which are key drivers for the chemicals industries. The production of agricultural chemicals is a key focus of the chemical industry in Africa. Africa contributed approximately 4 per cent to total world pesticides (insecticides, fungicides, disinfectants) production in 1998, and approximately 5 per cent in 2002 (CropLife Africa Middle East undated, UNSTATS 2005). Global trade in this sector is shown in Figure 5.

In 2002, Africa contributed only about 3 per cent of total world nitrogenous fertilizer production – with most coming from Egypt and South Africa; however, production from these two countries has declined between 1998 and 2002 (CropLife Africa Middle East undated). In 1998 Africa's contribution to global production of phosphates fertilizer was approximately 7 per cent, but this has also declined from 537 tonnes in 1998 to 369 tonnes in 2002 (CropLife Africa Middle East undated). The capacity to produce agricultural chemicals requires investment in

Table 1: Chemical production in 2001

Product	Production in metric tonnes		Africa as percentage of global production	Biggest producers in Africa	
	Global	Africa		Country	Tonnes
Gasoline	771 101	24 095	3.12	South Africa	7 948
				Egypt	5 616
Naphthas	183 226	10 401	5.68	Egypt	2 801
				Libya	2 606
Kerosene	82 882	6 280	7.58	Nigeria	1 210
				Egypt	966
Diesel	1 102 541	36 055	3.27	South Africa	7 150
				Egypt	6 635
Lubricants	39 229	1 123	2.86	South Africa	402
				Egypt	277
LPG from natural gas	145 913	10 334	7.08	Algeria	569
				Egypt	517
LPG from natural petroleum refineries	100 011	2 572	2.57	South Africa	7 150
				Egypt	6 635

Source: UNSTATS 2005

technology, access to finance and raw materials. It is notable that the top two producers of pesticides in Africa, Egypt and South Africa, are also leaders in the production of oil-related products.

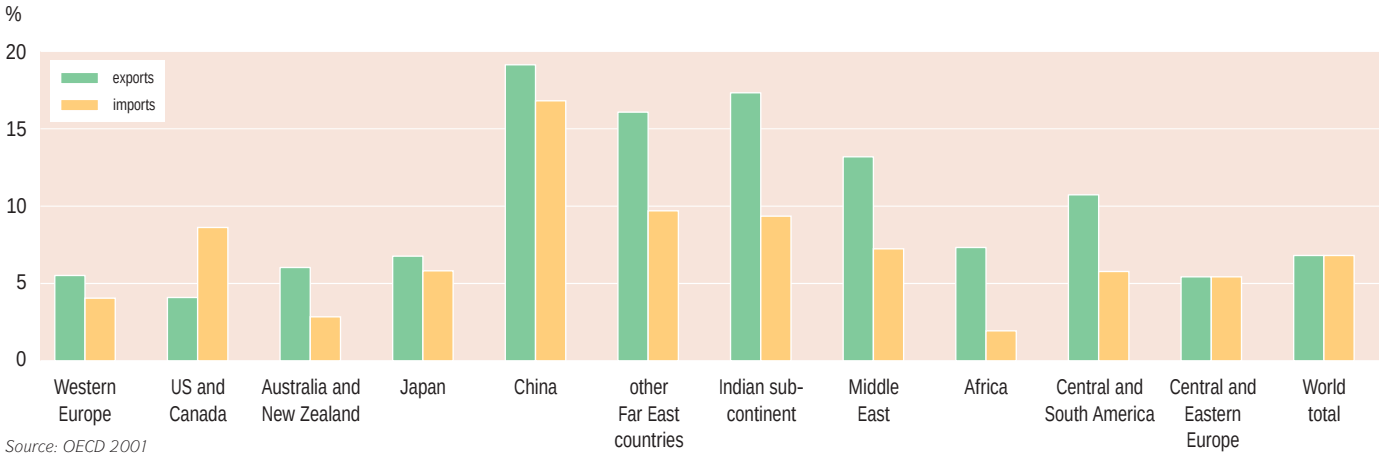
Mining chemicals produced in Africa include explosives and accessories such as fuses and detonators, mineral processing chemicals such as leaching agents, floatation agents, smelting and refining chemicals.

Trade

The chemical market in Africa is primarily targeted at meeting local needs rather than being export-orientated. Nevertheless, the import and export of chemicals are on an upward swing; this trend is expected to continue given the increasing demand for chemicals by Africa's growing economies (MBendi 2002). In the case of the Northern African Mediterranean countries, the proximity to European markets has led to a greater export focus than in other areas.

Although in all chemical sectors consumption is currently higher in developed countries than in developing countries, demand for chemicals and chemical products is likely to increase as disposable income grows. Globally, there is a correlation

Figure 4: Growth in trade in chemicals between 1979-96 (real terms, per cent/year)



Source: OECD 2001

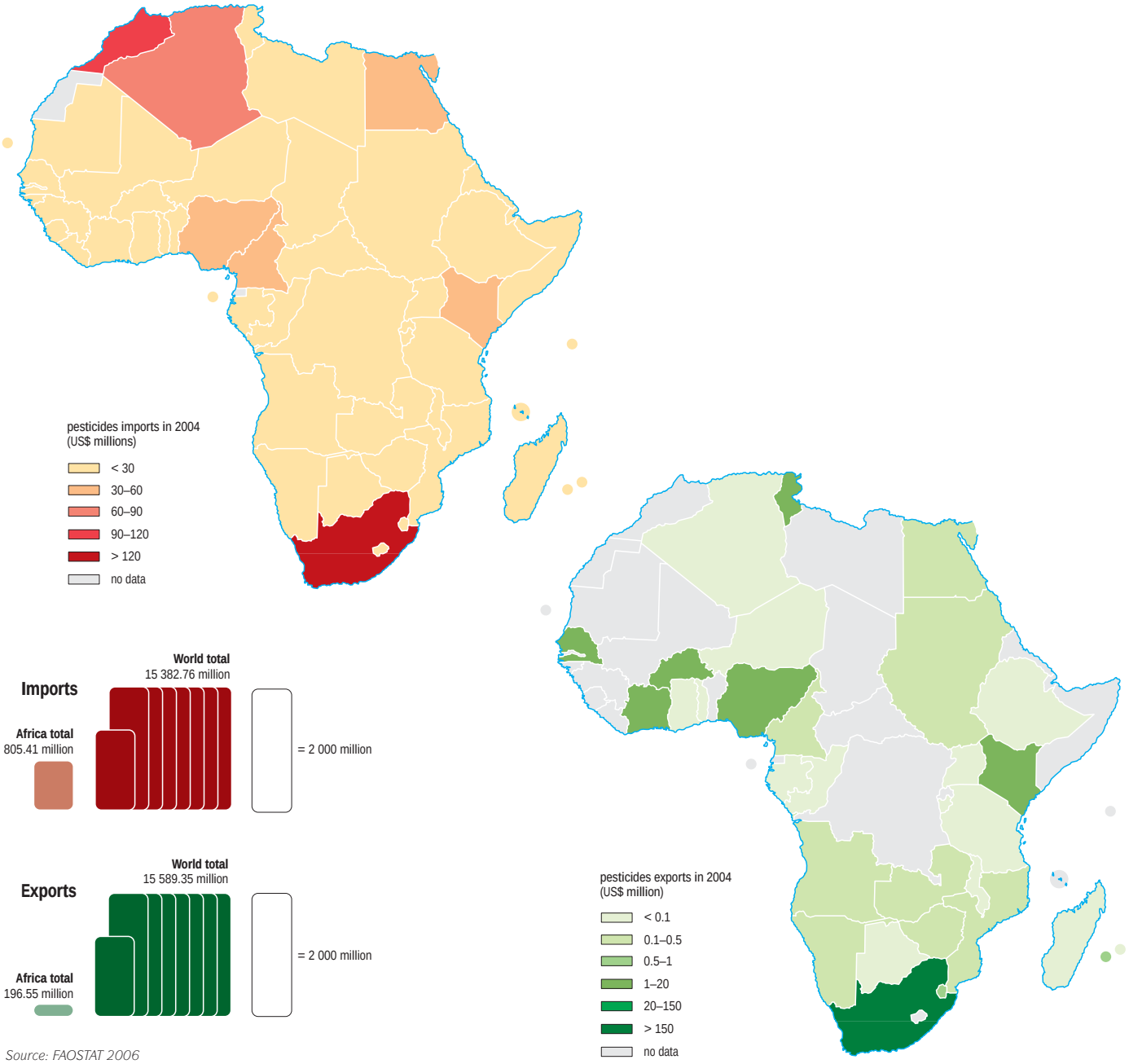
between chemical consumption and GDP per capita, which suggests that there is tremendous scope for increased consumption of chemicals in developing countries (OECD 2001). Still Africa's share of the global market is currently very small (Figure 4). These chemicals come from a range of countries: China and India are emerging as the major exporters of chemicals to Africa.

Generally, imports of chemicals exceed exports due to a mismatch in production and the size of the market. Figure 5 illustrates this in relation to trade in pesticides: most African countries were net importers of pesticides (FAOSTAT 2006).

OPPORTUNITIES AND RISKS

The chemicals industry and its products have many potential benefits particularly related to improving and sustaining human capital through new opportunities for employment, improved health and nutrition. At the same time the production and use of chemicals creates risks at all stages of their life cycle. The generation and release of intentionally and unintentionally produced chemicals, has contributed to environmental contamination and degradation at multiple levels – local, regional and global – and in many instances the impact will continue to be felt for generations.

Figure 5: Import and export of pesticides



Source: FAOSTAT 2006

Industry provides new opportunities for employment

Growth in the industrial sector creates new opportunities for employment and can also help diversify the economy. This is especially important given the high level of urbanization, and growing levels of unemployment and poverty in many cities. Unemployment is particularly high and an important factor in continued levels of low human well-being and slow growth: in 2003 the average rate of unemployment was 10.9 per cent in sub-Saharan Africa and 10.4 per cent in North Africa and these percentages have remained relatively stable over the last ten years (ECA 2005). Women and youth are among the most disadvantaged. These figures do not include those that are unemployed but not actively seeking employment.

Africa needs to find opportunities for expanding its industrial sector. The US Africa Growth and Opportunity Act, for example, provides some trade preferences that the chemicals sector in Africa could use.

Investing in research and development

The development of new chemical products is closely linked to investment in research. Currently most research takes place in developed countries and within large multinational companies. Investments in this area can help expand Africa's share of trade, especially in potential niche markets such as naturally-derived pharmaceuticals and cosmetics.

Africa, along with other countries in the tropics, is a major source of genetic resources that could support a growing localized industry and ensure that a higher percentage of the profits generated from pharmaceuticals remain in Africa. The development potential of the pharmaceutical industry is closely related to biodiversity, and research and development activities in this area. Opportunities associated with this development are discussed in Chapter 1: *The Human Dimension* and Chapter 6: *Forests and Woodlands*. It is estimated that less than 1 per cent of the world's 250,000 tropical plants has been screened for potential pharmaceutical applications (Groombridge and Jenkins 2002). At current extinction rates of plants and animals, the Earth is potentially losing one major drug every two years. Africa could effectively link the development of the pharmaceutical sector to its objectives of sustainable use of biodiversity.

Additionally, such investment may have positive spin-offs in other sectors – for example making medicinal care more accessible. In Africa many cannot afford commercially produced medicine, in Western Africa, for example, as many as 80 per cent of the people depend on traditional medicines (IDRC undated). Africa's market share in pharmaceuticals accounted for only 1.3 per cent in 1997, with the total trade worth about US$291 million million (Kanali 1998).

Pharmaceutical production at EPHARM in Addis Ababa, Ethiopia.

Source: P. Virot/WHO

Africa needs to be strategic about its research investments in this area. On the one hand increasing its share of global trade is important; on the other it needs to focus on meeting urgent health needs within Africa. Research partnerships, including multilateral and public-private-partnerships, as well as the regional or sub-regional pooling of resources can be important factors in creating a resource base for effective research and innovation (UN Millennium Project 2005b).

Agriculture

Increasing agricultural production is widely acknowledged as a priority area for Africa, and essential in addressing food security problems, human vulnerability to environmental change, and achieving Millennium Development Goal (MDG) 1 to eradicate extreme poverty and hunger (NEPAD 2002, UN Millennium Project 2005c). One key challenge, as discussed in Chapter 3: *Land* and Chapter 9: *Genetically Modified Crops*, is the problem of land productivity and related low crop yields. In Africa, low productivity is a factor of the ecological reality and low investment in agriculture. Productivity is further threatened by human-induced changes and natural processes; key among these are climate change and variability, and invasive alien species.

Synergistic growth in the chemicals industry could have positive spin-offs for the development of agriculture (UN Millennium Project 2005c). The use of agricultural chemicals, including fertilizers, herbicides, fungicides and insecticides can help improve yields, for example. Chemicals may also be beneficially used in livestock production as vaccines and in animal feed.

Chemical use in the African agricultural sector is likely to increase as a result of the growing commercialization as well as the growing focus of development agencies on improving yields of small farmers. In Africa the *per capita* use of fertilizers is relatively low, as shown in Figure 6. The UN Millennium Project notes the need for small farmers to be supplied with soil nutrients and other related technologies (UN Millennium Project 2005c), while at the same time recognizing that there must be increased use of sustainable agricultural practices if natural assets are to be preserved (UN Millennium Project 2005a). Environmentally-friendly options may include the use of nitrogen-fixing plants and agroforestry, as well as the application of bio-fertilizers, such as animal waste and plant mulch.

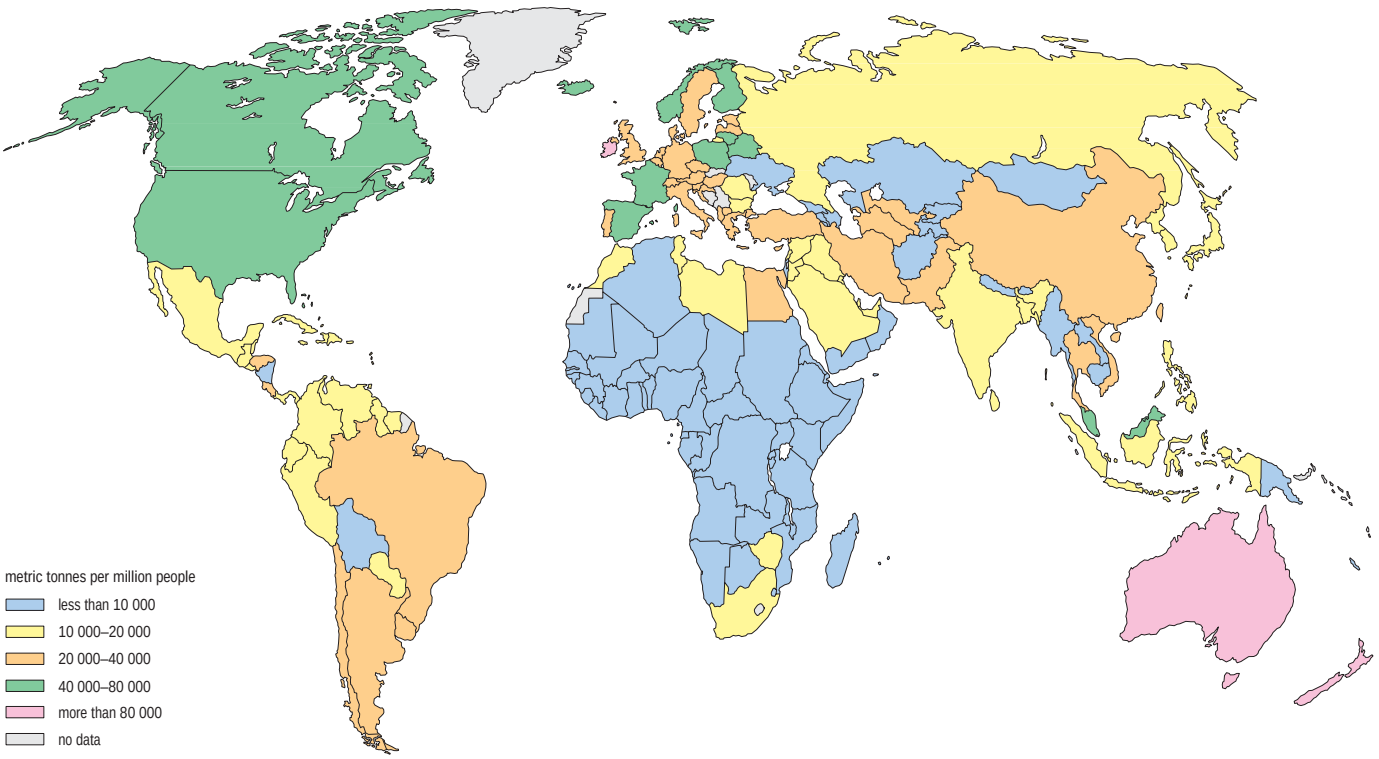
Agricultural extension and aggressive corporate marketing have contributed to increased use of agricultural chemicals. In many places, small farmers under pressure to engage in the market, produce improved crops and increase yields have abandoned traditional, more environment-friendly, practices. This may have a range of negative environmental impacts including on soil and water quality. In Africa, despite the poor levels of comparable data over the last five decades, trends indicate an increase in the concentration of nitrates and phosphates at river mouths, this mirrors the trends in developing economies elsewhere including in Southeast Asia (UNEP 2002). Inappropriate fertilization and irrigation practices can result in salinization and acidification of soil, and in Africa, chemical-related soil degradation affects 51 million ha of land, with about 40 million of these being nutrient-deficient and salinity affecting about 6 million ha (ECA 2001).

Food security and pest management

As discussed elsewhere in this report (Chapter 3: *Land* and Chapter 9: *Genetically Modified Crops*) the challenges of achieving food security are complex and require a multidimensional approach. In many parts of Africa, pests pose a significant threat with locust invasions, for example, repeatedly threatening food security especially in Western Africa (See Chapter 3: *Land*).

Chemicals are an essential aspect of pest management and Africa has relied extensively on the use of POPs (Box 1). However, it is important for Africa to begin to look for alternatives to many of the highly toxic chemicals it uses in pest control. Chemical use is a costly option. The

Figure 6: Global fertilizer consumption 2001



Source: UN Millennium Project 2005c; data from World Bank 2004

Box 1: What are POPs and PCBs?

Persistent Organic Pollutants (POPs) are chemicals that:

- Are extremely stable and persist in the environment;
- Bio-accumulate in organisms and food chains;
- Are toxic to humans and animals and have chronic effects such as the disruption of reproductive, immune and endocrine systems, as well as being carcinogenic; and
- Are transported in the environment over long distances to places far from the points of release.

Poly-Chlorinated Biphenyls (PCBs):

- Are persistent organochlorines;
- Permeate the air, water, and soil;
- Are toxic to humans;
- Bio-accumulate in organisms and food chains; and
- Settle into fats and oil. So fatty fish and marine mammals can provide rich sources of these pollutants. Cows grazing on contaminated grasslands or eating tainted fodder can transfer PCBs into the fat in their meat and milk. In fact, most foods can carry tiny traces of these toxic chemicals.

Source: Mörner and others 2002

highly toxic chemicals used to deal with locust plagues, for example, not only affect locusts, but also humans, animals, including livestock, and the environment. Apart from these dangers, spraying also requires huge logistical resources, which many of the poor countries most affected by locusts cannot afford (IRIN 2004). Additionally, storage of chemicals and the re-use of chemical containers also threaten human health.

Termites threaten infrastructure and food security

In many African countries, termites present a huge problem, threatening both infrastructure and food production and thus directly affecting human well-being and the potential for economic growth. Termites also pose significant threats to other goods including household furniture, paper products, many synthetic materials and food items. Globally, each year, hundreds of thousands of structures (bridges, dams, decks, homes, retaining walls, roads, utility poles, and underground cables and pipes) require treatment for the management of termites (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003).

Africa has high termite diversity of about 1 000 different species, reflecting its topological and climatological diversity. In particular, the tropical forests of Central Africa and all of the countries in Southern Africa contain diverse and abundant termite fauna. Genera infesting wooden structures include *Reticulitermes*, *Coptotermes*, *Psammotermes* (Family *Rhinotermitidae*), *Anacanthotermes* (*Hodotermitidae*), and several species of *Kalotermitidae*. Mound-building species occur throughout most of the African landscape. Some species have been transported over much of Africa due to commerce and nomadic migration (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003).

Some species directly threaten agricultural systems, as shown in Box 2. There are approximately 20-50 damaging termite species in savannah and forest ecosystems in the family *Termitidae*. The majority of species feed on plant material, living or dead, dung or soil rich in organic material. The greatest pest potential exists within the subfamily *Macrotermitinae*, which has a symbiotic association with the fungus *Termitomyces* (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003). The most economically important genera throughout Africa are *Macrotermes*, *Odontotermes*, *Pseudacanthotermes*, *Ancistrotermes* and *Microtermes*. These differ characteristically in their biology and mode of attack (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003):

- *Macrotermes spp.* build large mounds from which they forage outwards for distances up to 50 m in galleries. They attack plants at the base of the stem, ring-barking or cutting them through completely.
- *Odontotermes spp.* build both subterranean and epigeal nests. Damage is due to feeding either under soil sheeting on the outer surface of the plants or on the roots.
- *Microtermes spp.* and *Ancistrotermes spp.* have diffuse subterranean nests and attack plants from below ground by entering the root system and tunnelling up into the stem, hollowing it out and frequently filling it with soil.

Termite control measures vary considerably across Africa, and range from manual removal of queens and nests by hand, to soil applications (topical and injection) with termicides, to baiting. For termites that attack dry wood, fumigation with methyl bromide and topical and subsurface chemical injections are the standard practice. Chlordane is widely used. The costs associated with chemical use are extensive and include (Mörner and others 2002):

- health costs (treatment, working days lost by those ill and by those taking care of the ill);
- costs of exceeded residue levels (leaving a proportion of produce unfit for marketing);
- costs related to pesticide resistance and resurgence;
- pesticide-related research;
- costs of pesticide quality control and residue monitoring;
- costs of pesticide regulation; and
- costs of pesticide-related extension.

Alternatives to chemical use vary in efficiency depending on climatic factors and the species. It is imperative given the agreements under the Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention) for countries to begin to develop management systems based on alternatives. Alternatives include improved building practices such as building design (site preparation, construction and regular building maintenance and inspections), physical barriers, using preservative treated timber, space fumigation, baiting systems, thermal and biological control, and safer chemicals (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003). In general, however, changing from one chemical to another is not a long-term solution (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003).

Box 2: Major crops attacked by termites

Termites threaten key agricultural crops, which form the basis of household nutrition in much of Africa, including groundnuts, maize, sugar cane, yams and cassava. Cotton is also threatened.

Groundnuts

Microtermes and *Odontotermes* species cause damage to groundnuts in semi-arid tropical countries of Africa, resulting in yield losses of between 10 and 30 per cent. Management measures include the use of resistant groundnut varieties, cultural practices, botanical insecticides and minimal application of synthetic insecticides either to the soil or as a seed dressing. These treatments form a barrier, which repels or kills foraging termites.

Maize

Among cereal crops, maize is the most often damaged by termites. Yield losses of from 30 to 60 per cent have been reported in some parts of Africa. *Microtermes* and *Ancistrotermes* species attack maturing and mature maize plants, while *Macrotermes spp.* cause damage to seedlings. Species of *Odontotermes*, *Allodontermes* and *Pseudacanthotermes* can defoliate maize seedlings or consume the entire plant. Maize plants attacked early in the season can compensate damage with new growth. One of the options for farmers to manage termites is to sow at a higher rate. The other option is to dress the seeds with insecticides.

Sugar cane

The most damage to sugar cane is done by genera *Amitermes*, *Pseudacanthotermes*, *Macrotermes*, *Odontotermes*, *Microtermes* and *Ancistrotermes*. Yield losses can be very high. In Sudan losses of 18 per cent have been recorded and in Central Africa losses of 5-10 per cent are common. In Nigeria plant germination failure of up to 28 per cent has been reported. The most common damage to sugar cane is the destruction of the planting material (setts). The usual method of prevention is to dip the setts in various formulations of chlorinated hydrocarbons before planting, or to spray them in the furrows before filling in.

Yams and cassava

Yams and cassava are grown from tubers and stem cuttings, respectively, and are consistently attacked as seed pieces by Amitermes, a predominantly root-feeding species. *Ancistrotermes*, *Macrotermes*, *Odontotermes*, *Microtermes* and *Pseudacanthotermes* are also involved in damaging the maturing crops by hollowing out stems at ground level. The current management strategy consists of treating setts with aldrin dust.

Cotton

Termite species in the genera *Allondotermes*, *Ancistrotermes*, *Hodotermes*, *Microtermes* and *Odontotermes* have been reported to damage cotton especially in the drier parts of Africa. Management measures include broad-scale application of chlorinated hydrocarbons or seed dressings, and baiting with chopped grass treated with insecticides.

Source: UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003

Complete prevention and eradication of termites is not a plausible management objective; instead the focus should be on better management, and on reducing the costs to people and the environment. Successful termite management is a process that includes the talents of construction, pest management, and building management professionals. Lastly, termite management systems are most successful and least expensive when implemented pre-construction. Conversely, they are often less successful and more expensive post-construction.

Control of diseases

Chemicals are widely used in the control of diseases. Persistent organic pollutants (POPs) are used in vector control for diseases such as malaria. Pesticides such as dichlorodiphenyltrichloroethane (DDT) are used primarily to control malaria as well as in the veterinary sector to control plague-transmitting fleas and trypanosomiasis-transmitting tsetse flies (Mörner and others 2002). The use of these chemicals presents special challenges for Africa; the negative environmental impacts need to be weighed against the gains made from disease control.

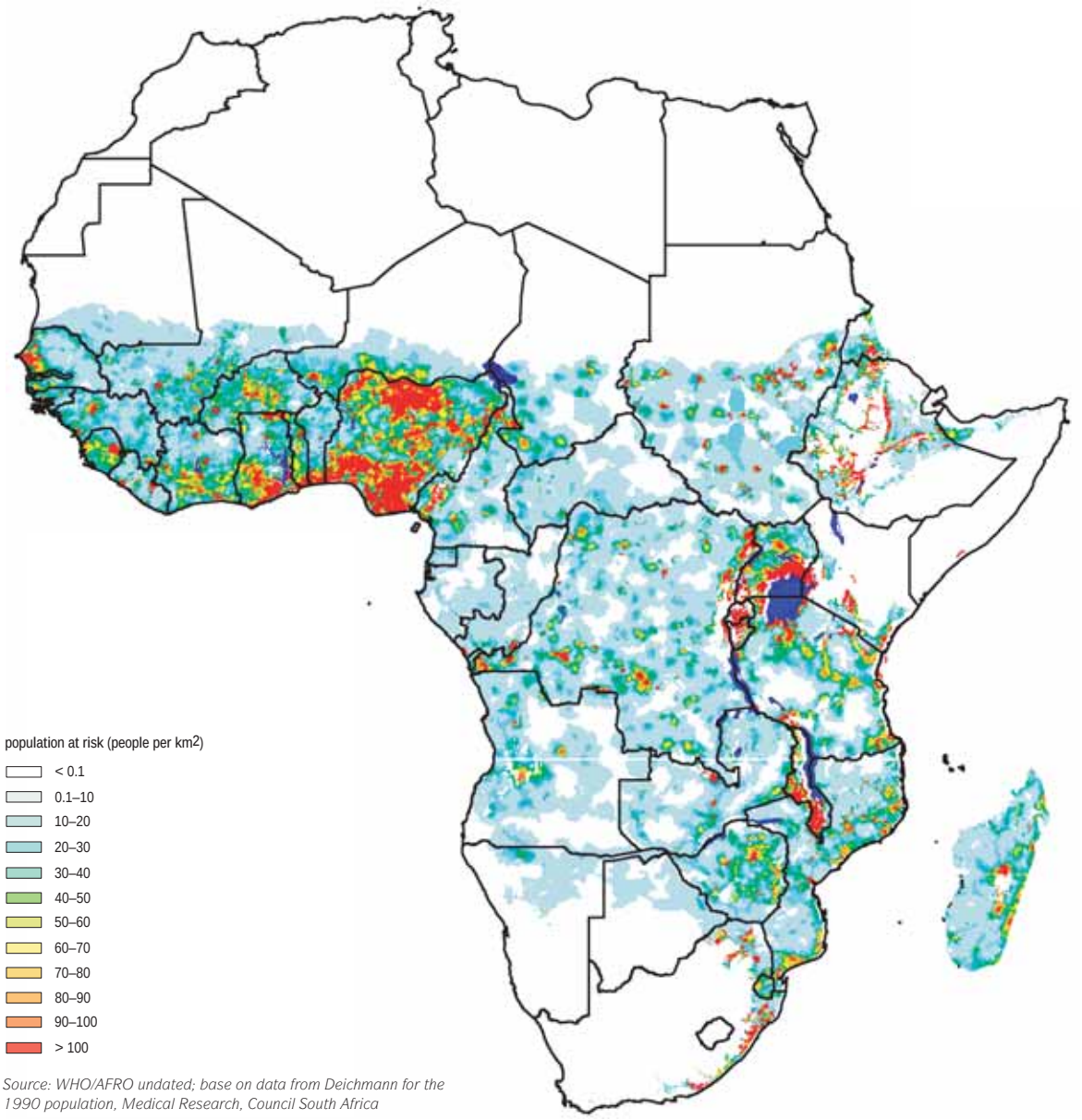
The high incidence of some diseases is not just a challenge in relation to mortality levels, but also threatens economic prospects. Malaria for example is still a primary killer in Africa (see Figure 7 for populations at risk). In 2001, there were an estimated 270-480 million cases per year with approximately 900 000 people dying from the disease annually (WHO/AFRO 2001). Malaria has slowed annual economic growth by 1.3 per cent, imposing a loss of US$12 000 million on the region per year (RBM/WHO 2003). Despite the environmental threats it poses, DDT has been the most cost-effective and efficient way of controlling malaria. This is the main justification for its continued use and its exemption under the Stockholm Convention until such time that alternatives are found. South Africa's experience is illustrative. When South Africa stopped using DDT in 1996, the number of malaria cases in the KwaZulu-Natal province rose from 8 000 to 42 000 by 2000 (Tren and Bate 2004). South Africa tried various alternatives but they proved less effective. Since reintroducing DDT, it has been able to reduce the number of deaths in the province to less than 50 per year (Tren and Bate 2004)

However, while DDT is important for disease control, there are concerns that its continued use constitutes a health risk especially for countries with limited chemical management infrastructure. DDT has also been found to bioaccumulate especially in aquatic species including crayfish, prawns and fish, and in this way poses a further threat to human health. With climate change, the incidence and range of malaria is predicted to increase (see Chapter 1: *The Human Dimension*) potentially increasing the need for the continued use of this highly toxic chemical.

DDT spraying in Namibia.

Source: N. Duplaix / Still Pictures

Figure 7: Population at risk from malaria



Source: WHO/AFRO undated; base on data from Deichmann for the 1990 population, Medical Research, Council South Africa

Freshwater systems and access to safe water

Pollution places freshwater systems at risk and threatens the availability of safe water for human consumption, by disrupting essential ecosystem services. Ecosystems provide effective mechanisms for cleansing the environment of wastes; this service is now overtaxed in many settings, leading to local and sometimes global waste accumulation (MA 2006). Well-functioning ecosystems absorb and remove contaminants. For example, the role played by wetlands in maintaining freshwater quality by the removal of excess nutrients is well-established. As the Millennium Ecosystem Assessment (MA) notes, these systems are under threat and this poses new challenges for management (MA 2006):

- Where excessive wastes are discharged into ecosystems, ecosystems are unable to cope and waste treatment technologies are required to restore or preserve ecosystem balance, and thus reduce or eliminate the risks to human health.
- Recycling can be an important environmental management strategy, however where waste contains POPs or heavy metals, recycling can lead to the accumulation of these pollutants and increased human exposures through food and water

Meeting water needs is a priority for Africa, and countries have agreed, in terms of the MDGs and the Africa Water Vision 2025, to increase the number of people with access to safe water (see Chapter 4: *Freshwater*). The lack of safe water poses a major threat

Children filling used containers with water for cooking and drinking, Rwanda.

Source: A. Mohamed

to human well-being. In 2002, 303 million people across Africa still did not have access to safe water (WHO and UNICEF 2004). The lack of access to safe water is a product of many factors including increasing pressure on limited resources by population growth and a lack of priority given to this issue. Access to safe water varies within countries, with poor and rural people being at the greatest disadvantage. For example, in Congo, 77 per cent of city and town dwellers have access to safe drinking water but only 17 per cent of rural inhabitants do (TWAS 2002). About 627 000 children die annually from diarrhoeal illnesses, related to a large extent to unsafe drinking water (Gordon and others 2004).

Inorganic chemical compounds and POPs in food and water present risks to people. Such contamination may be the result of natural processes (as in the case of fluoride or arsenic contamination of water sources) or from human releases of toxic chemicals into the environment (through, for example, pesticide use). In small quantities fluoride is good for teeth, however in high concentrations it destroys teeth and accumulates in bones resulting in crippling skeletal damage (Gordon and others 2004). Because they are still growing, children are at highest risk (Gordon and others 2004). As of 2004, cases of dental and skeletal defects have been reported in Ethiopia, Eritrea, Kenya, Niger, Nigeria, South Africa, Sudan, Tanzania and Uganda (Gordon and others 2004).

Inorganic nitrogen pollution of inland waterways has more than doubled globally since 1960 and increased by a factor of over ten for many industrialized parts of the world (MA 2006, UNEP 2002). As already noted, pollution impairs the ability of ecosystems to provide clean and reliable sources of water. Deterioration of freshwater quality is magnified in cultivated and urban systems (due to high use and high pollution sources) and in dryland systems (due to high demand for flow regulation and absence of dilution potential) (MA 2006). This is particularly significant for Africa, given the extent of drylands within the region (see Chapter 3: *Land*).

There is also an increasing presence of pharmaceutical products or residues in the environment from sewage and solid waste discharges, however the health risks these chemicals pose have not yet been quantified (WWF 2004a, MA 2005).

In addition to the threats posed by pollutants, water quality is also affected by pathogens, which fall into three general categories: bacteria, viruses and parasitic protozoa. Bacteria like *Vibrio cholerae*, *Salmonella typhii* and several species of *Shigella* routinely inflict serious diseases such as cholera, typhoid fever, and bacillary dysentery, respectively. Chemicals can play an important role in the treatment of water against such pathogens.

Given the general non-availability of piped water to homes people have to collect water from shared wells, rivers or community access points. Many people are forced to use old containers for collecting water. Due to a lack of awareness, agricultural chemical containers are often used and illness can often result.

Chemical exposure

Toxic chemicals can cause a variety of adverse health effects. Toxic substances such as arsenic, cadmium, lead and sulphuric acid contaminate water and soil, and affect human health. More than 50 000 tonnes of obsolete pesticides have been stockpiled in Africa contaminating tens of thousands of tonnes of soil. These obsolete pesticides represent a major threat for human health (NEPAD 2003). Low-level exposure to some chemicals present in industrial effluent or used as pesticides, such as PCBs, dioxins, and POPs such as DDT, may cause endocrine disruption, undermining disease resistance and affecting reproduction (MA 2006). They are also responsible for more acute health impacts, including poisoning. Persistent organic pollutants cause a range of health problems, even at low levels of exposure, including reproductive and developmental disorders, damage to the immune and nervous systems, and a range of cancers (Gordon and others 2004, MA 2006). Exposure during key phases of foetal development can be particularly damaging (IPEN 2002). Heavy metals pose serious threats, particularly to children and during foetal development (Gordon and others 2004). In Africa, between 18 and 24 per cent of children have concentrations of more than 10 micrograms per decilitre (µg/dl) of blood

Box 3: Lead poisoning and the tragedy of a mining boom

Lead exposure may come from contaminated air, water or food. Motor vehicle exhaust fumes from leaded fuel, smelters, lead manufacturing and recycling industries, waste sites (eg contaminated landfills), old lead water piping and lead-combining solders, and leaded paint are common sources of lead contamination. The amount of lead that may dissolve in water depends on acidity, temperature, water hardness and standing time of the water. Secondary pollution from industry can contaminate water through the effluents produced. Other sources include the use of lead-containing ceramics for cooking, eating or drinking. In some countries, people are exposed to lead after eating food from cans that contain lead solder in the seams.

In many mining centres, average atmospheric lead concentrations reach 0.3-0.5 µg/m^3 and exceed 1 000 µg/g in dust and soils. The people of Kabwe, in Zambia, face a serious threat from lead and zinc mining activities. At its peak, Kabwe was the largest and richest lead mine in Africa. Unfortunately there were few pollution controls. The mine closed in 1994 and since then the town and province have not only faced growing economic hardship but also the risk of lead poisoning. The vegetation, water and soil are contaminated and about 90 000 children are at risk from lead poisoning. Concentrations of 5 µg/dl threaten brain development; in Kabwe, many children have concentrations exceeding 300 µg/dl. Average blood level is 60-120 µg/dl.

Lead can damage the nervous and reproductive systems, and the kidneys, and it can cause high blood pressure and anaemia. Lead accumulates in the bones and lead poisoning may be diagnosed from a blue line around the gums. Children are amongst the most vulnerable. Lead is especially harmful to the developing brains of foetuses and young children and pregnant women. Lead interferes with the metabolism of calcium and Vitamin D. High blood lead levels in children can lead to irreversible learning disabilities, behavioural problems and mental retardation. At very high levels, lead can cause convulsions, coma and death.

To address the problem of lead pollution in Kabwe, the Zambian government has adopted various programmes. There are proposals to either cover the mine dumps with vegetation or cap them with concrete to prevent air pollution. In 2003, the Zambian government asked 2 000 residents to vacate their canal-side homes so that the waterways could be dredged. However, for most residents, finding alternative accommodation is not a reality.

Preventive measures are clearly more appropriate than remedial measures. The World Health Organization (WHO) identifies the following options:

- Environmental standards that remove lead from petrol/gasoline, paint and plumbing;
- Removal of lead pipes, or flushing pipes with cold water each morning before drinking if they cannot be removed;
- Enforcement of occupational health standards;
- Surveillance of potentially exposed population groups, especially the vulnerable ones (small children, pregnant women, workers);
- Water treatment;
- Removal of lead solder from food cans;
- Use of lead-free paint in homes; and
- Screening of children for blood levels over acceptable limit and referral for medical care as necessary.

Source: UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003

(Gordon and others 2004). Box 3 gives an overview of problems associated with lead contamination, with a special focus on mining in Central Province in Zambia.

With growing production and consumption, and new economic development, the risks associated with chemical use will increase. This will place new demands on Africa's chemical management institutions. In addition to intended environmental releases, there is also an increased risk of accidental releases and chemical-related accidents. Examples of hazardous incidents include the misuse of mercury in small-scale mining, PCBs in the electricity sector, DDT in the health sector and pesticides in the agricultural sector.

These chemicals pose serious risks that are exacerbated by the lack of adequate access to information regarding safe handling, use and disposal of chemicals. See for example the risks associated with Lead in Box 3 and DDT in Box 4. Poverty and lack of access to information may exacerbate these negative impacts. In the context of scarce resources, chemical containers are often re-used by rural people for household purposes including the collection of water and can result in poisoning. More than 11 million poisoning cases by pesticides occur annually in Africa (NEPAD 2003), yet few African countries have specialized poison centres. In 2004, only ten African countries had poison centres, and none had more than five (Gordon and others 2004). Further, since agriculture is the main employer for women and children, they are the most exposed to chemical risks. In many cases, both for subsistence and commercial farming, producers and workers have insufficient knowledge about the health risks posed by chemicals and therefore fail to take adequate protective measures.

Box 4: Health and environmental effects of DDT on health and environment

- DDT disturbs sexual development and behaviour in birds such as gulls.
- The capacity of the immune system is impaired by DDT, and also by certain synthetic pyrethroids – pesticides that have been promoted as DDT alternatives.
- The nervous system can suffer permanent damage from exposure during the foetal stage or early in life.
- Lactation in women can be impaired by DDT – providing a possible link with oestrogen mimicry.

Source: Mörner and others 2002

Natural resource use and adverse environmental impacts

The chemical industry is dependent on raw materials including coal, gas, air, water, minerals and genetic resources. With increased production the demand for these resources will also increase. Promoting sustainable use of natural resources and the adoption of cleaner production must, therefore, be a focus of industrial management. The industry itself is increasingly recognizing this through, for example, environmental standards adopted by the International Standards Organization (ISO). Consumers are also increasingly demanding such integrated approaches.

Industrial processes require large amounts of water and energy. In non-OECD countries, the use of energy for chemical production has increased. Given the shift of the industry to developing countries there has also been a shift in the share of energy use in these countries from 20 per cent in 1971 to 43 per cent in 1998 (Buccini 2004). Increasing energy use also results in increased emissions of greenhouse gases (GHG) that contribute to climate change (see Chapter 2: *Atmosphere*). Specific threats posed by climate change and variability are discussed in Chapter 1: *The Human Dimension* (health), and Chapter 3: *Land* (food security). The chemicals industry accounts for one-quarter of the total releases of CO_2 from industrial sector operations, although this amounted to only 4 per cent of the emissions from all sources in 1997 (Buccini 2004).

Impacts on biodiversity

While many environmental contaminants degrade quickly in the environment, others (Buccini 2004):

- Are released in quantities, concentrations or under conditions so that elevated concentrations are sustained in the environment; and
- Have a combination of physical and chemical properties so that, once released to the environment, they degrade very slowly and remain present in the environment and organisms for many years or even decades, even when released in relatively small quantities. These chemicals are said to be persistent.

Persistent chemicals can, through natural environmental processes, be distributed over long distances, leading to regional and global contamination (Buccini 2004). Many of these enter the food chain and are retained in organisms at concentrations higher than those in food and water – a process known as biomagnification. These

Box 5: Impacts of chemicals on fish catch and wetlands in Senegal

Water pollution by biomedical waste and agricultural and industrial chemicals affects wetlands and favours invasion of these areas by invasive species such as *Typha* and *Salvinia molesta*. The potential of Senegalese fisheries resources is decreasing significantly due to the destruction of the plankton by chemicals released by agricultural and industrial sectors. This has resulted in a continuous decrease in the catches and a loss of quality. From 1969 to 1988, official catches decreased from 20 000 to 8 000 tonnes.

Source: CSE 1999

substances are said to be bioaccumulative. In recent decades, there has been increased attention paid to addressing the risks posed by substances that are persistent, bioaccumulative and toxic (PBT), POPs and some metal compounds. However, many other chemicals, thought to be less harmful, are having significant negative impacts on biodiversity and human health (WWF 2004a).

Chemical pollution compromises the integrity of ecosystems, and thus directly threatens biodiversity. The increased discharge of nitrogen compounds from fertilizers in rivers can result in the eutrophication of surface and coastal seawater, and, in extreme cases, a state of complete oxygen depletion (anoxia) which severely affects the ecosystem and results in fish deaths. Excessive use of chemical fertilizers also contributes to the degradation of land through salinization, thus limiting agricultural production potential.

Chemicals pose many threats to wildlife. Research over many decades has demonstrated the adverse and often irreversible effects of POPs, PCBs, and heavy metals on the endocrine systems, especially reproductive hormones (WWF 2004a). These disruptions are now understood to have much more extensive effects including on thyroid and pituitary systems. Neurological damage is a common feature of chemical poisoning and many chemicals are carcinogenic. With the increase in chemical use these impacts on wild animals have increased (WWF 2004b). Chemicals previously thought to be safe, but with negative impacts on wildlife include (WWF 2004a):

- Perfluroocatanes – these are widely used as surfactants and emulsifiers. They are used as water protectors for carpets, textiles, leather, food packaging and other containers. They are also used in the production of shampoo and dental cleaners, and as lubricants for bicycles, tools and zips.
- Phtalates – this group of chemicals are used as softeners in a variety of plastic products including in medical equipment, building products, car products, upholstery, clothing and children's toys.
- Phenols – these are used in the production of polycarbonate plastics that are widely used in electrical appliances.
- Polybrominated flame retardants – these are widely used in furniture, building materials and clothing.

Increasing human consumption and poor waste management are key factors in this growing threat to biodiversity.

MANAGEMENT CHALLENGES

Africa needs to address the threat that existing and increasing chemical use will have on human and environmental health. As the International Conference on Chemicals Management (ICCM) noted:

> "The sound management of chemicals is essential to achieve sustainable development, including the eradication of poverty and disease, the improvement of human health and the environment and the elevation and maintenance of the standard of living in all countries at all levels of development" (SAICM 2006).

Developing a more effective chemical management system requires addressing the specific challenges Africa faces in management. There is already an extensive global system for chemical management, and it is important not to duplicate efforts but to create synergies and better systems for implementation. Africa faces challenges related to the availability of information and the communication of this to users, inadequate capacity to effectively monitor the use of chemicals, lack of access to cleaner production systems and technologies for waste management, as well as poor capacity to deal with poisoning and contamination. The management of obsolete chemicals, stockpiles and waste presents serious threats to human well-being and the environment in many parts of Africa.

As chemical use and production increases Africa's chemical management institutions, which already have limited resources and capacity, will be further constrained and overburdened and will not cope. Measures and

systems need to be developed to reduce exposure to negative impacts and to reduce human vulnerability.

Management of obsolete pesticides

Contaminated sites and obsoletes stocks present serious problems for Africa and require immediate actions. Estimates suggest that across Africa at least 50 000 tonnes of obsolete pesticides have accumulated (NEPAD 2003). Box 6 describes the extent of the problem in Tanzania. These hazardous pesticides are contaminating soil, water, air, and food sources. They pose serious health threats to rural as well as urban populations and contribute to land and water degradation.

Poor people often suffer a disproportionate burden. In poor communities these dangers are compounded by a range of factors including unsafe water supplies, poor working conditions, illiteracy, and lack of political empowerment (ASP 2003). Poor communities often live in closer proximity to obsolete pesticide stocks than wealthy people. Children may face heightened exposure and where they do are at higher risk than adults. The WHO estimates that pesticides may cause 20 000 unintentional deaths per year and that nearly three million people may suffer specific and non-specific acute and chronic effects, mostly in developing countries (ASP 2003). The risk faced by poor communities is exacerbated by inadequate access to healthcare systems; this is particularly the case for farming communities.

Low-cost mosquito netting – as on the windows of this hut – can reduce the need for chemical sprays to control mosquitoes.

Source: P. Virot/WHO

As in other fields of environmental management, partnerships that bring together a range of actors

Box 6: The challenge of obsolete pesticides in Tanzania

The exact quantity of obsolete pesticides in Tanzania is not known, since a comprehensive study to determine location, quantities, types and state has not been carried out. Nevertheless, information gathered through surveys and public complaints provides a conservative estimate of more than 90 tonnes.

Preliminary data on obsolete pesticides at Arusha and Tanga, Tanzania*

Trade name	Common name	Quantity
Gesaprim	Atrazine	470 litres
Actellic super dust	pirimiphos methyl + permethrin	10 kg
Benlate	benomyl	11 kg
DDT		40 tonnes
Thiodan	endosulfan	8 tonnes
DNOC		3 000 litres

* collected by a team of experts formed by NEMC

Other significant stockpiles include:

- Unused or obsolete pesticides on private farms and in warehouses of cooperatives in cotton and coffee growing areas. An inventory conducted in seven regions in October 1989 by National Environment Management Council (NEMC), in collaboration with Tropical Pesticides Research Institute (TPRI) revealed these stocks including 18 tonnes of DDT and DDT formulations.
- There are about 11 000 litres and 350 kg of the organophosphates Damfin P (methacrifos) and phosphamidon and the fungicide Thiovat (sulphur) in the Co-operative and Rural Development Bank (CRDB) warehouse in Mikocheni, on the outskirts of Dar es Salaam, since 1988.
- About 40 000 litres of expired pesticides are located in cotton growing regions of Mwanza and Shinyanga in the southern part of Lake Victoria. The products, which include endosulfan, flumeturon, atrazine, malathion and methidathion and DDT were found during a baseline survey conducted by the Tanzania-Germany Project on Integrated Pest Management (IPM) in 1993.
- Between 15 and 20 tonnes of expired Decis 0.5 per cent (deltamethrin), DDT 75 per cent, Thiodan (endosulfan) and Cottoran 500 (fluometuron) are stored in the Tanzania Cotton Marketing Board warehouses, Eastern zone.
- A dump of 50 tonnes at Vikunge farm in the coastal region consists of DDT, aldrin and endrin. This is part of a consignment bought as aid through the Ministry of Agriculture from Greece in 1987.

Source: Rwazo 1997

Box 7: Global support to reduce Africa's chemical stockpiles

The Rabat Programme of Action (Basel Convention) agreed to enhance the capacity of the region to:

- prevent the future accumulation of unwanted stocks of pesticides (including DDT), PCBs, and used oils;
- dispose of existing stocks of unwanted pesticides, PCBs, and used oils in a manner that is environmentally-sound, and socially and economically acceptable;
- develop a partnership with all stakeholders to address the environmentally-sound management of unwanted stocks of pesticides, PCBs, and used oils; and
- strengthen existing logistical and financial approaches, and pursue alternative and innovative approaches at the national, sub-regional, regional, and global levels to prevent and dispose of unwanted stocks of pesticides, PCBs, and used oils.

Source: CSE 1999

including the private sector, non-governmental organizations (NGOs) and governmental organizations can be an effective way of addressing problems. The Africa Stockpiles Programme (ASP) is a global programme supported by the Global Environment Facility (GEF). Prominent partners include the World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), WWF – the World Wide Fund for Nature (WWF), the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The objective of ASP is to clean up and safely dispose of all obsolete pesticide stocks in Africa and to establish preventive measures to avoid future accumulation so as to protect human and environmental health. Box 7 gives an example of one global initiative that supports Africa's efforts to reduce its chemical stockpiles.

POPs and PCBs

Although the use of POPs is regulated under international law, specifically in the Stockholm Convention, some are exempt from its provisions. In Africa these include DDT and Chlordane. The reasons for these exemptions are multifold, with both cost of alternatives and effectiveness being important considerations. In some cases, such as for DDT and chlordane, the objective is to give the exempted countries the opportunity to find suitable alternatives that are consistent with their social and economic situation before completing phase-out. The lack of public knowledge about possible alternatives is undoubtedly a factor in their continued use.

Poly-chlorinated biphenyls are mainly used in the manufacture of electrical equipment for electrical insulation. They are used in transformers and capacitors. These are persistent chemicals that do not break down easily and therefore their control and management is a serious challenge for Africa. Management requires undertaking complete inventories, preventing further releases into the environment, managing the stocks and contaminated sites and finally disposal. These challenges are enormous especially if considered within the context of the socioeconomic context of African countries.

Controlling emissions of dioxins and furans also presents a formidable challenge to African countries because of the potential impact on human health and environment. Technical and operational modifications to the industry and related attitude changes are required.

RESPONSES: POLICY AND INSTITUTIONAL ARRANGEMENTS

Recognition of the risks that chemicals pose to the human health and the environment has led to significant progress being made at the international levels to address this. Important recent landmarks include:

- Agenda 21 (1992);
- The World Summit on Sustainable Development (WSSD) (2002);
- The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) (1998) which entered into force in 2004; and
- The Stockholm Convention (2001) which entered into force in 2004.

These multilateral environmental agreements (MEAs) complement the more established global regime that includes:

- International Labour Organization (ILO) conventions dealing with workplace safety (including Convention 170 on Safety in the Use of Chemicals at Work and Convention 174 on the Prevention of Major Industrial Accidents);

- MEAs regulating trade in hazardous waste including Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989 (Basel) (which entered into force in 1992) and Africa's Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, 1991(Bamako) (which entered into force in 1998); and
- MEAs dealing with marine pollution.

Chemical management

In 1992, the United Nations Conference on Environment and Development (UNCED) focused world attention on concerns related to the risks inherent in chemical production, transportation, distribution, storage, handling and disposal of unused materials and wastes. It adopted Agenda 21 – a global programme of action. Several chapters of Agenda 21 deal directly with the use of chemicals. These focus on environmentally-sound management of toxic chemicals (see Box 8). including the control of illegal international traffic (Chapter 19), the management of hazardous waste (Chapter 20) and capacity-building in developing countries (Chapter 38) (UN 1992a). This further refined the global approach to environmental problems by emphasising the link between environment and development, the need for integrated responses, and global cooperation and responsibility.

The WSSD reviewed progress made towards achieving the targets set out by Agenda 21. It agreed to ensure that by 2020 chemicals are used and produced in ways that minimize the significant adverse impacts on human health and the environment. It recognized that to achieve this, new management approaches would need to be adopted including the use of transparent, science-based risk assessment and management procedures based on the precautionary approach, as set out in principle 15 of the Rio Declaration on Environment and Development (UN 1992b). Chapter 9: *Genetically Modified Crops* provides a full overview of science-based risk assessment and how it can be used to support informed decision making. WSSD also committed the global community to support developing countries in enhancing their capacity for the sound management of chemicals and hazardous waste by providing technical and financial assistance – endorsing the UNEP-led Strategic Approach to International Chemicals Management (SAICM) in pursuit of these goals.

The Stockholm Convention deals specifically with chemical management and in particular with POPs, PCBs and dioxides. The objective of this convention is to protect human health and environment. Parties are required to take action on an initial group of 12 specified chemicals. This treaty was adopted in May 2001 but, however it only entered into force in May

Box 8: Agenda 21, Chapter 19: Priority programme areas for managing toxic chemicals

1. **Expanding and accelerating international assessment of chemical risks.** Objective: to strengthen international risk assessment, assess several hundred priority chemicals or groups of chemicals by 2000, and produce exposure guidelines for a large number of toxic chemicals.
2. **Harmonization of classification and labelling of chemicals.** Objective: to develop, by 2000, a globally harmonized hazard classification and labelling system, including material safety data sheets and easily understandable symbols.
3. **Information exchange on toxic chemicals and chemical risks.** Objective: to increase the exchange of information on chemical safety, use and emissions among all involved stakeholders, and achieve full participation in and implementation of the procedure for PIC by the year 2000.
4. **Establishment of risk reduction programmes.** Objective: to eliminate unacceptable or unreasonable risks posed by toxic chemicals and, where economically feasible, to reduce such risks through risk reduction and precautionary measures based on life-cycle analyses.
5. **Strengthening of national capabilities and capacities for managing chemicals.** Objective: all countries should have in place, by 2000, national systems for the sound management of chemicals.
6. **Prevention of illegal international traffic in toxic and dangerous products.** Objective: to reinforce national capacities to detect and prevent traffic in toxic and dangerous products that contravenes national legislation or international legal instruments.

Source: Buccini 2004

2004 and it currently has 122 parties including over 30 African countries (Figure 8).

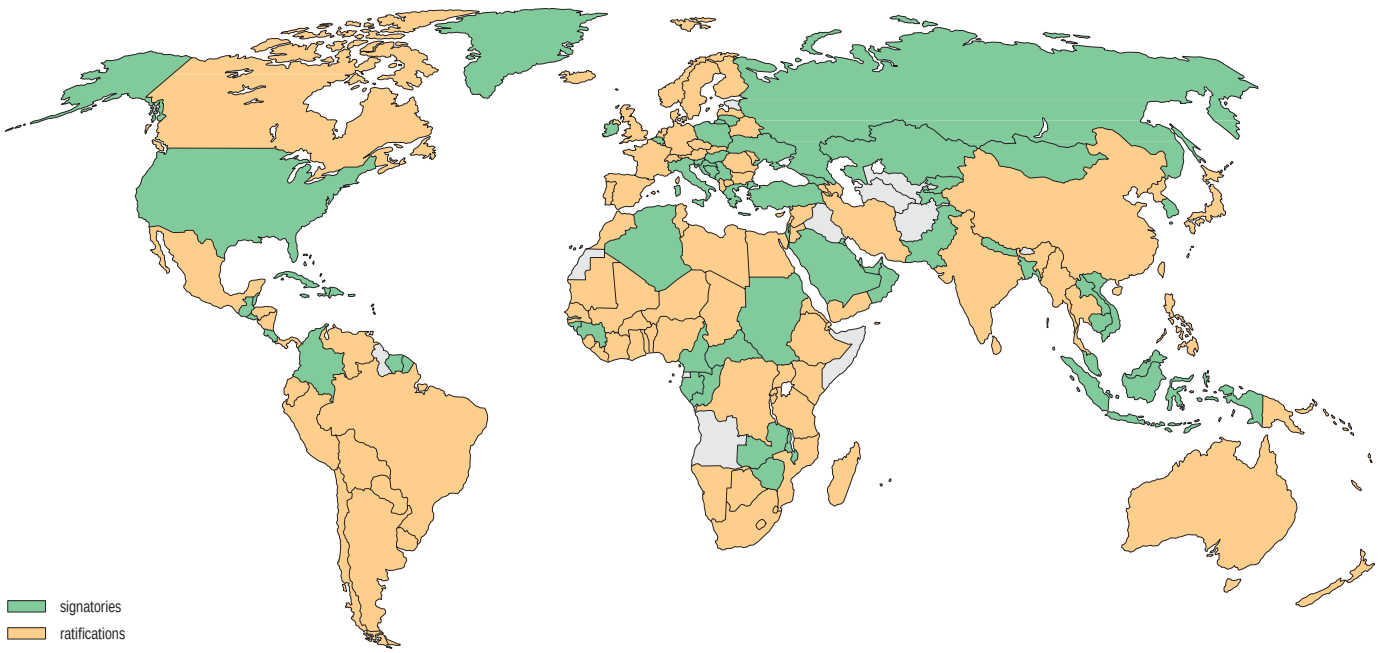
Parties are required, at a minimum, to reduce the total toxic releases from listed chemicals but also to work towards the overall goal of continuing minimization and, where feasible, ultimate elimination. Parties are also required to reduce or eliminate release from stockpiles and waste. They must develop and implement strategies to identify stockpiles and wastes containing POPs and to manage these in an environmentally-sound manner. Further, parties are required to develop national implementation plans (NIPs) within two years of entry into force of the Convention.

Within Africa there have been several important responses to improving chemical management. At a regional meeting in Abuja, Nigeria, in May 2004, African governments committed themselves to promote synergies and coordination among chemical regulatory instruments and agencies, and specifically proposed the following activities, (SAICM 2004):

- Manage chemicals at all stages of their life cycle, using the principles of "cradle-to-grave" life cycle management.
- Target the most toxic and hazardous chemicals as a priority.
- Ensure full integration of chemicals management and better coordination among stakeholders.
- Increase chemical safety capacity at all levels.
- Ensure that children and other vulnerable people are protected from the risks of chemicals.
- Promote corporate social responsibility and develop approaches that reduce human and environmental risks for all, rather than transferring the risks to those least able to cope with them.
- Incorporate the legal approaches or principles of precaution, polluter pays, and the right-to-know. This must be complemented by a commitment to substitution of toxic chemicals by less harmful alternatives and promote more environmentally-friendly practices by industries. This can be achieved through, among other measures, encouraging the private sector to seek compliance with the ISO 14000 standards.
- Integrate the precautionary, life cycle, partnership, liability and accountability approaches in management.

The NEPAD Environmental Action Plan (NEPAD-EAP) sets an Africa-wide approach to environmental management. Although chemical management is not one of the programme areas, it is identified as a key crosscutting issue. At the national and regional level, environmental action programmes will need to respond to the challenges of chemical management. Some of the actions that could be included are emergency response plans, prevention of illegal transboundary movement of chemicals, capacity-building of regional centres for the management of dangerous waste in the context of the Stockholm Convention, and the development and implementation of programmes for reducing hazardous waste.

Figure 8: Parties to the Stockholm Convention



Source: Stockholm Convention on Persistent Organic Pollutants 2006

International trade

The impacts of trade in chemicals on environmental sustainability and human well-being and development are key motivations for law development in this area. However, as the global trade regime strengthens it is uncertain whether such initiatives will come under threat from powerful trading blocs.

The Rotterdam Convention was adopted in 1998 in response to gaps within international law related to trade in hazardous chemicals. The Rotterdam Convention has 106 parties – including 37 African countries – and entered into force in 2004 (Secretariat of the Rotterdam Convention 2006). The rapid growth in chemical production and trade during the last three decades and the associated risks posed by hazardous chemicals and pesticides was an important motivation. It was evident that many countries lacked the institutional and infrastructural framework to effectively monitor import and use of such substances. The Convention seeks to promote shared responsibility and cooperative efforts in such international trade in order to:

- Protect human health and the environment from potential harm; and
- Contribute to their environmentally-sound use of chemicals by facilitating information exchange about their characteristics, providing for a national decision-making process on their import and export.

Two other treaties deal specific with the problem of the transboundary movement and disposal of hazardous waste. Africa's Bamako Convention was adopted by the Organization of African Unity (OAU) in 1991 because the approach of the global Basel Convention was seen as not sufficiently strong to protect Africa from the threat of hazardous waste dumping. The Convention has 29 signatories, 21 of which have ratified it, and entered into force in 1998 (AU 2005). However, many more African countries are party to the more trade-friendly Basel Convention.

The Basel Convention has 168 parties, of which 46 are Africa countries; it entered into force in 1992 (Secretariat of the Basel Convention 2005). The focus of this convention is to control the movement of hazardous waste, taking into account social, technology and economic aspects, to ensure the environmentally-sound management and disposal and to prevent illegal waste traffic. It recognizes the importance of the reducing hazardous waste generation, the centrality of information for effective management and the obligation to inform the importing country in advance. In 2001, the Conference of the Parties undertook to enhance capacity in Africa to deal with problems associated with stockpiles (see Box 7).

African has three Basel Convention Training Centres. These centres were established under the Secretariat of the Basel Convention with the specific objective of enhancing capacity-building. However, in recent years their mandates have expanded to include other activities related to the Rotterdam and Stockholm Conventions. The centres will support countries to synergize their chemical management-related activities at national level.

Toxic waste dump, Koko, Nigeria.

Source: C. Secrett/Still Pictures

New partnerships: a strategic approach to international chemicals management

At a global level, there has been long-standing cooperation in the management of potentially harmful chemicals. Development of legislation often focuses on a specific problem that needs to be remedied – this can result in a poorly harmonized approach that fails to create a holistic framework for tackling the depth and breadth of the issue. The development of treaties for chemical management faces precisely this problem. There has been a steady increase in global support for the development of an approach to chemicals that takes into account issues of human well-being, environmental sustainability and development and that provides a comprehensive managerial framework.

Since 2003, international organizations, governments and other stakeholders have come together in a UNEP-led initiative, SAICM. This initiative seeks to promote synergies and coordination among regulatory instruments and agencies; it includes an overarching strategy, a global plan of action and a high level declaration (UNEP 2005). The initiative was endorsed by the WSSD in Johannesburg in 2002. SAICM's policy strategy establishes objectives related to risk reduction, knowledge and information, governance, capacity-building and technical cooperation and illegal international traffic, as well as underlying principles and financial and institutional arrangements. To this end it has adopted a Global Plan of Action, which sets out proposed "work areas and activities" for implementation of the Strategic Approach.

Horticulture earns Africa millions of dollars, however it is also a major user of chemicals contributing to both soil and water pollution.

Source: M. Chenje

National legislation

Environmental law has been strengthened across Africa since UNCED. Environmental rights approaches have been developed in many African countries, including Benin, Ethiopia, Eritrea, Ghana, Malawi, Mozambique, the Seychelles and Uganda. Such approaches create a sound basis for dealing with the problems posed by chemicals, protecting human health and a safe environment, while promoting sustainable development.

The development of national legal instruments to implement a comprehensive approach to chemicals, however, has lagged behind. This is exacerbated by shortages of resource allocation for enforcement, monitoring, and training. Effective legislation will require the monitoring as well as the establishment of proper management and disposal systems. Establishing such systems and obtaining the requisite equipment is expensive. Opportunities to bring chemical producers in as part of a solution may be difficult. While it is important for legislation to create proper liability and cost-recovery measures, through, for example, the incorporation of the polluter pays principle, it is also important to look at possible incentives. Public knowledge and information about chemicals and their impacts, underlies the choices of consumers and, should be promoted. Consumer and shareholder values, interests and concerns can be an important shaper of corporate policy.

Technology and capacity issues will also need to be addressed in the implementation of legislation. For example, the development of environmentally acceptable disposal facilities requires a delicate balance between technology complexity and applicability. The requirement of the Stockholm Convention, that the parties develop NIPs, provides unique opportunities for countries to reassess their strengths and weakness in the area of chemical management at national level with global support.

Institutional arrangements for the sound management of chemicals

Institutional arrangements for the sound management of chemicals in African vary from one country to another. In many countries responsibility lies with several agencies. For example, Zimbabwe has four different ministries that administer chemical-related environmental laws, Botswana also has four ministries, while in South Africa responsibility is shared among departments for environment and tourism, agriculture and the provincial governments.

During the 1990s, most African countries established a wide variety of new institutional

arrangements for environmental management, protection and restoration. For example, many countries in Northern and Southern Africa created new environment ministries while most Eastern African countries favoured separate environmental protection agencies, as in Uganda and Kenya. Western and Central Africa have a mixture of both. However, the absence of coordination seriously undermines the formulation of a strategic approach and the translation of treaties related to chemical management into country programmes. When sectoral approaches dominate, the mechanisms for cooperation and coordination among different agencies are often ineffective.

Most countries face problems of access to adequate financial resources. Environmental ministries often have smaller budgets and weaker political voices than, for example, those that directly manage productive natural resources such as agriculture or determine economic policy. The result has been uncertainty and a reduced ability to plan and carry out core activities. Effective budgets for agencies have also shrunk. Competing for scarce funds and political commitment, existing institutions are frequently torn between competing priorities. The provision of budgets that cover the operations of institutions will remove some of the bottlenecks experienced. However, there is a need to identify new and additional sources for financial assistance. New financial resources are needed to undertake the programmes related to:

- Ensuring the protection of children and other vulnerable populations from the risks posed by chemicals, while increasing chemical safety at all levels.
- Promoting corporate social responsibility through the development of approaches that reduce human and environmental risks for all and do not simply transfer risks to those least able to address them.
- Promoting best practices in the manufacture, distribution, trade, use and disposal of chemicals and products required to meet sustainable development objectives.
- Reducing the risks posed by chemicals to human health and the environment, with a focus on measurable indicators.
- Updating and bringing laws in line with current scientific knowledge.
- Clarifying and harmonizing responsibilities of different ministries.

Table 2: Priority areas for promoting best practice in chemicals management and usage

Priority areas	Actions
Mining	Improve laws, licensing, surveillance and enforcement; health and safety, education and training at community to regional levels.
Agricultural usage	Improve monitoring, education and training at community and industry levels.
Petrochemical production and usage (including plastics)	Improve laws, licensing, surveillance and enforcement; health and safety, education and training.
Waste management and pollution control	Improve local waste services, sewage systems, industrial and agricultural effluent control; improve compliance with marine disposal convention (e.g. International Convention for the Prevention of Pollution from Ships (MARPOL)), health and safety standards.
Distribution, storage and disposal (including illegal dumping)	Improve laws, licensing and enforcement; health and safety, education and training; improve enforcement of existing conventions (eg Bamako); apply technological developments.
Inter-sectoral and intergovernmental cooperation	Promote consultation and engagement between stakeholders, locally, at the catchment level, nationally and internationally, especially in respect of air- and water-borne chemical dispersal.
Information systems, monitoring, Research and Development (R&D)	Apply ground-truthing and remote-sensing monitoring techniques, standards for monitoring, establish performance indicators, improve evidence base including community reporting, costing.
Human and operational capacity	Develop professional, technical and managerial resources; equipment and physical infrastructure investment and maintenance.

Source: Buccini 2004, ECA 2001, SAICM 2004, UN 1992, UNEP 2006

- Identifying and filling in gaps in the legal framework for environmental protection.

In order to promote the sound management of chemicals in Africa, it is essential that appropriate institutional, policy, legal and administrative arrangements are in place in all countries in the region. Although institutional arrangements for chemical management will vary from country to country due to different socioeconomic conditions, there are some essential elements for the sound management of chemicals that should be included.

An effective legal and policy framework for the management and control of chemicals should be multisectoral with the ability to promote a coherent and coordinated approach. This requires:

- Information gathering and dissemination systems;
- Risk analysis and assessment systems;
- Risk management policies;
- Implementation, monitoring and enforcement mechanisms;
- Effective management of wastes at source;
- Rehabilitation measures for contaminated sites and poisoned persons;
- Effective education and information communication programmes;
- Labelling requirements that support sound use and consumer choice;
- Emergencies and disaster responses;

Box 9: Systematic chemical assessments

Systematic assessments are used for ascertaining the nature and extent of impacts and risk posed by individual chemicals at the local, regional and global levels. The assessment of chemical related risks must be based on a life cycle assessment. This requires considerations of the wide spectrum of activity related releases including:

- Manufacturing;
- Processing;
- Handling;
- Transportation;
- End use; and
- Disposal.

Such assessments are essential for determining release conditions and whether the distribution should be broad, or preferentially concentrated in one medium.

Source: CSE 1999

- Liability and responsibility rules; and
- Environmental impact assessments and social impact assessments.

This could be supported through

- Multi-stakeholder participation;
- Rights of access to information;
- Application of the precautionary approach or principle;
- Cost-benefit analysis; and
- Adoption of the polluter pays principle (PPP).

CONCLUSION

Although the use of chemicals has supported the development of industry and agriculture, and generated broad health benefits through the management of disease, there are serious risks to human health and environmental sustainability associated with chemical use, making this a critical area to which Africa needs to turn its attention. The global nature of chemicals issues requires a comprehensive and global approach that brings together all stakeholders.

Several social and economic trends make sound management essential if development options are not to be foreclosed. Africans will face increased exposure to chemicals as a result of the growth of global trade in chemicals, changing production patterns and the predicted relocation of chemical production to developing countries, the growing market for chemical products, increasing urbanization and the lack of adequate resources for infrastructural development and maintenance particularly in the water sector, and increased industrial employment and corresponding work place exposure to chemicals

There is a need for improved coordination and cooperation between global, regional and national levels to identify gaps, reduce duplication, maximize institutional efficiency and develop synergies. However the success of MEAs must ultimately be assessed at the national level. It is essential for Africa to focus on creating an integrated policy approach and viable institutional mechanisms to support this. At the national level chemical environmental laws will need to be updated in line with the current scientific knowledge.

In facing the increased management challenges, national governments could, in line with regional and global trends, focus their attention specifically on (UNEP 2006):

- Risk reduction – prevention of and preparedness for accidents and natural disasters.
- Information and knowledge – improving the accessibility of information on hazardous chemicals.
- Governance – integration of SAICM objectives into national development planning.
- Capacity-building and technical assistance – promotion of life cycle approaches to chemicals management.
- Illegal international traffic – symposium on illegal international traffic in chemicals and hazardous wastes

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