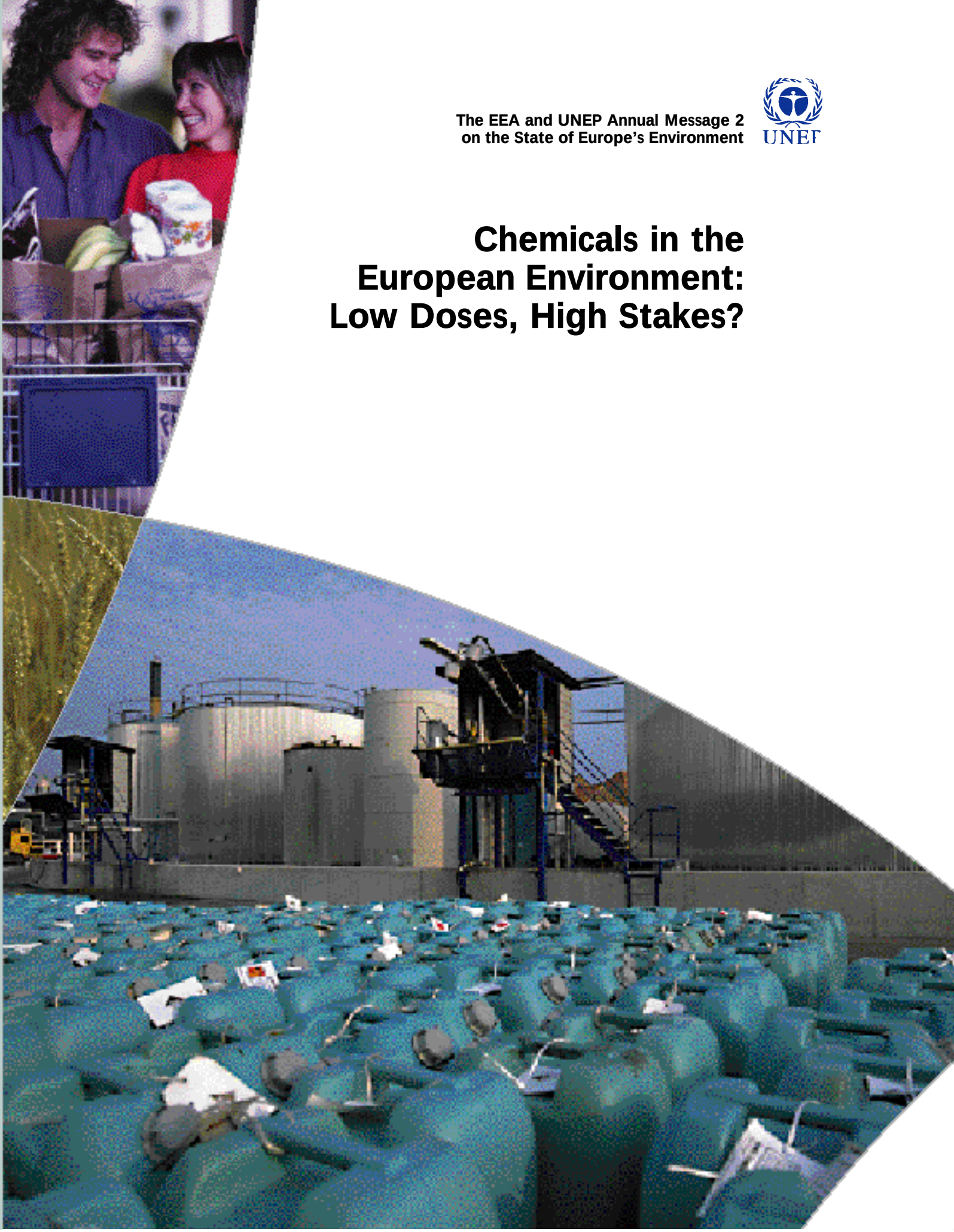
The EEA and UNEP Annual Message 2
on the State of Europe's Environment

Chemicals in the European Environment: Low Doses, High Stakes?



European Environment Agency

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European Environment Agency

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The EEA and UNEP have published this state of the environment message on "Chemicals in the European Environment" in order to raise awareness of the issues, and to help build the public and political support needed for all to enjoy the benefits of chemicals, but at a reduced cost both to nature and human society.

Preface

Following the first joint annual message on water stress in 1997, the EEA and UNEP are pleased to publish a statement on another subject of prime concern: Chemicals in the Environment. As "watchers" of Europe's Environment, these statements aim to raise public and political awareness on critical or emerging issues to facilitate preventative action by governments and others.

This year's annual message comes to you at a time when international activity in chemicals and the environment is moving into higher gear. The European Commission has begun a review of EU policies on chemicals, and governments have recently agreed the text of the so-called "prior informed consent" or PIC Convention, regulating international trade in hazardous chemicals. PIC will establish an international alert list and help developing countries obtain the information they need to protect their citizens and their environment. By preventing unwanted imports of dangerous chemicals, this convention will provide a first line of defence against future tragedies.

Meanwhile, rapid progress is also being made in reducing releases and emissions of persistent organic pollutants, or POPs. We now understand that in addition to the deaths and acute effects caused by direct and immediate contact, POPs – which include some of the most toxic chemicals ever made – can cause cancer, allergies, damage to the central and peripheral nervous systems, diseases of the immune system, reproductive disorders, interference with normal infant and child development, as well as damage to wildlife.

European countries have adopted an agreement on POPs under the Convention on Long-Range Transboundary Air Pollution at the fourth European conference of environment ministers in June 1998 in Aarhus, Denmark. The global community is not far behind. Talks on a worldwide POPs treaty began soon after in Montreal. These global talks are critical for Europe because POPs released in one part of the world can be transported to regions far away from their original source.

Encouraging as these efforts may be, a great deal remains to be done because many thousands of chemicals are on the market but without adequate information on their fate and impact on people and ecosystems.

As the costs of conducting toxicity testing of these chemicals and their degradation products under realistic conditions of exposure would be very large, consideration is being given to reducing progressively – but substantially – unwanted exposures to potentially hazardous chemicals that persist and accumulate in the environment: this seems to be an appropriate application of the precautionary principle to the problems of chemicals.

At the same time, more risk assessments and improved implementation of existing laws are urgently needed if an appropriate balance is to be struck between the risks and benefits of chemicals.

These different issues require the participation of civil society and increased public awareness and education. We must also provide industry with long-term scenarios that they can adjust to by developing efficient and lower-cost alternatives which will enable them to stay in business by doing sustainable business.

Clearly, solutions must be tailored to the properties and uses of each particular chemical and groups of chemicals, as well as to each country's unique circumstances. But action must be taken quickly. Each year that passes without effective action will result in decades of additional, unintended exposure to chemicals that are likely to be harmful to human health and the environment.

Domingo Jiménez-Beltrán
Executive Director
European Environment Agency

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Summary

- Manufactured chemicals are **widespread** in the air, soil, water, sediments and biota of Europe's environment, following the marketing of up to 100,000 chemicals in the EU, their use and disposal, and degradation.

- There is a **serious lack of monitoring and information** on these chemicals; their concentration and dispersion in air, water, sediments, soils, species and food; and related exposures and effects on people and ecosystems.

- Various control measures have reduced risks, and **some emissions and concentrations are declining** in Europe, particularly of a few persistent organic pollutants (POPs) and heavy metals, but some of these concentrations remain at levels that **may be hazardous**.

- Current toxicity risk assessments are based mainly on **single substances**, but people and ecosystems are generally exposed to very complex **mixtures**.

- For **75% of the 2,000 - 3,000 large volume chemicals** on the market there is **insufficient toxicity and eco-toxicity data** publicly available for "minimal" risk assessment under OECD guidelines.

- The costs in time and resources of filling the toxicity and exposure data gaps for the thousands of chemicals in use, their breakdown products and relevant mixtures, will be large, as the comprehensive toxicity testing of one substance costs an estimated ECU 5 M.

- While there is **little direct scientific evidence of *widespread* ill health or ecosystem damage** being caused by most manufactured chemicals, apart from ozone layer depletion, impacts from fossil fuel combustion emissions, and acute impacts, such as from accidents or local spillages, **"no evidence" does not necessarily mean "no effects".** The difficulties and costs of detecting effects, the long time lags between exposure and some effects, and the absence of relevant studies and data mean that the widespread exposures to low doses of chemicals may be causing harm, possibly irreversibly, particularly to sensitive groups such as children and pregnant women, and to parts of the environment.

- The evidence for some chemical hazards in some people is increasing, particularly for **neurotoxins, endocrine disruptors that may damage developmental and reproductive health, cancers and allergies.** The evidence on **disturbances to wildlife and ecosystems** from low level chemical exposures is also increasing.

- Because some of these hazards are **serious, irreversible and take a long time to appear**, action to reduce exposure without waiting for certain proof of harm is now included in many international agreements (the **"precautionary principle"**).

- This encourages (as a supplement to toxicity testing) the reduction and prevention of exposure through **reducing chemical "loads"** in the environment, particularly of substances that **persist and bio-accumulate** and which therefore are a potential threat to people and the environment.

- **Many laws** exist to protect workers, consumers and the environment, but their **implementation and effectiveness can be poor.**

- Awareness of the environmental and social costs (**"externalities"**) of chemicals is increasing, along with the associated use of **taxes** on chemicals to bring these costs into market prices, thereby encouraging greater eco-efficiency in their production and use.

- There is increasing use of **public information**, both about chemicals in consumer products and about emissions of chemicals to the environment, and they appear to be effective in encouraging less hazardous production and use of chemicals.

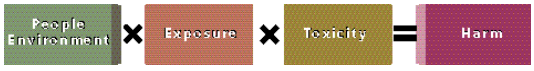
- Chemical **feedstocks** from "softer" chemicals than fossil fuels, such as plants, are being developed.

1. Introduction

Manufactured chemicals play a key role in the provision of a large range of goods and services that support our lifestyles and economies. However, even small amounts of some chemicals can endanger human health and the environment. With increasing quantities of such chemicals in the environment and improved scientific understanding of their effects on people and ecosystems, the challenge is to find the right balance between the benefits and risks of chemicals. This is a *"dilemma for modern society: we use chemical substances to solve problems, but we don't know the price we have to pay in terms of health and environment. We cannot exclude the risk of unpleasant surprises from chemicals of the kind man has repeatedly experienced in the past."* (KEMI, 1998.)

To what extent is Europe's use of chemicals affecting people and the environment? Paracelsus, the 16th century father of the science of poisons (toxicology) said *"All substances are poisons: it is the dose that determines whether they act as a poison or a remedy"* (Cassarett and Doull, 1980). A chemical may be potentially harmful (toxic), but if there is no, or very little **exposure** ("dose") to people or the environment, there is no chance, or risk of harm (Fig. 1).

Figure 1 **Both toxicity and sufficient exposure are necessary to cause harm**



However, as seen with the CFC chemicals that have damaged the ozone layer, it is very difficult to know, or predict, what the harmful level of exposure to chemicals may be, and then to ensure that actual exposures in the environment are kept below those levels. Certainty in these matters is rare, so all who have a stake in the risks of harm from chemicals – the public, businesses, policy-makers and scientists – have a role in trying to determine an acceptable "dose" of chemicals for humankind and for the planet.

Natural chemicals are also widespread in the environment and may cause problems for human health and ecosystems, but unless they enter the manufactured chemical processes, they are not covered here.

Some pesticides are mentioned, but particular legal controls on pesticides and biocides are not covered in this survey.

The current report aims to improve public awareness by exploring four key questions concerning the management of chemicals:

1. How many chemicals are there on the market and what is known about their hazards?
2. What is known about how chemicals move through and accumulate in the environment?
3. What are the known and suspected human and ecological risks from exposure to chemicals?
4. What are the current and emerging policy initiatives for reducing or eliminating these risks ?

There are many uncertainties about the impacts of chemicals on people and the environment, but the scientific and policy complexities are better appreciated and understood than they were just a decade or so ago. This has encouraged the development of a "new paradigm" in chemicals risk management based on the "precautionary principle" and on the provision of incentives to reduce the total "dose" of chemicals potentially hazardous to the environment.

In this context, the European Commission has begun a stock-taking of the legislative instruments governing chemicals, commencing in 1998 with the review of:

- the classification, packaging and labelling of dangerous substances Directive No 67/548/EEC
- the existing substances Regulation, (EEC) No 793/93.

The focus of this report is manufactured chemicals in Europe, but some information relates only to the EU, or to developments in other countries in the OECD (Organisation for Economic Co-operation and Development), which reflect the global nature of the production and use of chemicals.

2. Chemicals without borders

Most chemicals find their way into the environment via millions of consumer, agricultural and industrial products and processes. Once in the environment, they can persist for long periods of time or break down into other chemicals with their own risks. They may also produce health or environmental effects when they act together with other natural or manufactured chemicals that are already in the environment.

Tracking the pathways, fate and exposure implications of chemicals is essential for effective risk management, but it is complex. It requires:

1. identifying the flows of each chemical and its by-products through the economy, from mining or synthesis to manufacture, marketing and use, and on to possible recycling and ultimate disposal;

2. estimating emissions, pathways and depositions both to and from air, water, sediment and soil from the processes and products at each stage of their life cycle and identifying transformations of each chemical and resulting compounds;

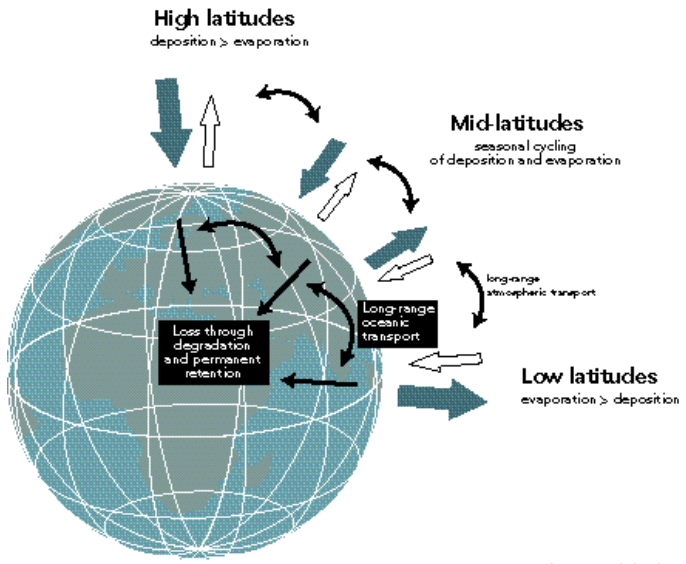
3. constructing an area pollution model (or "regional mass balance") for assessing the inputs, outputs, and fate of the chemicals on a geographic basis, and then estimating the likely exposures of people and ecosystems to the chemicals.

This kind of analysis requires data and information which is only available for very few chemical substances (EEA, 1998a).

Some organic (carbon-based) substances persist in the environment, travel long distances and consequently circulate globally. This means that although these persistent organic pollutants (POPs) can be found almost anywhere, it is difficult to identify where they originated, let alone the pathways by which they travelled.

One of the main ways that the most volatile POPs travel is through the "grasshopper" effect (Fig. 2). POPs released in one part of the world, via pesticides for example, can, through a repeated (and often seasonal) process of release, deposit, release, and deposit again, be transported to regions far away from their original source. This is why POPs can be found in the Arctic, thousands of kilometres from any major source of POPs.

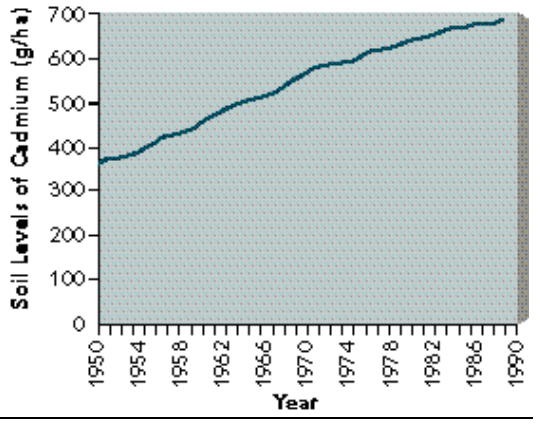
The "Grasshopper" Effect: Pathways and Processes involved in the long-range transport of semi-volatile Persistent Organic Pollutants (POPs) — **Figure 2**



Source: CCEC, 1997

Heavy metals such as lead, cadmium and more complex POPs like dioxins can also disperse over long distances. For example, cadmium in the Rhine basin in Germany has been on the increase for many years due to pollution from a number of sources, including oil combustion, steel production, zinc refining, cadmium plate manufacturing, and municipal waste disposal (Fig. 3). Because cadmium accumulates in soils and groundwater, efforts to reduce cadmium pollution could take about 15 years to start reversing the upward trend. Inhabitants of the region may be exposed to cadmium greater than the World Health Organization's recommended maximum acceptable levels, especially if the soil is acidified (Stigliani and Anderberg, 1994). Similarly, some pesticides can percolate slowly through soil

Figure 3 **Estimated build-up of cadmium in agricultural soils in the Rhine Basin 1950-1988**



Source:
Stigliani & Anderberg, 1994

and accumulate in groundwater and river sediments long after their use has stopped. For example, pyrethroid insecticides have been detected in river *sediments* at 10,000 times the level in the river *water,* where any monitoring of chemicals is usually focused. (Neal *et al.,* 1997, 1998).

POPs can also travel through living organisms and can become increasingly concentrated in the tissues of animals at high levels of the food chain, such as predatory birds and mammals, including humans. This "bio-magnification" can, for example, increase concentrations of polychlorinated biphenyls (PCBs) to many million times their initial presence in the physical environment.

The ways in which humans and the environment are exposed to chemicals are thus multiple and complex, and exposure to mixtures, not just single substances, is common. However, enough is known about the exposures and effects of certain substances, including some POPs and heavy metals, to justify reducing exposure to them and to other chemicals that also persist and bioaccumulate. In addition, more research is needed in order to better understand the movements and metabolism of the thousands of other chemicals released and present in the environment.