12. Environment and human health

There is growing concern about the links between the environment and health. Worldwide, and probably also in Europe, one quarter to one third of the burden of disease appears to be attributable to environmental factors. Vulnerability and exposure, however, vary markedly between different groups and areas, with children and the elderly being particularly at risk.

There is reasonable understanding of cause-and-effect relationships between water, air pollution and human health. However, the health consequences of other environmental factors and exposures, such as those resulting from climate change and chemicals in the environment, are a result of complex interactions between the environment and humans that are far less understood. For some chemicals, such as endocrine-disrupting substances, the effects on humans are particularly difficult to unravel but the impacts on wildlife have been substantial, with implications for human health. Other chemicals in the environment, the disposal of wastes and noise continue to cause worry.

There are several diseases that are of concern, as expressed in the European Union research agenda. Examples include: allergy and asthma, neurotoxic effects of environmental contaminants, environmental factors influencing the onset of puberty, food and fertility; and cancer, heart disease and obesity associated with risk correlated to environment, diet and genetic factors.

Outdoor air pollution plays a role in the causation and aggravation of asthma and allergic responses, which are increasingly prevalent diseases, especially in children. Much outdoor air penetrates indoors, and as people breathe both, an integrated approach to both outdoor and indoor air pollution is needed.

While there have been considerable improvements in European levels of air and water pollution in recent decades some of the traditional, environmentally related diseases such as cholera, typhoid, malaria etc. persist, and in some parts of eastern Europe, the Caucasus and central Asia have increased. Transport continues to be a significant contributor to health effects throughout the European region from accidents, air pollution and noise.

Pharmaceuticals and consumer care products and electromagnetic fields are emerging issues. Many types of chemical classes, ranging from endocrine disruptors, anti-microbials and antidepressants to lipid regulators and synthetic musk fragrances have been identified in sewage and domestic wastes. While exposures are very low, the increasing presence of such biologically active substances is of concern.

12.1. Introduction

While the past decade has seen various achievements that give grounds for optimism about improvements in Europe's environment and health in the 21st century, understanding the complexities of what environmental factors cause ill health is clearly going to remain difficult and, very often, the more we know the more we realise what we do not know. It does not come as a surprise, therefore, that scientific and public controversies over environment and health have been (e.g. over leaded petrol and brain damage in children), or are currently (e.g. over antibiotic growth promoters in animal feed and increased human resistance to antibiotics) common within scientific and public circles.

Public policy decisions on 'real' or 'perceived' environmental hazards (potential damage) and risks (probability of damage) are thus difficult to make and evaluate. However, understanding the types of information needed for environmental health decision-making, as well as its use and limitations (see Box 12.1), will contribute to a wider appreciation of the reasons for public 'concerns', differences in expert opinions, and the actions, or inactions, of governments.

People indeed feel very concerned about the links between their environment and their health, more so now than in the early 1990s when environmental issues were much higher on their and the media's agenda (EEA, 1999). A recent study (WHO, 2002a) confirms that the region still faces many urgent and serious challenges. This rising concern was clearly reflected in the 1999 London Declaration in which European ministers of environment and health committed themselves to taking action on a number of issues, based on the

precautionary principle (WHO, 1999a), to be appraised at their next meeting in 2004, in Budapest.

The EU fifth framework research programme, while gathering facts on this matter, concluded that:

'The most common diseases affecting Europeans today are the result of a combination of factors occurring at various timescales, and for different periods, on people whose vulnerability is determined by their genetic make-up, age, state of health, diet and well-being. Consequently, it is difficult to disentangle the exact causes of ill health. ... Cancers have been linked to tobacco smoke, asbestos, some pesticides, diet, sunlight, pollutants in diesel fumes, heavy metals, and many other carcinogens. Cardiovascular diseases have been blamed on inhalable particles, tobacco smoke, carbon monoxide, and a high-cholesterol diet. Exposure to lead, cadmium, (methyl), mercury, tobacco smoke, and pesticides are all being associated with delayed or abnormal pre- and postnatal development. Noise can also have serious health effects. Some facts and figures illustrate these problems:

- occupational exposure to certain pesticides may increase the risk of Parkinson's disease (or Parkinsonism) by 15 to 20 %;
- some 10 million people in Europe are exposed to environmental noise levels that can result in hearing loss;
- worldwide, it has been estimated that 3 million people die prematurely because of air pollution;
- in Europe, asthma affects one child in seven. Allergies, notably asthma, have continued to increase dramatically over the past 30 years;
- environmental tobacco smoke increases the risk of lung cancer in non-smokers by 20 to 30 %;
- in the United Kingdom alone, the total annual cost of asthma is estimated at over EUR 3.9 billion; and
- in some European countries, testicular cancer is increasing in prevalence and an increasing number of young men have low sperm counts; similar symptoms can be produced in rats by exposure to specific chemicals, but there is so far no clear evidence that environmental exposure to these chemicals affects male reproductive health in humans.' (European Commission, 2002)

Bearing these findings in mind, new environment and health priority areas were set for the sixth framework research programme (European Commission, 2003):

- human health implications of exposure to chemical residues in the environment;
- allergy and asthma;
- neurotoxic effects of environmental contaminants;
- effects of environmental exposure to complex chemical mixtures;
- environmental factors influencing puberty onset;
- cancer risk correlated to environment, diet and genetic factors;
- food and fertility.

Taking this background into consideration, the chapter aims to:

- give an overview of monitored and emerging environmental health issues in Europe;
- describe the health effects of some air

Box 12.1. Environmental health indicators

Background
The Third Ministerial Conference on Environment and Health (London, 1999) acknowledged the need for further development of information and assessment systems as a basis for implementing and monitoring policies and also for communication with the public.

Data systems on environment and health are spread among different agencies and the links between environmental impacts and health effects are not sufficiently considered. It is also difficult to compare the environmental health situation across Europe since the methods of data collection, reporting, analysis and communication are not harmonised.

Objective
Recognising these problems, WHO Europe (World Health Organization), supported by a large group of Member States, and in collaboration with the European Environment Agency (EEA), is developing and testing a European system of environmental health indicators covering all main environmental issues of health relevance.

The process
A set of 'core' indicators has been selected for pilot implementation on the basis of a feasibility study in 14 Member States. The set includes indicators that are feasible, relevant for policy and that enable comparative assessments across Europe. Selected countries of the WHO European Region have volunteered to pilot test the proposed indicator system.

Outcomes
When established, the system should:
- enable tracking of progress in environmental health across Europe;
- provide countries with appropriate environmental health information to make comparisons and support their national policies;
- contribute to the broader objective of reporting on sustainable development.

A proposal for a comprehensive system of environmental health indicators linked with assessment and reporting mechanisms will be prepared for endorsement by ministers of environment and health at the Fourth Ministerial Conference on Environment and Health in Budapest, 2004, for implementation in the WHO European Region.

Source: http://www.euro.who.int/EHindicators

and water pollutants where the cause-and-effect relationships are quite well established;
- increase awareness of the multi-causality of many diseases, where multi-exposures of pollutants and lifestyles also play an important role;
- inform on the multiple impacts of large-scale environmental problems, e.g. climate change and wastes, where the impacts on health are complex, often delayed, and are the product of many, perhaps small, environmental factors acting together;
- describe the environment/health risks of one vulnerable group: children.

12.2. Environmental health problems — an overview

Childhood and maternal underweight, unsafe sex, high blood pressure, high cholesterol, unsafe water sanitation and hygiene, indoor smoke from solid fuels, tobacco and alcohol are the leading causes of the global burden of disease. It is estimated that 25–33 % of such disease is attributable to environmental factors (WHO, 2002) though this varies considerably between regions of the world (Lancet, 2002), with 'lifestyle' factors such as tobacco, high blood pressure alcohol, high cholesterol and physical inactivity dominating the developed regions. Europe is predominantly developed but with some parts, particularly in some areas of EECCA, having features common to developing countries.

Attributing environmental risk factors to the total disease and lack of well being burden in Europe is extremely difficult because of scientific uncertainty and poor data, but it could be between 2–20 % or more, varying from 100 % for some diseases such as lead poisoning to 2 % for waterborne diseases.

Everyone is vulnerable to environmental impacts but the ability of people and societies to adapt and cope is very varied. Vulnerability is not equally spread, and some groups (e.g. poor people, children, women, old people) are at greatest risk.

This section is limited to a selection of those environmental stressors which people may be exposed to indoors or outside. It does not cover occupational impacts on health in any detail, for reasons of space, focus and time. A more comprehensive and integrated environment and human health paper will be prepared for the World Health Organization (WHO) Ministerial Conference on Environment and Health 2004. Reflecting, in this context, the important contribution of transport to environmental health issues, the Transport, Health and Environment Pan-European Programme was launched three years ago to streamline existing activities and make progress towards transport patterns that are sustainable for both health and the environment (see Box 12.2).

12.2.1. Health effects of pollutants

Three major groups of air pollutants are of primary health importance in relation to outdoor air quality: particulate matter (PM), ozone and heavy metals (see Chapters 4 and 5).

Particulate matter

There have been several studies on morbidity and mortality from respiratory or cardiovascular diseases resulting from exposure to PM.

PM covers a highly correlated mixture of primary pollutants such as black smoke, nitrogen oxides (NO_x), sulphur dioxide (SO_2) and carbon monoxide (CO). Association of health outcomes with concentration of suspended PM is best established for respirable or inhalable particles (PM_{10} or PM_{25}). However, data from routine monitoring of PM_{10} is available from a limited proportion of cities, and even fewer regularly collect data on PM_{25} (see Chapter 5, Section 5.3.2). Therefore, data for total suspended matter or black smoke were alternatively used for estimation of health impacts, using the risk coefficients obtained in studies based on the same exposure matrix to calculate an annual average PM_{10}. The resulting population exposure is presented in Figure 12.2, which shows that more than half of the population of cities participating in the latest WHO survey are exposed to PM_{10} levels higher than the target limit value of 40 µg/m^3 in the EU accession countries, while the exceedance is estimated at only 14 % of the population in EU cities.

An estimate of mortality due to long-term exposure, assuming that the risk of mortality increases linearly with annual concentrations of PM, showed (WHO, 2001a) that around 60 000 deaths per year may be associated with the long-term exposure to particulate air pollution exceeding the level equivalent to PM_{10} = 5 µg/m^3 in the 124 cities with PM data. If this number is extrapolated to the

whole urban population of Europe, the number of deaths is four times greater (i.e. about 240 000), and since life is shortened, on average, by at least a year in each of the cases, this contributes significantly to the burden of disease in Europe.

The proportion of mortality associated with PM is greater in cities in the accession countries than in the EU cities. Exceedances of the 2001 target limit value of 40 µg/m^3 account for about 1 % of mortality due to natural causes in EU cities, and 5 % in the EU accession countries (WHO, 2002a).

For example in 2000 the monthly average concentration of particulate matter in the air exceeded the environmental safety standard in 23 Ukrainian cities. Only 15.3 % of the population in Ukraine lives in settlements with low air pollution. 52.8 % with considerable air pollution, 24.3 % with high air pollution and 7.6 % with very high air pollution.

Studies have also been performed on the relationship between exposure to PM and respiratory or cardiovascular diseases leading to admission to a hospital. In the 91 cities with daily average PM_{10} data included in the analysis, the daily variations in PM levels above 10 µg/m^3 were associated with nearly 6 700 admissions for respiratory diseases and 2 600 admissions for cardiovascular diseases per year. If the PM pollution is assumed to be similar in other cities of the EU, then the number of hospitalisations associated with the daily increases of PM levels would amount to 47 000 per year, the incidence rate being markedly higher in the accession countries than in the EU.

There are no air quality monitoring data from EECCA that allow reliable health impact assessment for these countries. However, the scarce and not very precise information available indicates that urban air pollution levels in large cities of the region are higher than in the western parts of Europe (see Chapter 5, Box 5.3), so the health impacts may be expected to be significant. The situation highlights the need for improvement of assessment capacities, as a necessary part of air quality improvement programmes.

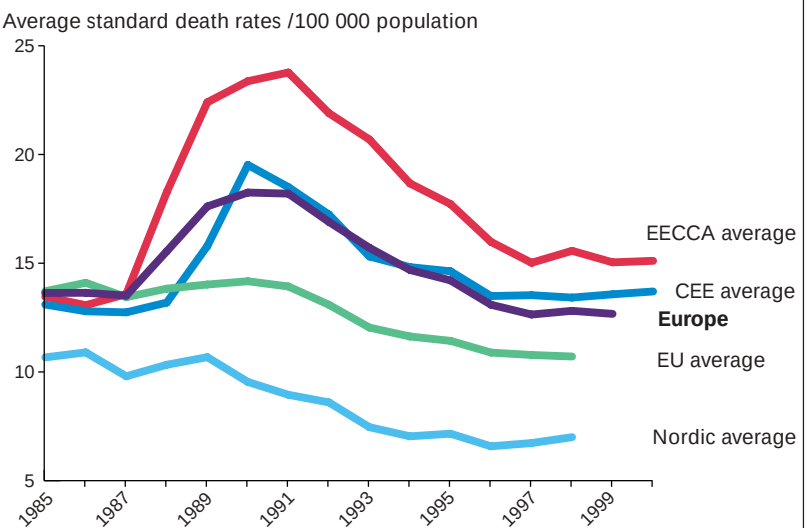
There is an uncertainty factor of at least two in these estimates and calculations, which also take no account of whether the sources are local or long range. In many populated areas, particularly where there are no heavily

Box 12.2. Transport, environment and health

Transport is the dominant source of air pollution in urban areas, with a large part of the urban population still being exposed to excesses of ambient quality levels for one or more pollutants (particulate matter — PM, nitrogen dioxide, benzene and ozone) (EEA, 2002). Current levels of air pollutants, including PM, in Europe have a major impact on mortality (see Section 12.2.1). Traffic-related air pollution is estimated to account, each year, for more than 25 000 new cases of chronic bronchitis in adults, more than 290 000 episodes of bronchitis in children, more than 0.5 million asthma attacks, and more than 16 million person-days of restricted activity (Dora and Racioppi, 2001).

Despite some improvements in recent years, traffic accidents still cause approximately 120 000 deaths and 2.5 million injuries per year in Europe (Dora and Racioppi, 2001; ECMT, 2002). Figure 12.1 generally shows a decrease in mortality caused by road traffic accidents, probably due to a reduction in their severity, resulting from improvements in the safety of vehicles and road infrastructures and progress in the treatment of trauma. Although the death rate in the 12 countries of eastern Europe, the Caucasus and central Asia (EECCA) has fallen considerably since 1991, it is still about 1.5 times higher than in the EU. In the EU, the death rate in the worst-performing country (Greece) is about four times that in the best-performing one (Sweden).

Deaths caused by road traffic accidents Figure 12.1.



Sources: WHO, 2000a; Racioppi, 2002

The annual number of accidents causing injuries has been more constant, with a slightly increasing trend since 1993, possibly as a result of a reduction in the severity of accidents, consistent with the reduction in death rates (WHO, 2000a; Racioppi, 2002).

Speed and alcohol are the two major causes of road traffic accidents. A 1.6 km/hour reduction in average speed is linked with approximately a 5 % reduction in accidents and injuries of all severities. Alcohol is involved in about 15–20 % of traffic accidents in Europe. One in four deaths of young men in the age group 15–29 is related to alcohol, with crashes accounting for a large portion of these premature deaths. In parts of eastern Europe the figure is as high as one in three, as highlighted at the WHO European Ministerial Conference on Young People and Alcohol (Stockholm, 19 February 2001).

Pedestrians and cyclists are particularly vulnerable, accounting for about 20 % of those involved in serious road accidents in the European Region. This appears to play a major role in discouraging cycling and walking as a transport mode, which is most regrettable since these modes are good for the health. This stresses the desirability of providing appropriate and safe conditions for walking and cycling.

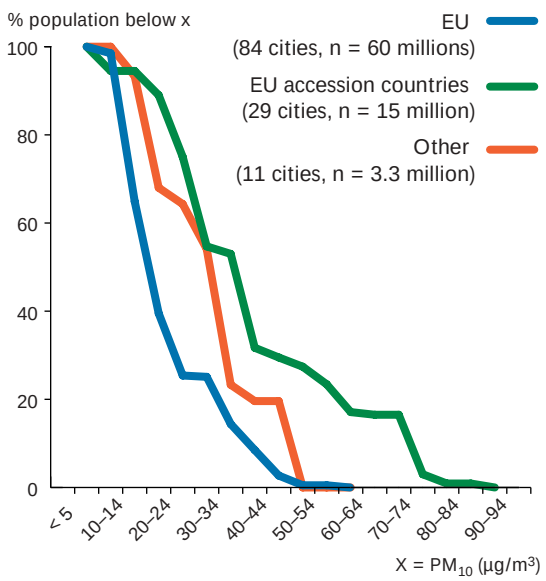
Road traffic is the predominant source of human exposure to noise, except for people living near airports and railway lines. Around 65 % of the people in Europe, about 450 million, are exposed to noise levels leading to serious annoyance, speech interference and sleep disturbance (Dora and Racioppi, 2001).

Other effects of traffic that may impact on human health include aggression and nervousness, reduced community contacts and constraints on child development.

Sources: WHO, 2000a; Racioppi, 2002

Figure 12.2. **Population exposure to estimated PM_{10} levels in 124 European cities**

Source: WHO, 2001a



polluting local sources of particulate matter, as much as 40–60 % of PM_{10} levels may be attributable to long-range transport, which is therefore a substantial contributor to the total exposure of the European population to airborne particulates (WHO, 2002a).

Ozone

Ground-level ozone and other photochemical oxidants are formed in the lower atmosphere by reactions of volatile organic compounds and nitrogen oxides in the presence of sunlight. Ozone can be transported over long distances and is therefore a regional air pollution problem causing damage to crops, etc. (see Chapter 5). High concentrations of ozone in the troposphere, typical for the summer months, lead to an increase in the frequency of respiratory symptoms; nearly 1 000 emergency hospital admissions and more than 2 000 premature deaths per year can be attributed to this pollution in the EU countries (WHO, 2002a).

Heavy metals

Heavy metals such as cadmium, lead and mercury are common air pollutants and are emitted predominantly into air as result of various industrial activities (see Chapters 5 and 6). Their long-range transboundary effects have been assessed in a number of studies (WHO, 2002b).

Lead and its compounds may enter the environment at any point during its mining, smelting, processing, use, recycling or disposal. Children are the critical population for environmental lead exposure which may influence cognitive functions as well as the central nervous system. The influence may occur when living in close proximity to point sources of emission, by exposure to lead paint flakes or lead-contaminated soil; long-range transport of lead is assumed to contribute about 0.03 % to the actual lead content in the topsoil layer and therefore does not influence the lead content of food to any significant degree. A persisting, local problem is exposure to lead from its continued use in transport fuels in several countries in the eastern part of the region, in spite of commitments made by ministers of transport and environment at the Vienna Regional Conference on Transport and Environment (Vienna, November 1997) to phase out leaded gasoline.

12.2.2. Water and sanitation

Worldwide, insufficient water quality and supply, sanitation and hygiene are believed to be the second biggest cause, after malnutrition, of loss of potentially healthy years of life due to death and illness. The measure used is disability adjusted life years (DALY).

Drinking-water related infections

A number of serious infectious diseases, such as hepatitis A, cholera and typhoid fever, can be spread via contaminated drinking water, as can more common intestinal diseases such as gastroenteritis. It is estimated that there are about 4 billion cases worldwide of diarrhoea per year, resulting in 2.2 million deaths (WHO, 2002a).

Table 12.1 provides the latest information available from 17 European countries on possible waterborne diseases in the period 1986–96. Only 2 % of the cases caused by bacteria, viruses and parasites are reported as being linked to drinking water (WHO, 2002c). However, a number of confounding factors (e.g. social conditions, immunity, reporting and assessments) make the estimates unreliable. Flooding also contribute to waterborne diseases; in Ukraine, in 1998, during the floods in Trans-Carpathian region the rate of the typhoid fever sickness exceeded the average indicator (0.28 cases per 100 000 inhabitants) in the country with 6.83 cases per 100 000 inhabitants (Ukraine NCP, 2002).

A recent study compared the under-five mortality rate from diarrhoeal diseases per

100 000 in European countries with the United National Development Programme (UNDP) human development index (HDI) and World Bank income groupings. It reported markedly higher mortality in people with lower middle/low income in countries with medium level of development than in other population groups (Figure 12.3). The relationship seems to be applicable for the whole decade 1991–2000, but there has been considerable improvement for the two groups since 1993.

A similar relationship between European countries with a medium HDI and people with a lower middle/low income was found with regard to incidences of viral hepatitis A per 100 000, but with less improvement during the 1990s (Figure 12.4). Lower middle income was also a strong determinant of the incidence in countries with high HDI until 1998.

Compliance with drinking-water standards

WHO guidelines for drinking-water quality recommend that indicators of faecal contamination (Escherichia coli (E. coli) or thermo-tolerant coliform bacteria) should not be detectable in any 100 ml sample of water intended for drinking, water entering the distribution system, or water within the distribution system. An overview of results is given in Figure 12.5.

It is not possible from the material available to establish a direct relation between exceedances of standards and occurrence of drinking-water related diseases, but, generally speaking, the higher the exceedance, in each case and relatively (i.e. percentage of all samples exceeding standards), the higher the risk of drinking-water related diseases.

Chemicals and drinking-water quality

WHO has established guideline values for more than 100 chemicals in drinking water, all being of health concern. However, in European countries only a few are important for routine monitoring purposes: lead, arsenic, fluoride, nitrate/nitrite and pesticides. Only nitrate/nitrite and pesticides will be dealt with here since they are the ones that most frequently give rise to health concerns.

High concentrations of nitrate in drinking water are of concern because nitrate can be reduced to nitrite, which can cause methaemoglobinaemia, a disease especially dangerous in babies (blue baby syndrome).

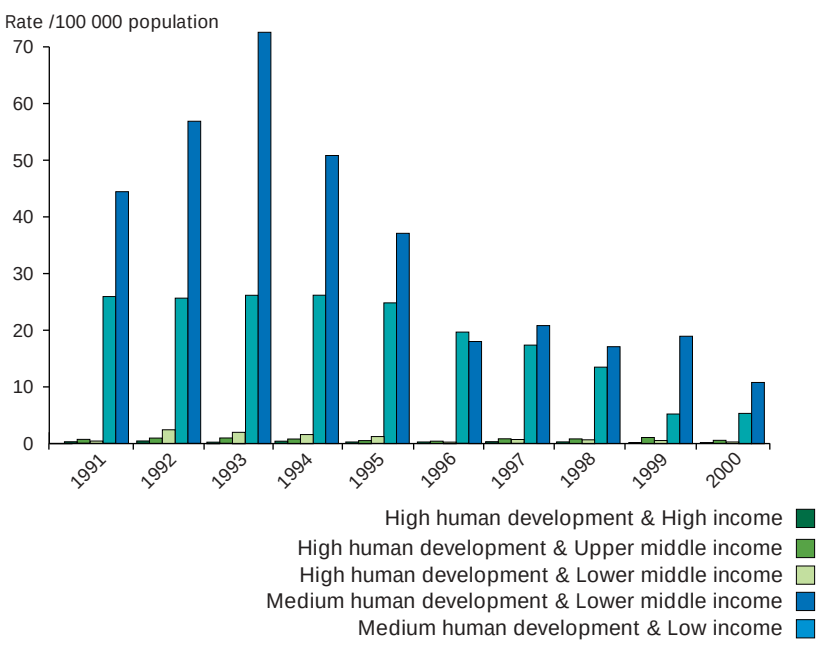
Reported cases of gastrointestinal or other possibly waterborne diseases and cases of these diseases linked to drinking water in 17 European countries, 1986–96 — Table 12.1.

Causative agent diseases	Total number of cases reported	Number of cases and linked to drinking water
Bacteria: bacterial dysentery, cholera, typhoid fever and others	534 732 (20.8 %)	15 167 (2.8 %)
Viruses: hepatitis A and Norwalk-like virus	343 305 (13.4 %)	6 869 (2.0 %)
Parasites: amoebic dysentery, amoebic; meningoencephalitis,; cryptosporidiosis and; giardiasis;	220 581 (8.6 %)	4 568 (2.1 %);
Chemicals: dental/skeletal flourosis and methaemoglobinaemia	7 421 (0.3 %)	2 802 (37.8 %)
Unspecified cause: gastroenteritis and severe diarrhoea	1 461 171 (56.9 %)	22 898 (1.6 %)
Total	**2 576 210 (100 %)**	**52 304 (2.0 %)**

Notes: Countries included are Andorra, Austria, Croatia, Czech Republic, England and Wales, Estonia, Germany, Hungary, Latvia, Lithuania, Malta, Norway, Republic of Moldova, Romania, Slovakia, Slovenia and Sweden. On average, the countries had data available for 7 of the 12 diseases (range 3–10). Other bacterial agents include: Aeromonas, Campylobacter and Salmonella spp.

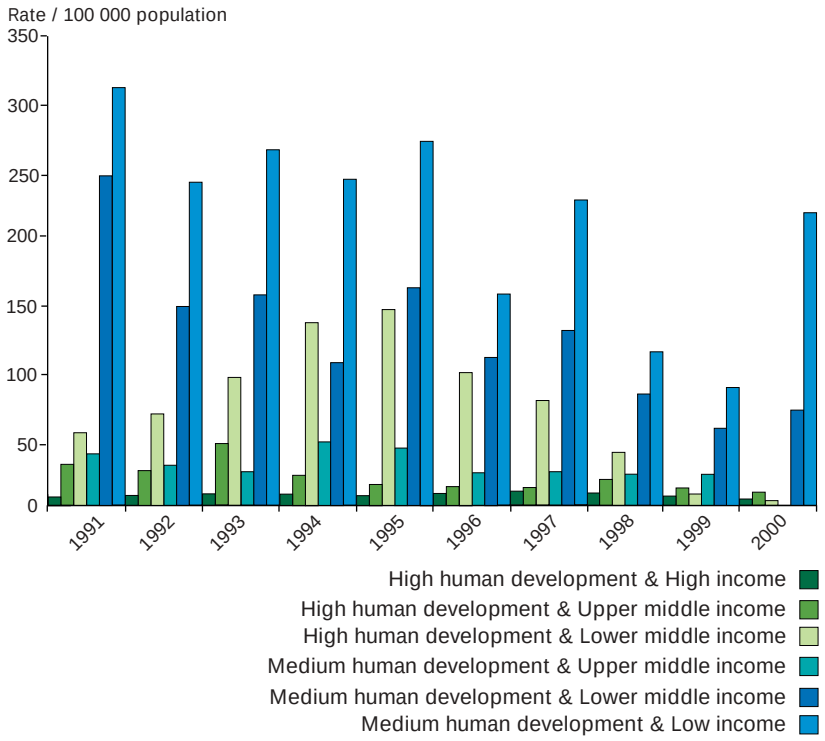
Source: WHO, 2002b

Under five mortality rate from diarrhoeal diseases per 100 000 — Figure 12.3.



Source: WHO, 2002a

Figure 12.4. **Viral hepatitis A incidence per 100 000**



Source: WHO, 2002a

Progressive symptoms are stupor, coma and, in some cases, death.

Analysis of methaemoglobinaemia-related data has been made in several countries (Figure 12.6). For instance, in Romania between 1985 and 1996, 2 913 cases were recorded of which 102 were fatal. The severest conditions prevail when drinking water is contaminated microbially and with high concentrations of nitrate (maybe up to 1 000 mg/l) at the same time.

Water resources located in intensively farmed agricultural land are liable to be contaminated by nitrate (see Chapter 8). Consequently the rural population is at highest risk. Some countries in Europe consider contamination by pesticides to be among their major problems with drinking-water quality. A number of reports on exceedances of standards (for EU countries) and/or WHO guidelines exist, some of the exceedances being quite severe and frequent. For example, 12.3 % of drinking-water samples tested in 1995 in England and Wales exceeded the national standard for isoproturon of 0.1 µg/l. Nevertheless, the significance of concentrations exceeding EU standards or WHO guidelines for human health is unclear. No association between exceedances of EU standards or WHO guidelines for pesticides and the general incidence of morbidity or mortality has been established, possibly because the safety margin built into EU standards/WHO guidelines is considerable, and because of the scarcity of appropriate studies.

However, over the past 10 years UK industry has spent more than USD 1.5 billion on capital expenditure, and an additional USD 150 million per year on running costs, to remove residues from drinking water. This is not sustainable over the long term as pesticide removal is an energy and resource-intensive process. It would be better if the money spent on removing pesticides from drinking water were diverted to developing non-chemical alternatives, where that is feasible (Pesticide Action Network (UK), 2002).

Water supply, coverage, discontinuity

The percentage of the total population served by piped water supply in Europe mostly varies between 50 % and 100 %, with over or well over 90 % in many countries. The proportion of the population connected can vary significantly between different areas of the same country. For example, 78 % of the population in the northeastern part of Italy is connected to a public supply, compared with only 27 % in the Italian islands. The rural population, which in many countries accounts for around 50 % of the total population, is the worst supplied. Only in a few countries (e.g. Iceland, Norway, Denmark) is all of the rural population connected to a home water supply, while in Republic of Moldova and Ukraine 18 % and 25 % respectively enjoy the same facility (see Box 12.3). The situation in EECCA has not improved over the past decade. On the contrary, many of the supply systems, especially in rural areas, broke down during the first half of the 1990s due to lack of economic resources for repair and maintenance, and are now beyond rehabilitation. In these areas people rely on local, often individual, water sources and latrines, a situation which frequently causes a health hazard because of the short distance between drinking-water intake and a possible source of faecal contamination.

Discontinuity of supply, especially when combined with severe leaks in supply pipelines, also affects drinking-water quality and thus health. Problems in providing the population with continuous supply vary from non-existent in some countries to being of major importance in some eastern European

countries and EECCA, mostly due to economic difficulties, lack of maintenance, or interruptions in power supplies. In many towns in these countries, the population only has water supply during a few hours per day and water pressure is often only sufficient to reach the lowest two to four floors of apartment buildings. People are often tempted to leave their taps open in order to collect a few buckets of water when it comes, which, although understandable from an individual point of view, causes much water loss.

Consumption and leaks

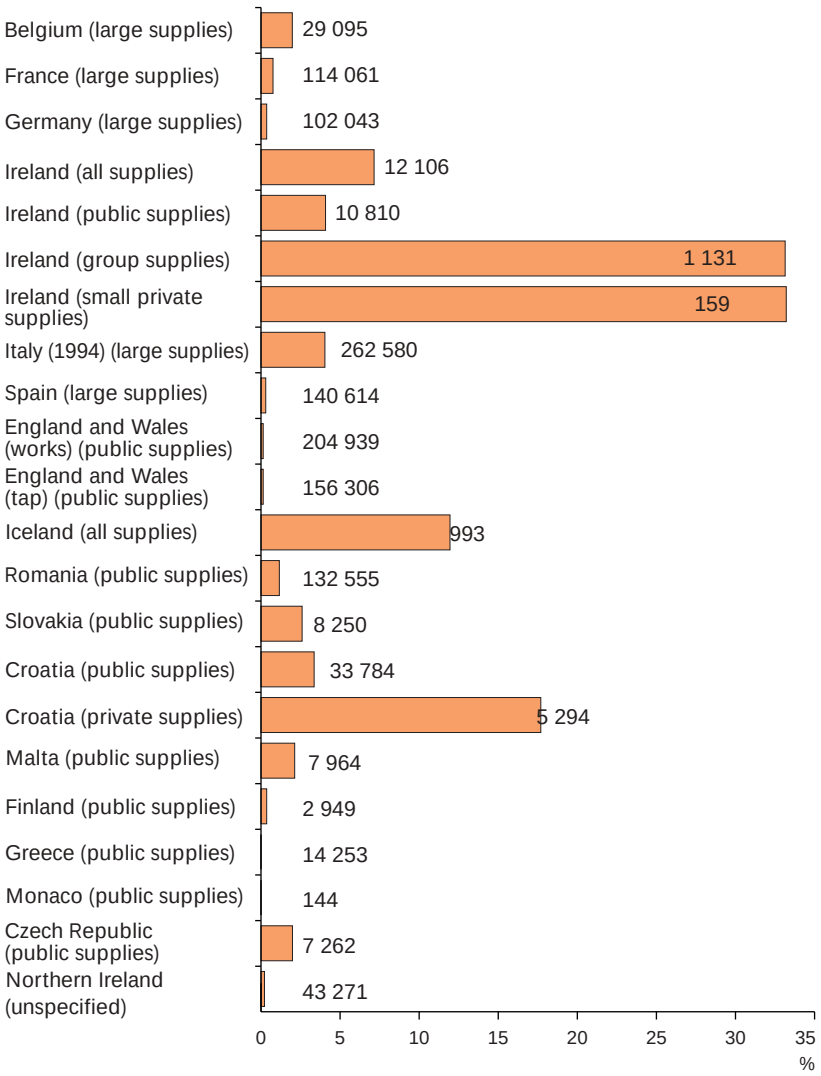
The big differences in drinking-water consumption patterns between western and eastern Europe are probably the result of discontinuity of supply and leaks. Other reasons for low water use efficiency may be low water prices and lack of awareness-raising campaigns. While 150–300 l/person/day seems to be the norm in western Europe (WE), 400–600 l/person/day is found quite frequently in some towns of eastern Europe and EECCA. In addition to the waste of resources, this also adds to the economic difficulties of public utilities in these countries. Water abstraction, treatment and pumping are quite expensive. From a health point of view this money could be better used to repair leaks and ensure continuity of supply. This should be considered a priority area of effort for most eastern European and all EECCA countries.

Leaks are not only a question of waste of resources; they also affect health as they serve as entry points for contaminants. The more leaks, the more the health hazard, especially if leaks are associated with discontinuity of supply as vacuum in the pipes will then easily occur. Losses vary from country to country and within the same country (Table 12.2). Leaks cannot be totally avoided, and poor metering and monitoring in some countries make accurate estimates difficult. However, 10 % or less loss through leaks would be a good benchmark.

Sanitation, coverage

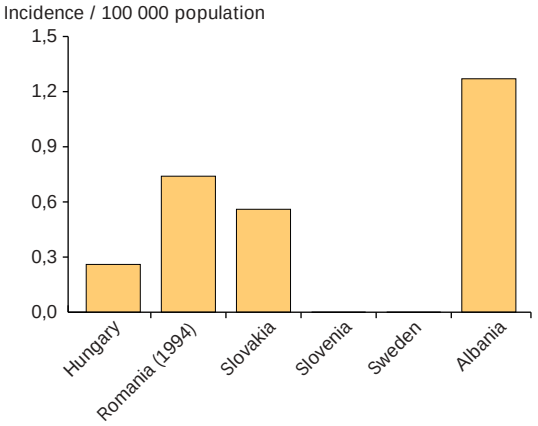
The global coverage of sanitation by world region in 2000 has been estimated in WHO, 2001b. The sanitation situation in European urban areas is comparable to those in North America and Oceania (nearly 100 % coverage), while the situation in European rural areas (about 70 % coverage) is worse than in North America and Oceania (80 % upwards). The percentage coverage is barely increasing with time. In this estimate

Percentage of drinking-water samples exceeding national standards for faecal coliform bacteria in 1995, European countries — Figure 12.5.



Note: Numbers give the number of samplings
Source: WHO, 2002a

Incidence of methaemoglobinaemia in selected European countries, 1996 — Figure 12.6.



Note: Records for methaemoglobinaemia in Romania are for cases related to well water only.

Source: WHO, 2002b

Box 12.3. Health water-related issues in the Republic of Moldova

In the Republic of Moldova the most commonly reported infectious diseases are viral hepatitis A and acute intestinal diseases, 15-18 % of which are transmitted via drinking water. From the non-infectious diseases the most commonly reported is fluorosis, which is directly related to the use of water with high concentration of fluorine; 100 000 cases of fluorosis were reported among the population from around 70 settlements in the country.

The centralised water supply serves 55 % of the population. The rural population (54 % of the total population) uses 90–95 % of well water and only 5–10 % of tap water, though 18 % are connected to the centralised water supply while 82 % and 18 % of the urban population is served with centralized water supply and wells respectively. The water is supplied with breaks from 8 to 16 hours per day, with the exception of Chisinau. In the country, the average water consumption does not exceed 30 l/person/day in rural settlements and 50–70 l/person/day in urban settlements. In Chisinau and Balti the water consumption is 130–140 l/person/day. At present 42 % of the population is connected to a sewage system (68 % and 9 % of the urban and rural population respectively).

According to the State Sanitary Service drinking water is extracted for 70 % from groundwater and for 30 % from surface water. More than 50 % of the population do not have access to drinking water of good quality; the worst situation is in the southern part of the country. 49 % of the centralized reservoirs of drinking water, 83 % of the non-centralized reservoirs and 39 % of the surface reservoirs used by population show a non-compliance with the health standards. For wells the major problem is due to high nitrate concentrations — 74 % of the samples.

Another major problem is the microbial pollution of the water sources. Among the samples showing a non-compliance with the health standards, 14 % are from groundwater, 32.3 % from wells and for surface water 62 % from the Dniester river and 23 % from the Prut river.

Regarding bathing waters, an intensive bacteriological pollution is reported. Coliform lacto-positive bacteria was reported for more than 240 000 cases. From 37 recreational places only 2 correspond to the sanitation and hygiene standards.

Source: Republic of Moldova NCP, 2002

'sanitation' is understood as any kind of disposal facility, on or off site. It does not necessarily mean that a sewerage system is available. No assessment of sanitation coverage in European subregions is available.

The linkage between water supply, sanitation, hygiene and health is important. In a household without tap water it is difficult to make a flushing toilet work properly, if at all, and it is a demanding exercise to keep personal hygiene, the cleanliness of the dwelling and clothes at a satisfactory level. Hygiene, well-being, and consequently health, are at serious risk

Recreational water

Recreational water environments have a diverse range of hazards to human health. These include factors associated with microbial pollution, accidents, exposure to toxic algae products, occasional exposure to chemical pollution and sunburn.

Clear evidence indicates that exposure to faecal pollution when bathing leads to health effects. Gastroenteritis is the most frequently reported adverse health outcome investigated, and evidence suggests a causal relationship between increasing recreational exposure to faecal contamination and frequency of gastroenteritis. There is also reason to believe that other severe infectious diseases such as typhoid fever and viral diseases such as hepatitis A and E may be transmitted to susceptible bathers who make recreational use of polluted water.

Monitoring for compliance with EU and national standards or WHO guidelines has been used for a number of decades as a tool to ensure bathing water quality that is not likely to cause harm to health (see Chapter 8). Compliance in EU countries is increasing slightly for seawater bathing points, while a considerable improvement has been noted for freshwater bathing points in the period 1993 (30 % of sites complying) to 1997 (80 % of sites) (WHO, 1999b). Results in five non-EU countries are similar (WHO, 2002c), but data are too few and sporadic for a comprehensive assessment of the situation in non-EU countries.

Like any kind of compliance monitoring, bathing water quality monitoring always gives a retrospective picture of the situation. Efforts are therefore being made to develop another approach to classifying beaches for health risk by combining a measure of faecal contamination with an inspection-based assessment of the susceptibility of an area to direct influence from human faecal contamination (WHO, 2002c).

An overview of mortality rates from accidental drowning and submersion per 10 000 population in 38 European countries in 1994 is given in WHO, 2002a. Data suggest that males are more likely to drown (range: 0.08 per 10 000 population for the United Kingdom to 3.77 for Latvia) than females (range: 0.02 for the United Kingdom to 0.55 for Lithuania), but it is not clear whether this is because more males swim. Greater alcohol consumption by men is also a contributing factor, as are heart attacks, sea currents and surf.

In terms of all accidental deaths in the European Region, drowning accounts for less than 10 % of the 280 000 deaths due to accidents.

While discussions of the health hazards associated with recreational use of bathing water and beaches have concentrated on compliance with bathing water quality

standards and the data on drowning/submersion), other health hazards like incidental cuts (sharp stones, metal and glass pieces, needles, urchins) and sunburn that can lead or contribute to development of skin cancer may be more important in terms of morbidity and mortality.

12.2.3. Food-borne diseases

Food-borne diseases caused by microbial hazards are a growing public health problem. The WHO Programme for Surveillance of Food-borne Diseases in Europe has been collecting official information from the Member States of the WHO European Region for the past 20 years. Most countries with systems for reporting food-borne diseases have documented significant increase during that period in the incidence of diseases caused by micro-organisms in food including *Salmonella* (Figure 12.7) and *Campylobacter*. New hazards have emerged in the food chain such as enterohaemorrhagic *E. coli*, multi-drug-resistant *Salmonella typhimurium* DT-104 and bovine spongiform encephalopathy (BSE). Variant Creutzfeldt-Jacob disease, with 105 deaths reported in Europe, is strongly linked to exposure to BSE.

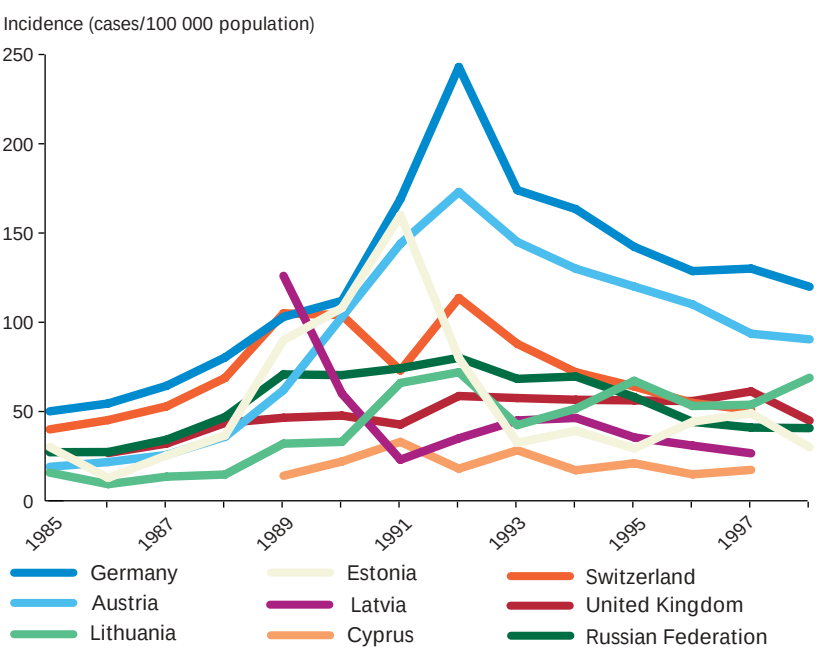
The possible hazards to human health from genetically modified foods (see for example Advisory Committee on Novel Foods and Processes, 1994; Royal Society, 1998) include: new allergens being formed through the inclusion of novel proteins which trigger allergic reactions at some stage; antibiotic resistance genes used as 'markers' in the genetically modified (GM) food being transferred to gut micro-organisms and intensifying problems with antibiotic-resistant pathogens; and the creation of new toxins through unexpected interactions between the product of the GM and other constituents.

Estimated losses from water networks in selected European countries, mid-1990s — Table 12.2.

Country	Comments/observations
Albania	Up to 75 %;
Armenia	50–55 %
Bulgaria/	Sofia 30–40 % Other than Sofia — more than 60 %
Croatia	30–60 %
Czech Republic	33 %
France/	National average (1990) 30 % Paris 15 % Highly rural areas 32 %
Germany (former West Germany)	3 700 l/km of mains pipe per day 112 litres per property per day
Hungary	30–40 %
Italy/	National average 15 % Rome 31 % Bari 30 %
Kyrgyzstan	20–35 %
Republic of Moldova	40–60 %
Romania	21–40 %
Slovakia	27 %
Spain	20 % Bilbao 40 % Madrid
Ukraine	30–50 %
United Kingdom (England and Wales)	8 400 l/km/day of mains pipe 243 litres per property per day

Sources: Mountain Unlimited, 1995 and 1997; Water Research Centre, 1997; Istituto di Ricerca sulle Acque, 1996; WHO, 2002a

Incidence of salmonellosis in selected European countries, 1995–98 — Figure 12.7.



Source: WHO, 2002a

12.2.4. Ionising radiation

It is generally (and cautiously) assumed that the effect of radiation on health is proportional to the dose received. Exposure of the European population to ionising radiation, as in the rest of the world, is almost entirely from natural sources (about 94 % on average), with about 6 % from medical exposures and about 0.1 % from man-made sources. Nuclear power accounts for about 0.02 % of the total (see also Chapter 10, Table 10.3, which, however, excludes natural sources).

Exposure to radiation from natural sources can be quite significant in terms of the health burden in some populations. For example, radon in the domestic environment can give rise to annual doses that exceed the International Commission on Radiological Protection (ICRP) dose limit for occupational exposure. A small proportion of the population in countries such as Finland, Sweden and the United Kingdom receive considerably higher than average doses, causing several thousands lung cancers in Europe.

Routine releases of radioactive material from nuclear installations to the marine environment have fallen significantly since the 1970s. In 1996 atmospheric discharges accounted for 88 % of the total collective dose from nuclear installations, with power stations contributing half the collective dose. The reprocessing plants at Cap la Hague and Sellafield have provided the largest contribution to collective dose. Individual doses near nuclear sites were all below the relevant dose limit set by ICRP. Improvements to the transparency and availability of radiation exposures and doses have recently been proposed (Spira *et al*, 2002).

Few releases of ionising radiation have been reported as a result of accidents at nuclear power plants or the testing and disposal of weapons (see Chapter 10, Section 10.3.1). The Chernobyl accident is so far the only nuclear accident to be assigned a 7 on the INES (international nuclear event scale) scale (see Chapter 10, Figure 10.8), with significant health consequences, besides its psychological effects.

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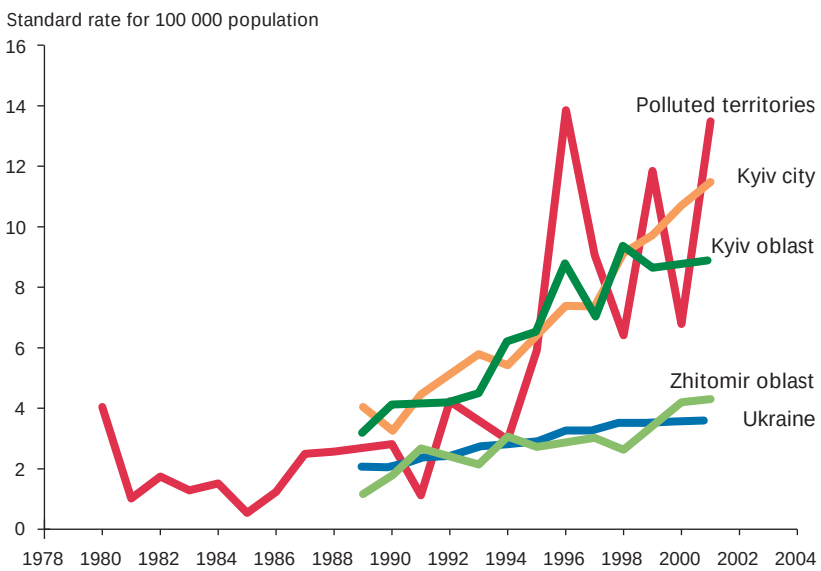
Almost immediately, serious health effects were seen from the Chernobyl accident. Of the 600 workers present at the plant when the accident took place, 134 received high doses (0.7–13.4 Gy) and suffered from radiation illness. Among those, 28 died during the first three months following the accident and 2 more soon after. About 200 000 recovery operation workers received doses of between 0.01 and 0.5 Gy between 1986 and 1987. This group is at potential risk for late consequences and is being followed closely (UNSCEAR, 2000).

The population in the affected territories has since 1986 been subjected to both external and internal exposure to radiation from the deposited radionuclides, which has gradually decreased with time. Bioaccumulation in the food chain has contributed significantly to the internal exposures. Contaminated vegetation led to contamination of dairy and meat products of animals that were grazing in areas affected by atmospheric fallout. There are still a number of indigenous populations in northern Europe and the Arctic, many of which subsist on a diet that includes natural food products (reindeer meat, fish, berries and mushrooms), which were all found to have high radio-caesium contents post-Chernobyl.

Among the individuals exposed in childhood, especially in the most severely contaminated areas in Ukraine, Belarus and the Russian Federation, about 1 800 cases of thyroid cancer had been found by 1999. This is an increase in the numbers found by WHO in 1995 (see Chapter 10), and additional cases are to be expected, especially among those exposed at a young age. In Ukraine, on the basis of yearly checking, the number of healthy children is decreasing. Among the

Figure 12.8. **Thyroid gland cancer of population from different regions in Ukraine**



Source: Anon, 2002

children reported as affected by the Chernobyl accident, 59.3 % were reported as being healthy in 1987 and 23.9 % in 2000. The number of children (among the children affected by the accident) with malignant new growths in 1993–2000 has increased by 55 %, and in particular the number of children with malignant tumours of the thyroid gland has increased by 28 %. The increase in thyroid cancer now appears to affect the general population of the Ukraine, though increases in general tumour rates are usually due to a combination of factors (see Figure 12.8) (Anon, 2002).

However, the conclusions of the Third International Conference on the Health Effects of the Chernobyl Accident, held in Kiev in June 2001 (UNSCEAR, 2001) on these issues were:

- 'There is no doubt that the incidence of thyroid cancer has substantially increased in children who were 0-18 years old at the time of the accident and that this is related to radiation from the accident. An increased number of cases of thyroid cancer among liquidators who worked in 1986 is expected to occur.
- There is no significant increase in leukaemia in adults or children living on contaminated territories of the three affected countries.
- While there has been increased incidence of solid tumours, there is little significant and/or consistent evidence of a radiation-related increase in clean-up workers, evacuees, or residents of contaminated areas in the three affected countries.'

On other health effects, UNSCEAR, 2001 concluded:

'At 15 years after the accident other types of health effects seem to have emerged. These are primarily neuropsychiatric and cardiovascular diseases, but also include: deteriorating health of liquidators, increased invalidity among liquidators, decreasing birth rate, diminishing health of new-borns, increased pregnancy complications, impaired health of children.

A number of factors inherent to the Chernobyl accident, including worsening socio-economic conditions, continuing residence in contaminated territories, diminishing food supply, vitamin deficiency, relocation, and psychological stress, may contribute to these effects.'

The conference made a number of recommendations for further collaborative studies.

Better monitoring and preparedness was another consequence of the accident. A large number of monitoring stations and automated alarm networks were established throughout Europe. For example, 92 stations were established in the United Kingdom as part of the RIMNET, the radioactive incident monitoring network, which was set up by the UK Government in response to the accident, to enable the country to be better prepared should a similar event occur in the future.

12.2.5. Electromagnetic fields

Electromagnetic fields (EMF) can be broadly divided into static and low-frequency electric and magnetic fields (ELF), where the common sources include power lines, household electrical appliances and computers, and high-frequency or radio-frequency fields (RF), for which the main sources are radar, radio and television broadcast facilities, mobile telephones and their base stations, induction heaters and anti-theft devices. Exposure to the public to EMF is large and increasing, so even small health impacts could be of significant public health interest.

Complying with exposure limits recommended in national and international guidelines helps to control risks from exposures to EMFs that may be harmful to human health. However, long-term, low-level exposure below the exposure limits may cause adverse health effects via 'chronic' impacts, or otherwise influence people's well-being.

Scientific knowledge about the health effects of ELF is substantial and is based on a large number of epidemiological, animal and in-vitro studies (WHO, 2002d). Many health outcomes ranging from reproductive defects to cardiovascular and neuro-degenerative diseases have been examined, but the most consistent evidence to date concerns childhood leukaemia.

In 2001, an expert scientific working group of WHO's International Agency for Research on Cancer (IARC) reviewed studies related to the carcinogenicity of static and extremely low frequency (ELF) electric and magnetic fields. Using the standard IARC classification that weighs human, animal and laboratory evidence, ELF magnetic fields were classified as 'possibly carcinogenic to humans' on the

basis of epidemiological studies of childhood leukaemia, which showed, on average, a 2 fold excess of leukaemia associated with living near power lines.

The IARC 'strength of evidence' for this risk is half way between the strongest categories ('a human carcinogen', or a 'probable carcinogen') and the weakest ('insufficient evidence' and 'probably not a carcinogen') in their 5 categories. It is possible that there are other explanations for the observed association between exposure to ELF and childhood leukaemia, and the extent of the hazard, if true, appears to be small. Sweden, for example, estimates less than one extra leukaemia case in children per year from overhead power lines (Socialstyrelsen, 2002). Options for reducing exposures to ELF from power lines varies from low to very high cost options (California Dept of Health, 2002).

Currently, research efforts are concentrated on whether long-term, low level radio-frequency exposure, even at levels too low to cause significant temperature rise, can cause adverse health effects. Several recent epidemiological studies of mobile phone users found no convincing evidence of increased brain cancer risk. However, the technology is too recent to rule out possible long-term effects. Mobile phone handsets and base stations present quite different exposure situations. Radio-frequency exposure is far higher for mobile phone users than for those living near cellular base stations. Apart from the infrequent signals used to maintain links with nearby base stations, handsets transmit radio-frequency energy only while a call is being made. However, base stations are continuously transmitting signals, although the levels to which the public are exposed are extremely small, even if they live nearby. Given the widespread use of the technology, the degree of scientific uncertainty and the levels of public apprehension, more research, clear communications with the public and exposure reductions in line with the precautionary principle, especially for children (Stewart, 2000), are needed. Some European countries have taken exposure reduction steps e.g. Italy, Switzerland, Belgium and parts of Austria. Exposure reduction measures need to address total exposures to RF from base stations mobile phones and other RF sources. Network infrastructure sharing by phone operators is one of the Stewart Report recommendations that could reduce both exposures and public concern.

12.3. Multi-causality and multi-exposure, and the importance of timing

Fully integrated approaches to health would include, among all stressors, environment-related stressors. This is not only because human lungs and livers do not discriminate between pollutants that come from the factory or the street. Exposures to stressors from all sources may be additive, synergistic (more than the sum of the parts) or antagonistic (less than the sum of the parts), and therefore need to be included in any integrated assessment of environmental health risks.

12.3.1. Chemicals, with a focus on endocrine-disrupting substances

Chemicals, whether anthropogenic, from different points along the life cycle of a product or in foods, or naturally present in the environment at high concentrations, can have many different health effects. The trends in health effects from chemicals are difficult to gauge, although many scientific papers on their potential hazards to human health have been published during recent decades. Knowledge of causal factors and the chemical pollutants that may contribute to human health effects, including the sensitive groups, is summarised in Table 12.3.

Increased incidences of testicular cancer and breast cancer, as well as a decline in the quality of sperm, have been observed in several countries. The causes of these trends are largely unknown; exposure to chemicals may be responsible (the endocrine-disrupter hypothesis), but so may changes in lifestyle.

Pesticides are the most common cause of acute and sub-chronic poisoning. The main reason for this is not only the amount of pesticides used in comparison with other chemicals, but also their high toxicity, their use by non-professionals, and inappropriate storage.

Scientific evidence and information concerning actual exposures to chemical substances and their possible health effects is lacking in most European countries. Lack of data for health impact assessment poses a big problem. Indeed, there has been little progress since Europe's environment: *The second assessment* (EEA, 1998).

The past two decades have witnessed growing scientific concern and public debate over the potential adverse effects that may result from exposure to a group of chemicals

that are able to alter the normal functioning of the endocrine system in humans and wildlife, endocrine-disrupting substances (EDS). These concerns emanate primarily from adverse effects in certain wildlife, fish and ecosystems, the increased incidence of certain endocrine-related human diseases, and endocrine disruption resulting from exposure to certain environmental chemicals observed in laboratory experimental animals.

The International Programme on Chemical Safety has performed a global assessment of the current state of the science relative to environmental endocrine disruption in humans and wildlife (Table 12.4). Generally, studies examining EDS-induced effects in humans have yielded inconsistent and inconclusive results, which is the reason for the overall data being classified as 'weak'. This highlights the need for more rigorous studies. Most evidence showing that humans are susceptible to EDS is provided by studies of high exposure levels. The effects of chronic, low levels of EDS are much more obscure. In particular, the relationship between early-life exposures to EDS in humans and functioning in adult life is poorly understood.

Compared with humans, the evidence that wildlife has been adversely affected by exposures to EDS is extensive. In part, this may reflect the fact that many studies on wildlife have been conducted in areas where the levels of environmental chemicals are known to be high (e.g. point source discharges in the Baltic and the Great Lakes). These studies have focused predominantly on animals inhabiting aquatic ecosystems, which bioaccumulate certain EDS, and represent one of the largest sinks of environmental chemicals that may act as EDS.

Given the dynamic nature of the endocrine system, future efforts in the study of EDS need more focus on the timing, frequency and duration of exposure to these chemicals.

12.3.2. Allergies and asthma

Outdoor air pollution plays a role in the aggravation, and possible the causation of asthma and allergic responses, which are increasingly prevalent diseases, especially in children. Outdoor air pollution penetrates indoors, which makes it necessary to have an integrated approach to both outdoor and indoor air pollution. Other key components of indoor pollution which have been associated with respiratory and allergic

Major health impacts and some associations with environmental exposures to chemicals Table 12.3.

Health impact	Associations with some environmental exposures
Infectious diseases	• water, air and food contamination • climate change
Cancer	• smoking and environmental tobacco smoke (ETS) • some pesticides e.g. phenoxy herbicides • asbestos • natural toxins • food, e.g. low fibre, high fat • polycyclic aromatic hydrocarbons, e.g. in diesel fumes • some metals e.g. cadmium, chromium • radiation (incl. sunlight) • several hundred other animal carcinogens
Cardiovascular diseases	• smoking and ETS • carbon monoxide (CO) • lead • inhalable particles • food, e.g. high cholesterol • stress
Respiratory diseases, including asthma	• smoking and ETS • sulphur dioxide • nitrogen dioxide • inhalable particles • fungal spores • dust mites • pollen • pet hair, skin and excreta • damp
Skin diseases	• some metals, e.g. nickel • some pesticides, e.g. pentachlorophenol • some foods (allergies)
Diabetes, obesity	• food, e.g. high fat • poor exercise
Reproductive dysfunctions	• polychlorinated biphenyls (PCBs) • DDT • cadmium • pthalates and other plasticisers • endocrine disruptors
Developmental (foetal and childhood) disorders	• lead • mercury • smoking and ETS • cadmium • some pesticides • endocrine disruptors
Nervous system disorders	• lead • PCBs • methyl mercury • manganese • aluminium • some solvents • organophosphates
Immune response	• UVB radiation • some pesticides
Chemical sensitivity?	• trace amounts of many chemicals?

Source: EEA

Table 12.4. **Some key points from the executive summary of the WHO/IPCS scientific assessment of endocrine disrupting substances, 2002**

Source: IPCS, 2002

Species/impact	Evidence	Knowledge gaps
Humans		
Sex ratios declining (fewer males)	'Associated with unidentified external influences'	'Stressors and mechanisms of action unknown'
Infertility and spontaneous abortions	'Associated with high exposures to certain chemicals'	'EDS relationship is speculative'
Birth defects in males	'Increases reported and animal data shows EDS damage to male reproductive tract'	'Role of EDS is unclear'
Falling sperm counts	'Declines observed in several, but not all countries/regions'	'No firm data addressing link to EDS'
Early puberty	'Concerns about EDS'	'Mechanisms of action and other causes e.g. nutrition need clarifying. In most instances EDS mechanisms not demonstrated'
Neurological development	'Human and animal studies clearly indicate that prenatal PCBs can have adverse effects'	
Immune function	'Exposure to EDS in humans and animals has altered immune function'	'Not clear that is due to endocrine medicated mechanisms'
Cancer - breast	'Evidence does not support a direct association with EDS: Mid-century exposures to organochlorines were higher than today'	'Exposure data from critical periods of development are lacking'
Cancer - testes	'Increases in some countries from 1910 and earlier cannot be attributed solely to chemicals introduced later. Some evidence of increases e.g. similar geographic variations links to birth defects'	'EDS exposure data are lacking'
Cancer - thyroid	'Direct association between exposure to EDS not demonstrated'	
Cancer - endometrial	'Limited data do not support causal role for EDS'	
Endometriosis	'Associated with some EDS'	'Studies remain equivocal'

Overall assessment: 'Biological plausibility is strong for possible damage to some functions, particularly reproductive and developmental. Some health trends warrant concern and more research. Non-EDS causes need exploring'.

responses are dust mites, spores from pets, damp, environmental tobacco smoke and nitrogen oxides from gas ovens. Other lifestyle factors of importance are family size, vaccinations, day care, illnesses and medication, and diet.

The prevalence of asthma in children of school age varies in different locations of Europe. Wide geographical variation in prevalence is noted also in adults. There is an indication that prevalence has increased over the past decade. The frequency of asthma attacks, sometimes requiring medical assistance or hospitalisation, has been shown to be associated with air pollution levels. Also indoor air pollution, notably biological aerosols, such as house mite dust, has been found to be associated with asthma symptoms. However it is not certain if the environmental conditions cause the onset of the disease, or only increase the chance of exacerbation of the symptoms, and it is not known to what extent the geographical variations in asthma level and trends are related to environmental factors. Some factors that may contribute to the observed rise in asthma include increased loads of

aero-allergens in indoor spaces (linked with the reduction of ventilation and increased moisture build-up in 'energy efficient' houses), changes in diet (less omega-3 fatty acids and antioxidants) and less-developed immune systems in 'highly civilised' societies. However the present data raise more questions than answers (Strachan, 1995). Figure 12.9 illustrates the multi-causal chain of factors implicated in childhood asthma.

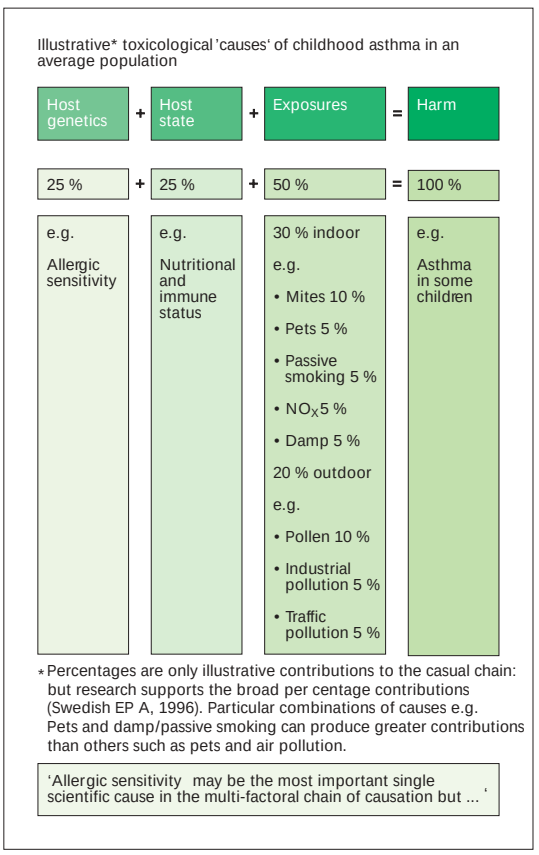
12.3.3. Climate change, ozone depletion and health effects

Some characteristics of global environmental issues are their multi-causality and their extensive and delayed direct and indirect effects (Figure 12.10).

The potential consequences of climate change include increases in sea level, more frequent and intensive storms, floods and droughts, changes in biota and food productivity (see Chapter 3). Changes in ecosystems may affect the growth, transmission and activity of vector-borne or infectious diseases, such as malaria and dengue fever. Human health is likely to be adversely affected, either directly or indirectly, through complex interactions of ecological systems (McMichael, 1998; WHO, 1999c). The direct effects may result from changes in exposure to thermal extremes, and be expressed by an increase in heat-related disease and death, but also by a decrease in cold-related disease.

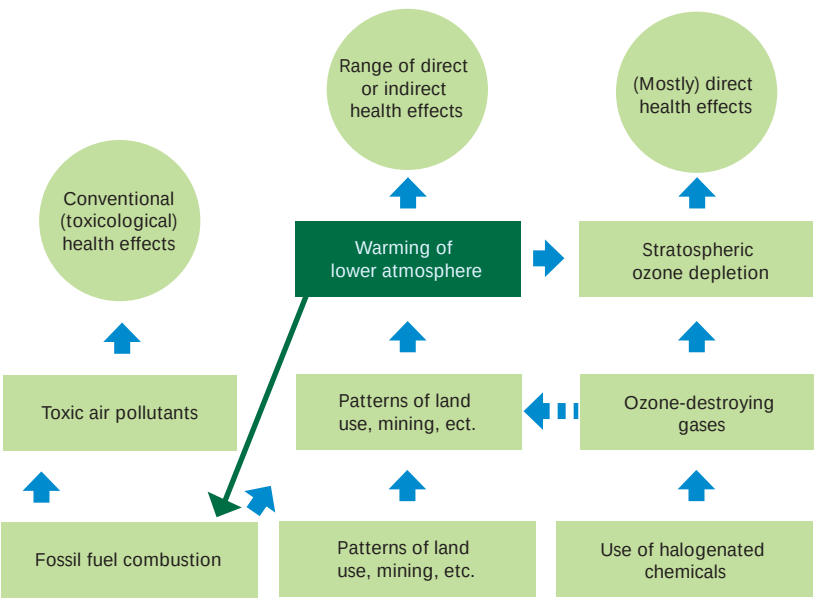
Although it is difficult to attribute recent floods or periods of excessive heat to climate change (see Chapters 3 and 6), experience from past events demonstrates their relevance to human health. Physical health effects from floods do not only occur immediately during or after the incidents (e.g. drowning), they also arise as a consequence of living in damp or dusty conditions, or they appear as communicable diseases, chest infections, coughs and colds, during the weeks or months following flooding. Drought and desertification can also affect human health directly and indirectly, for example through changes in the areas of occurrence of infectious and respiratory diseases (UNCCD secretariat, 2000). Other extreme weather events can lead to psychological disorders, disease or death, indirectly causing an increase in morbidity. Although there are some signs of these climate effects already beginning to happen, (shifting geographical range and longer seasons of some vector-borne diseases (WHO, 1999c), much of the burden of ill

Scientific causes and social intervention causes for childhood asthma — Figure 12.9.



Source: EEA

Interactions between climate change, stratospheric ozone depletion, air pollution and health effects — Figure 12.10.



Sources: McMichael, 1998; WHO, 1998

health from climate change will be on our children and theirs. Climate change policies based on avoiding these health impacts will also have considerable secondary benefits of avoiding shorter-term health impacts from fossil fuel combustion. Very few countries have addressed human health effects within their national climate change impact assessments (Figure 12.11) and comparisons between countries or regions are difficult, as assessment methods differ from country to country (WHO, 2001c).

An increase in ultraviolet solar radiation as a result of stratospheric ozone depletion (see Chapter 4) is associated with a number of health effects (WHO, 2000b). A 10 % decrease in stratospheric ozone is projected to cause an additional 300 000 non-melanoma skin cancers and 4 500 melanoma cases per year, worldwide (UNEP, 1994). For each 1 % decrease in stratospheric ozone, the average annual percentage increase in the incidence of non-melanoma skin cancer ranges from 1 % to 6 %, and for squamous cell carcinoma and basal cell carcinoma from 1.5 % to 2.5 %. Over the past two decades it has become clear that UVB exposure can impair specific and non-specific immune responses. Children are particularly vulnerable to the adverse health effects of stratospheric ozone depletion because of the long time-period of exposure, and the length of time available for an adverse health effect to appear.

12.3.4. Waste

Efficient disposal of wastes is one of the basic requirements for people's well-being. Waste disposal (including collection, transport, treatment and final disposal) is therefore an important environmental health issue (see Box 12.4).

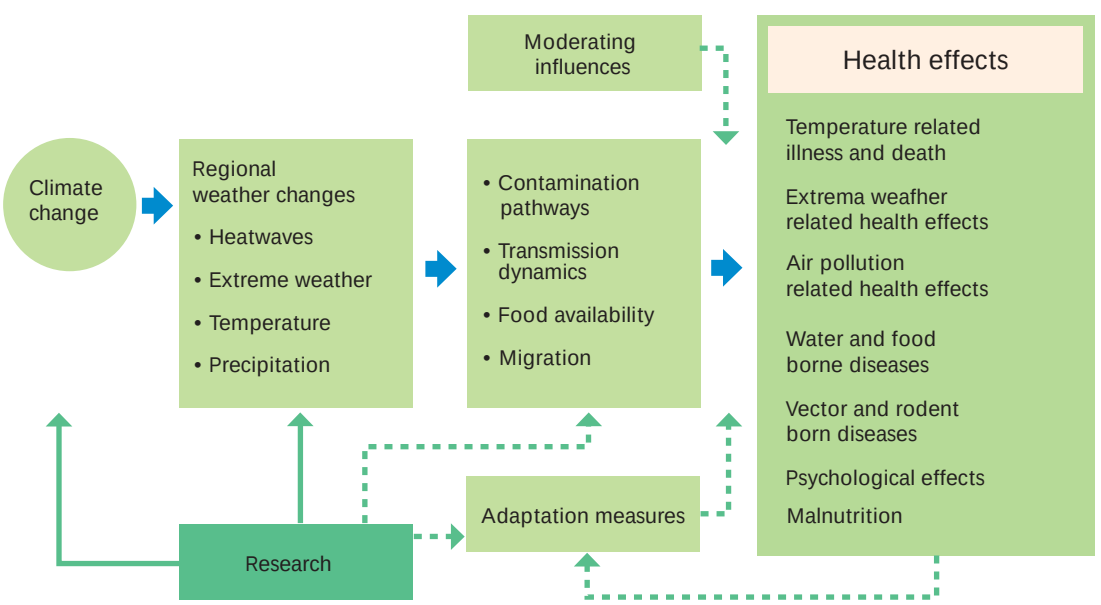
Generally speaking, waste disposal sites that are within 1 km of residential areas, gardening, agricultural activities, hospitals, schools, kindergartens or playgrounds may have an impact on human well-being and/or health. Groundwater abstraction within a radius of 2 km may also be considered a risk. Direct health consequences of waste disposal are, however, difficult to prove and therefore poorly illustrated.

In spite of many and extensive studies, a plausible link between chemical waste deposits and measurable illness has only been found at a minority of locations. The results of these epidemiological studies are seriously affected by many confounding factors, e.g. different lifestyles, smoking, diet, housing quality, and susceptibility of ethnic, gender or age-specific groups to particular medical conditions (Rushbrook, 2001a).

Reported health effects from hazardous waste sites range from non-specific symptoms, such as headache, nausea, vomiting, stomach ache, fatigue and irritative symptoms, to specific conditions such as low birth weight, congenital defects and a

Figure 12.11. **Pathways by which climate change affects health**

Source: Patz *et al.*, 2000



constellation of neurobehavioural deficits (EEA/WHO, 2002). A study on the risk of congenital anomalies near hazardous waste sites in Europe showed a 33 % increase in the risk of non-chromosomal anomalies (Dolk *et al.*, 1998), and another study (Vrijheid, 2002) suggests a similar risk of increased chromosomal anomalies.

Healthcare waste, i.e. wastes from hospitals and medical practices, is composed of two fractions of which 'non-risk' healthcare waste typically represents 75–90 %. This fraction is comparable to municipal waste, while the remaining fraction, 'hazardous' or 'risk' healthcare waste includes all items that may have an elevated chemical, biological or physical risk to health. This fraction which is divided into a number of categories (potentially infectious waste, pathological waste, used sharps, pharmaceutical waste, chemical waste, pressurised cylinders and radioactive waste) is believed to have a much higher potential to cause ill health (Rushbrook, 2001b).

There is very little quantitative data on the probability of pathogen transmission from most healthcare waste to medical and waste workers and none that demonstrates transmission to the general public.

12.4. Children — a vulnerable group

European children (at least those in western Europe) today benefit from better food, cleaner water, more preventive health measures, such as vaccination, and a higher standard of housing and living than ever

Box 12.4. Pharmaceuticals and personal care products in sewage and water

While the point source emissions of pollutants from manufacturing waste streams have long been monitored and subject to controls, the environmental impact of the public's activities regarding the use of chemicals is more difficult to assess. Of particular concern is the widespread release to sewage and surface waters or groundwaters of pharmaceuticals and personal care products (PPCP) after their ingestion, external application, or disposal. Certain pharmaceutically active compounds (e.g. caffeine, nicotine and aspirin) have been known for more than 20 years to enter the environment, by a variety of routes — primarily via treated and untreated sewage effluent. A larger picture, however, has emerged only more recently, where it is evident that numerous personal care products (such as fragrances and sunscreens) and drugs from a wide spectrum of therapeutic classes can occur in the environment and drinking water (albeit at very low concentrations), especially in natural waters that receive sewage.

During the past three decades, the impact of chemical pollution has focused almost exclusively on conventional 'priority pollutants' especially on those collectively referred to as 'persistent, bioaccumulative and toxic' (PBT) pollutants or persistent organic pollutants (POPs). This diverse 'historical' group of persistent chemicals (comprising mainly agricultural and industrial chemicals and synthesis by-products, heavily represented by highly halogenated organics) may however be only one piece of a larger puzzle. This bigger picture, if it does exist, has been largely unattainable with respect to risk assessments. Many other chemical classes (those that can be loosely referred to as 'unregulated bioactive pollutants' or 'unassessed pollutants) must also be better considered as part of a larger puzzle. Pharmaceuticals can be viewed simply as an example of one set of environmental pollutants that have received little attention with respect to potential impact on either ecological or human health.

Sewage and domestic wastes are the primary sources of pharmaceuticals and personal care products in the environment. These bioactive compounds are continually introduced to the environment (primarily via surface waters and groundwaters) from human and animal use largely through sewage treatment works systems, either directly by bathing/washing/swimming or indirectly by excretion in the faeces or urine of un-metabolised parent compounds.

Whether pharmaceuticals and personal care products survive in natural waters sufficiently long to be taken up in untreated drinking water, or whether they survive drinking water treatment, creating the potential for long-term exposure of humans, has received even less investigation than has their environmental occurrence. Certain drugs/metabolites, however, have been documented in potable waters in Europe (Daughton and Ternes, 1999). The extremely low concentrations (parts per trillion, ng/l), orders of magnitude below therapeutic threshold levels, might be expected to have minuscule (but still unknown) health consequences for humans, even for those who continually consume these waters over the course of decades; the primary concern, if any, would focus on those with heightened drug responses or the health-impaired (e.g., foetuses, infants and children, or aged or diseased individuals).

A myriad of chemical classes, ranging from endocrine disruptors, anti-microbials and antidepressants to lipid regulators and synthetic musk fragrances have been identified in sewage and domestic wastes. Excluding the anti-microbials and steroids (which include many members), over 50 individual pharmaceuticals and personal care products or metabolites (from more than 10 broad classes of therapeutic agents or personal care products) had been identified as of 1999 in environmental samples (mainly surface and ground waters). Concentrations generally range from the low ppt- to ppb-levels. It is important to note that these only comprise a subset of substances in wide use.

Sources: Daughton and Ternes, 1999; Daughton, 2001

before. Globally, however, about 1 in 10 children will not live to see their fifth birthday, although this global average conceals wide variations. This is due chiefly to infectious diseases, which still kill many children in the less developed world. There are also parts of Europe, such as areas in EECCA, where, following social and economic breakdown, the classic infectious diseases, such as diphtheria, malaria, TB, cholera and typhoid, are re-emerging. The life expectancy of people in some areas of some EECCA countries has fallen dramatically within the last decade, to an average of less than 50 years in several of the more polluted and impoverished zones, such as in Kazakhstan and Tajikistan. Infant mortality rates in Europe vary enormously, reflecting the large differences in social, economic and environmental conditions, as well as the healthcare systems across the region.

While most children in WE are no longer dying of infectious diseases, they are at increased risk from some cancers and birth defects, as well as asthma, allergies, brain damage and behavioural disorders. This has been called the 'new paediatric morbidity' (EEA, 1999). The causes of these diseases are not as obvious as the causes of infections but, as they have grown to prominence fairly recently, changes in the environment and other factors of modern life are likely to be playing a significant role.

Children today are routinely exposed to a number of 'hidden hazards' from micro-pollutants in air, water, food, on soils and surfaces, and in consumer products. These include newly created synthetic chemicals, which did not exist 50 years ago. For 84 % of the high production volume chemicals on the European market, there is insufficient toxicity information available for even the most basic risk assessments recommended by the Organisation for Economic Co-operation and Development (OECD). Children are not 'little adults' but are particularly vulnerable to pollutants because of their immature biological development, behaviour, metabolism, greater exposure to pollutants, relative to body weight, and longer life at risk than adults. 'It's the timing of the dose that can make the poison.'

Children are therefore potentially more vulnerable to environmental hazards than adults, and require special protection. However, this is not generally provided for since most safety standards for chemicals are based on adult data, although improvements to standards are developing continuously. Some pesticide residues in food and water, because they can accumulate in the particular diets of children, are of concern, especially for possible impacts on the brain and on behaviour. Environmental causes of autism, attention deficit/hyperactivity disorder (ADHD) and lowered IQ are being investigated and seem to be involved in some of the increases in these disorders.

Some other chemicals that can damage the brain and affect behaviour are lead, mercury, polychlorinated biphenyls (PCB) and dioxins which can be absorbed via food, water, air, surfaces and consumer products. Some chemicals (PCB, dioxins) accumulate in body fat and are passed on to the foetus and infant. Although more dose is passed on through breast milk, the lower, pre-natal dose via the mother appears to be more hazardous because of the greater vulnerability of the foetal brain. Hormones in meat may cause brain damage and cancer.

Other environmental pollutants include some radionuclides, which are especially dangerous for children, because they penetrate into children's bodies in the process of growth and serve as 'building material'. Primarily, this has an impact on the genetic code and disruption of the immune system leading to malignant new growths (formations) (see Section 12.2.4).

Environmental health impacts on children (some of which only become apparent in adult live) in Europe could include: reproductive disorders (cancers and defects of the testes, breast cancer, falling sperm counts); asthma; other respiratory diseases and allergies; some other cancers, such as leukaemias and nervous system tumours; and injuries. The possible environmental causes of these health impacts include passive smoking, pesticides and other chemicals, traffic, alcohol, diet and poverty (EEA/WHO, 2002).

The contribution of environmental pollutants to some diseases of US children has recently been estimated. The environmental attributions to the diseases were: lead poisoning (100 %), asthma (30 %), cancer (5 %) and neurobehavioral disorders (10 %). The corresponding estimates of annual costs were: lead poisoning (USD 43.4 billion), asthma (USD 2.0 billion), cancer (USD 0.3 billion) and neurobehavioral disorders (USD 9.2 billion). The total annual costs were USD 54.9 billion,

Environmental risk factors for children's health Figure 12.12.

	Perinatal disease	Respiratory illness	Diarrhoeal disease	Insect-borne disease	Physical injuries
Housing and shelter	xxx	xxx	xx	xxx	xxx
Water supply and quality	x	x	xxx	xxx	xx
Food safety and supply security	xx	xx	xxx	xx	xxx
Sanitation and hygiene	x	x	xxx	xxx	xx
Solid waste	xx	xx	xxx	xxx	xx
Outdoor air pollution	xx	xx	x	x	x
Indoor air pollution	xxx	xxx	x	x	x
Hazardous chemicals	xxx	x	x	x	xxx
Technological accidents	xx	xx	x	x	xxx
Natural hazards	xx	xx	xx	xxx	xxx
Disease carrying factors	xx	xx	xx	xxx	xxx
Social/work environment	xxx	xx	xxx	xxx	xxx

XXX High risk source XX Moderate risk source X Low risk source

Source: WHO, 2003

2.8 % of total US healthcare costs (Landrigan *et al.*, 2002).

Children's environmental health is now receiving special attention, especially in North America, and increasingly in Europe (International Conference, Ukraine 2002). Priorities for action include better exposure monitoring, research, exposure standards designed for children, reduced exposures, information to consumers and citizens about residues and emissions, and awareness-raising, education and training of health professionals and child carers, including parents. Table 12.5 shows an approach to the development of children and environmental health indicators which will provide the basis for the first pan-European report on this issue to be presented at the Budapest Ministerial Conference on Health and Environment, 2004.

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