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THE STATE OF THE ENVIRONMENT

ENVIRONMENT AND HEALTH

10th June 1986

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Executive Summary *

Introduction

1. People depend for their well-being on the health of the societies in which they live. This depends in turn on a decent level of sustained economic development, on a healthy environment and a proper use of its resources. The achievement of sustained development, the promotion of health, and the rational use of environmental resources are simply inseparable.

2. All over the world, in developed and developing countries alike, environmental degradation is undermining development and damaging human health. This ill-health saps the strength of the work-force, and so further obstructs development, leads to greater environmental loss, and causes even more disease. Yet this vicious circle can be broken — and reversed. If the environment is improved, both economies and people will become healthier.

3. The United Nations Environment Programme unequivocally endorses the definition of health embodied in the WHO Constitution, which describes it as "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity". But because of the limitations of such a brief report a more restricted approach has to be adopted. Thus, the report will address only main health problems that can be mitigated by environmental improvements.

Facts and Figures

Quality of life indicators

4. Over the last decade the world has become healthier. Infant mortality has decreased and life expectancy increased in almost every nation. Yet gaps exist between the rich and the poor in developed and developing countries and an enormous gap remains between the two groups of countries. A baby born in a developing country is ten times more likely to die before its first birthday than one born in an industrialized nation. A European or a North American can expect to live more than 20 years longer than an African or a South Asian. People in developing countries mainly suffer from communicable diseases, largely caused by underdevelopment. People in industrialized countries and rich sectors of developing countries, by contrast, die predominantly from degenerative diseases, mainly cardiovascular diseases and cancer, which are caused, to a great extent, by ill-planned development and overconsumption.

Water-borne diseases

5. Every year 4,600,000 children under five die of diarrhoea in developing countries. Every small child in the third world suffers an average of three diarrhoeal attacks a year — and such repeated attacks, even if they do not cause death, lead to malnutrition which stunts physical and mental growth. Two million people die of malaria each year; some 100 million people are infected annually. Two hundred million people suffer from the debilitating vector-borne disease, schistosomiasis.

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* *The reader is referred to the full text of the report State of the Environment 1986 for the qualifications that many of the statements in this summary require.*

*6. Yet these water-borne diseases are preventable. Schistosomiasis and diarrhoeal diseases arise from the pollution of water by human wastes, as a result of poor sanitation. Most people in developing countries do not have clean drinking water or proper sanitation facilities. If these were provided the diseases would be controlled. Malaria presents a more complex problem but can also be combatted by, **inter alia,** sound environmental management techniques. An encouraging example of what can be done comes from the determined collaborative effort against onchocerciasis (which threatens 50 million people with blindness in Africa) in the Volta river basin. After a ten-year effort the risk of blindness has been reduced to virtually nil in 90 per cent of the 700,000 sq km originally infested. Similar international resolve is needed to beat the other communicable diseases.*

Food Production

7. Health suffers through the environmental effects of both a lack of development and inappropriate development. In most cases, at least in developing countries, the two factors act together, to varying degrees, to cause disease and injury.

8. Schistosomiasis and malaria, for example, are both spread through poorly planned water resource projects. Good design can prevent this happening. Similarly, the construction of large dams can spread or subdue onchocerciasis, depending on how well they are adapted to local conditions. But poverty and the attendant underdevelopment, including illiteracy, bring in other factors of tradition and ignorance, e.g. barefoot farmers, to play a synergistic role in spreading schistosomiasis.

9. In an effort to increase food production, the world-wide consumption of fertilizers has been increasing by ten per cent a year in the 1980s. In some countries, over-use has caused nitrates to accumulate in ground water at levels that threaten the lives of young children; and, since some phosphate fertilizers contain cadmium, their present rate of growth is likely to push cadmium intakes in Europe above tolerable levels in a few decades. Over-use of nitrate and phosphate fertilizers has led to so much nitrate running off from the fields into surface water that it has provoked blooms of algae which contaminate shellfish and have caused severe outbreaks of paralytic poisoning.

10. Pesticides, including herbicides, which have also brought major increases in crop yields throughout the world, also pose severe problems. About one million people are estimated to be poisoned by pesticides each year, and between 5,000 and 20,000 of them die. The toll is particularly high in developing countries, where the chemicals are intensively used on cash crops, but where proper safety precautions are often not taken and protective clothing is often not worn. Over-use of pesticides has also led to pests — including some that infect humans with disease — becoming resistant to the chemicals, and thus becoming harder to control. There is also concern about the effect of pesticide residues in food, though levels of many of the most persistent have been reduced in developing countries.

11. Aflatoxins, which contaminate poorly stored food in warm humid countries also pose a major public health hazard, and other mycotoxins have been responsible for very serious poisoning incidents in temperate countries. The main staple foods of Africa and Asia are often contaminated and may lead to acute poisoning. It is suspected that aflatoxin poisoning combines with exposure to the B-hepatitis virus in causing primary cancer of the liver — one of the commonest cancers in Asia and perhaps the most widespread of all in sub-Saharan Africa.

12. Any food, however, is better than none, and, as the tragic events in Africa in 1984 remind us, starvation is an increasing peril in that continent. The African food crisis has environmental routes. The natural cycle of drought has become a cycle of disaster because of

the abuse of the land. Overgrazing, overcultivation, deforestation, and poor irrigation schemes have led to the spread of desertification. And, as the vegetation goes, weather patterns are further disrupted, leading to more drought. The problem is by no means confined to Africa. It affects vast areas of the world and ultimately may threaten other areas with similar catastrophes.

13. Some 10 million sq km of Africa are effectively closed to cattle ranching because of the prevalence of trypanosomiasis (sleeping sickness), which impairs the productivity of cattle and affects some 20,000 people a year in the continent. Clearing the land of the disease would require a vast, and probably prohibitive, amount of human and financial resources.

Energy

14. The production and use of energy, which underpins all development, also damages health through its effect on the environment. The collection of the necessary raw materials costs lives: accidents in coal mines are a well-known danger, but evidence now suggests that the gathering of fuelwood claims more than ten times more lives for the same energy production, even in developed countries. The casualty rate must be far higher still among the tired and overworked firewood gatherers, mostly women, in developing countries. There have been major disasters when dams have burst and coal slag heaps have collapsed. Further catastrophes have occurred during the transport and storage of gas and oil. Coal and uranium miners contract serious occupational diseases, and pollution also occurs during the processing of fuel.

15. The most serious health effects in energy use arise from the burning of coal, oil, gas, wood, dung and other organic fuels. In Asia, Africa and Latin America, use of wood, dung and agricultural wastes in open hearths causes dangerous concentrations of toxic gases to build up in houses. Estimates suggest that one per cent of the rural population in India and Nepal — tens of millions of people — suffer from chronic heart and lung diseases as a result, and the incidence of chronic bronchitis and emphysema is much higher still. Other health effects include asthma and nasopharyngeal cancer.

16. Fuel burning has also been the cause of serious city-wide air pollution, from the traditional London smogs that killed thousands of people in the 1950s, to the photochemical smogs that became famous in Los Angeles in the 1960s and now bedevil Mexico City, Sao Paolo, and many other cities in both developed and developing countries. Car emissions are the main contributors to photochemical smog, and they also contribute, with emissions from power stations, to the so-called 'acid rain' which may pose threats to health by mobilizing toxic metals such as cadmium from the soil. The levels of some air pollutants have been declining in some cities at least — but there is obvious potential for further reductions in emissions. Many countries have already taken steps to reduce or eliminate lead emissions from vehicles.

17. Most energy production gives rise to wastes that require controlled disposal, but the most controversial — and potentially the most hazardous — wastes arise from the nuclear fuel cycle. Large quantities of radioactive materials have been discharged to the Irish Sea from the Sellafield reprocessing plant in the United Kingdom, though emissions have been greatly reduced over recent years and will doubtless diminish further. Much attention is being paid to the problem of finding safe disposal facilities for nuclear wastes, whether or not spent fuel is reprocessed.

18. Nuclear accidents are a cause of major concern, particularly since, on 26 April 1986, an accident in one of the four nuclear plants at Chernobyl, (Ukrainian SSR, — much the worst incident in the history of nuclear power — caused alarm around the world. The accident led to

a fire, which raged at the plant for days, and sent a cloud of radioactive material wandering across Europe. Two workers at the plant were killed outright and some 300 taken to hospital. Twenty-five of these had died of radiation exposure by early June. Some 90,000 people had to be evacuated from a 30 kilometre radius around the reactor.

19. Even energy conservation can pose health risks. Insulating buildings makes it harder for potentially dangerous gases, including radon, to accumulate indoors, and high concentrations of this radioactive gas have built up in many houses in developed countries. In the United States, radon may be responsible for as much as a fifth of the deaths from lung cancer among non-smokers each year. Measures can be taken, however, to prevent excessive concentrations building up.

Industry

20. Industrial pollutants are causing increasing concern in both developed and developing countries. A number of areas already suffer from levels of cadmium in food which are close to those at which cadmium impairs renal function. Lead may irreversibly damage children's brains. Methylmercury can impair the central nervous system. Perhaps the greatest controversy of all surrounds agents that cause cancer, including ionizing radiation. It is extraordinarily hard to determine the actual health effects of these agents, either singly or in combination, but the toll of all such pollutants put together is certainly several orders of magnitude lower than that of the communicable diseases.

21. It is unquestionable, however, that most industries also affect the health both of their workers and of the general public through pollution. Thus the asbestos industry has taken a particularly heavy toll of workers' lives in mines, mills, dockyards and the like, both in developed and developing countries, and continues to pose hazards both to workers and the general public. This brief report, unable to cover the vast range of industrial production processes, has concentrated on one industry, the chemical industry, by way of an example.

Chemical and Toxic Wastes

22. The world-wide production of organic chemicals has risen dramatically: from seven million tonnes in 1950, to 63 million tonnes in 1970, to about 250 million tonnes today. The numbers of chemicals produced have grown even more. In the process, substances of varying degrees of toxicity and unpleasantness are released to air and water. Workers in the chemical industry are usually the first to suffer from the effects of toxic substances, and outbreaks of serious occupational disease have often provided the first clues to specific dangers.

23. Catastrophic accidents have occurred in chemical plants including, most recently, at Flixborough in the United Kingdom, in 1974, at Seveso in Italy two years later, and — worst of all — at Bhopal, India, in 1984. The Bhopal tragedy was worse than it might have been because poor people, lacking decent housing, settled close to the plant: the Seveso accident was also particularly alarming because it took place in a heavily populated area.

24. Toxic wastes have often been subject to haphazard disposal and have polluted the environment. They have also been moved across national borders, sometimes without the knowledge of national authorities. There is a risk that particularly polluting industries will be set up in developing countries where pollution controls are less strict. But, in general terms, it is extremely difficult to predict the health effects of releases of chemicals to the environment, not least because effluents and discharges usually contain diverse and complex mixtures of substances. Further, some effects may occur sporadically and long after exposure, thus making them difficult to recognize.

Climatic change

25. The combustion of fossil fuels and the release of some chemicals are certain to lead to changes in the world climate. A recent UNEP/WMO/ICSU conference assessed that the accumulation of carbon dioxide and other trace gases in the atmosphere would lead to an increase in global mean equilibrium surface temperatures of the atmosphere of between 1.5 and 4.5 degrees centigrade by the year 2030. This would be accompanied by a rise in sea level of between 0.20 and 1.40 metres, and to unpredictable changes in rainfall patterns and food production. The consequences to human health are as yet unknown, but they are bound to be momentous.

Human settlements

26. Before long, for the first time in history, humanity will become a predominantly urban species. This change of habitat is increasingly bringing its own health problems as the rapid growth of cities, particularly in developing countries, fundamentally alters the human environment.

27. In developing countries more and more people are crowding into the unhealthy squatter settlements that are proliferating in almost every major city. The provision of clean water and sanitation cannot keep pace, and diarrhoeal diseases are frequently the largest single cause of death, particularly among young children. Even the provision of standpipes — a seemingly unattainable dream in most squatter settlements — does not necessarily provide families with clean water; for, unless appropriate vessels are used, the water often becomes contaminated while it is being stored after collection. The very overcrowding of these settlements increases the spread of infectious diseases.

28. Such problems are particularly acute when large populations are resettled, an increasing phenomenon. A variety of diseases can be closely linked to an environmental origin: diseases associated with poor hygiene, such as diarrhoeal diseases, infestations with internal parasites, and skin diseases; diseases associated with crowds and crowding, such as respiratory and sexually transmitted diseases. Unplanned resettlements, when squatters throng to new resource development projects in the hope of economic gain, pose a particularly serious problem, largely ignored by the authorities. As settlements are not officially recognized, they are not considered for even the most basic health and sanitation facilities, and they thus become centres of ill-health.

29. The cities of developed countries have largely overcome these problems. But the degenerative diseases which cause most deaths in the industrialized world are aggravated by factors that contribute to the stress of urban life, including noise, pollution, the fast pace of life, and such behavioural responses to the environment as over-eating, lack of exercise, smoking, alcoholism, and drug taking.

Natural disasters

30. Natural disasters kill many thousands of people each year and make millions homeless. Even allowing for their greater frequency in developing countries, they claim a disproportionate number of victims there. As always, the poor suffer most. In their aftermath, malnutrition and infectious diseases spread as essential services are disrupted. Natural disasters are not simply 'acts of God'. They are often aggravated by the activities of man. Deforestation of watersheds, for example, leads to increases in the number and severity of floods in the plains. Poor buildings are less able to withstand earthquakes.

Development, Health and Environment

31. Provision of a healthy environment to protect public health pays. The Government of Venezuela, for example, found on occasion that the provision of clean water paid for itself five to eleven times over in increased productivity that better health brought to the work-force. Thus, a better environment leads to better health which ensures higher productivity, less waste, and less expenditure on treating the sick.

32. Yet, far too little money is spent by Governments on preventing and controlling damage to the environment, and thus its effects on health. In an ideal world, public health expenditures should be regarded as an absolute priority, and exempted from the normal economic justifications in much the same way as almost every country, developed or developing, judges military expenditures. For example, access to a supply of safe drinking water could be defined as a 'human right'.

33. In the real world, however, where budgetary resources are scarce and subject to many competing demands, expenditure on the environment and health is inevitably going to be subjected to rigorous scrutiny. Unfortunately, it is hard to measure the costs and benefits of such expenditures in conventional ways. We simply do not know all the environmental effects of our activities, or their impact on health, nor can we easily attach a monetary value either to the damage or to its mitigation.

34. Fortunately considerable work has been done on developing innovative techniques. Cost-benefit analysis is only one of a whole range of analytical tools that should be used and include environmental impact statements, cost-effectiveness studies, new ways of estimating the cost of environmental loss, and direct approaches to the public to ask them their priorities.

Recommendations

35. The report will end with recommendations for action.

INTRODUCTION

1. Human health, it is often said, consists of 'mens sana in corpore sano' — a healthy mind in a healthy body. But we now know that this is not enough. Both minds and bodies depend for their well-being on the health of the societies in which they live. And neither the societies, nor their people, can flourish unless they enjoy a decent level of development, and above all, a healthy environment.

2. This report aims to show that the achievement of sustained development, the promotion of health, and the rational use of the environmental resources are absolutely inseparable. Disregard one and, sooner or later, the other two will collapse. If the environment is abused, both health and development suffer; people become ill from environmental diseases, and development — which depends on the use of environmental resources — fails. Similarly, if nations do not develop, poverty condemns their people to continued disease, debility and early death, and drives them to destroy their environment in their desperate attempt to survive. Finally, ill-health is itself an enormous drain on resources, sick people are less productive, and are often driven to do further environmental damage. In such matters, as the late Barbara Ward used to say, "everything connects".

3. Neglect of these fundamental connections has led humanity into a vicious circle. All over the world, in developed and developing countries alike, environmental degradation is undermining development and damaging human health. And ill-health is sapping the strength of the workforce, thus further obstructing development and leading to greater environmental loss.

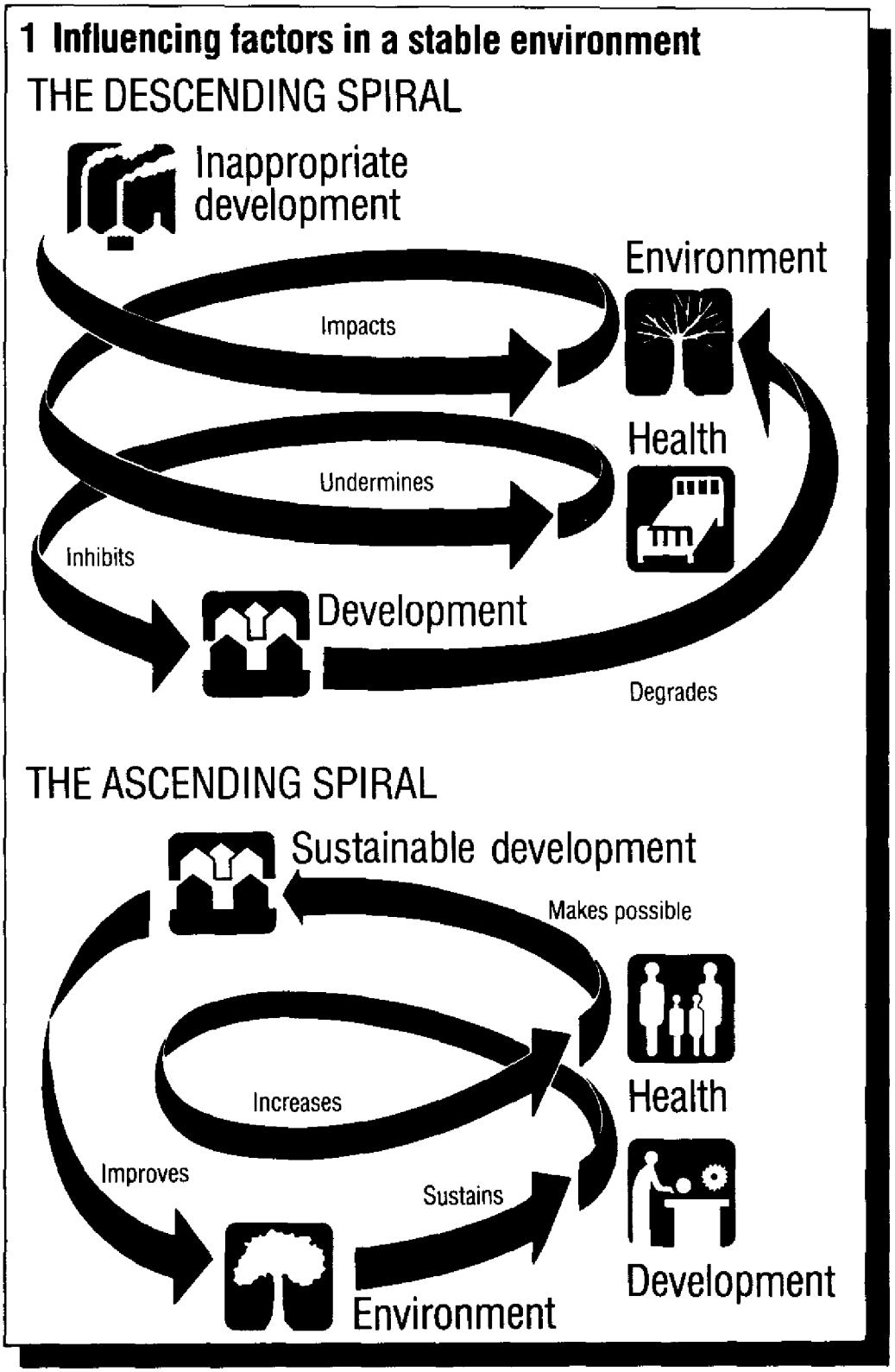
4. Lately, this dismal cycle has been gathering pace. High population growth and rapid technological advance have made environmental problems, and the cohort of health impacts that accompany them, particularly acute. These have deepened the development crisis afflicting most of the Third World, and constrained the growth of even the strongest economies.

5. Yet the cycle can be broken — and reversed. If the environment is improved, both economies and people will become healthier. Health, development and the environment will become interlocked in a positive, upward spiral instead of the present, negative, downward one. If this is to happen, governments will have to give a much greater priority to environmental and health issues than they have ever done to date. This report will strive to show how this can be done. (Fig. I).

6. In attempting this task, the report has broken away from the traditional approaches to the study of health and the environment, which have concentrated on considering the various impairments to health due to environmental causes or, more restrictively, the effects of changes in the environment on health. The report emphasizes the development aspects of health and the environment, and so has set out to deal with the subject according to the human activities that affect health through their impact on the environment.

7. The report — and the United Nations Environment Programme — unequivocally endorse the definition of health embodied in the constitution of the World Health Organization(1) which describes health as 'a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity. But, since the report must, necessarily, be brief, it has had to adopt a tighter definition. It will therefore regard environmental health in the restricted sense of the absence of disease — and it will

1 Influencing factors in a stable environment



define it as consisting of problems that can be mitigated by suitable interventions on the environment. This rules out such diseases as smallpox or leprosy and individually self-imposed risks such as tobacco smoking (as distinct from inhaling smoke produced by a neighbour) or drug taking. Even so, the number of issues to be addressed is beyond the scope of this report. The following criteria were therefore set to allow selective objectivity:

(a) The seriousness and urgency of a problem, whether it consists of an emerging issue or of an existing one of newly acquired magnitude (e.g. the size of the affected population);

(b) The state of our knowledge of the problem;

(c) The feasibility of controlling the problem through intervention on the environment.

8. The issues reviewed in the report, while having their main impact locally, are all common to a number of countries and most involve people in their millions. Although many of the issues concern developing countries only, others are still to a large extent limited to developed countries. But, as development necessarily unfolds, these issues will increasingly occupy the minds of planning, environmental, health and education authorities in developing countries, making it imperative to create or further strengthen those inter-sectoral links that are a requisite for development, if the world is to become a better, environmentally sound, wholesome and rewarding place to live.

9. The report has been hampered by lack of data. The well-being of a population is ultimately reflected in its vital and health statistics. Unfortunately most countries only publish the most general statistics — allowing the researcher to calculate crude mortality rates and life expectancies, but virtually nothing else. If proper statistics were available for all countries — and even for areas within countries — much more could be done, since variations between countries and areas with different environmental circumstances can provide valuable clues on how the environment and health affect each other. Furthermore, countries that do not collect adequate statistics cannot tackle their problems effectively; without proper data it is impossible to formulate well-targeted programmes.

10. During the preparation of this report a particular attempt was made to obtain data from developing countries and certain other countries, with little success. UNEP will continue in its efforts to track down and incorporate such data in future reports and would appreciate every assistance from the relevant Governments.

Chapter I

HEALTH EFFECTS OF HUMAN ACTIVITIES WITH ENVIRONMENTAL CONSEQUENCES

1. Over the last decade, according to such statistics as are available, the world has become healthier. Infant mortality decreased and life expectancy increased between the periods 1970 to 1975 and 1980 to 1985 in all but three of the 150 countries whose data are tabulated by the World Health Organization.(2) But this encouraging progress — one of the signs that some of the goals of "Health for All by the Year 2000" are being partially met —, is tempered by the fact that a spectacular difference remains between the situations in developed and developing countries.*

2. Typically, a baby born in a developing country is ten times more likely to die before its first birthday than one who happens to start life in an industrialized nation. Furthermore, the gap has widened over the last decade, for the greatest proportional falls in infant mortality have occurred in the developed countries, where the rates were already low. And, whereas the difference in life expectancies has narrowed over the past decade (as it has over the last 30 years) (3), a European or a North American is still likely to live more than 20 years longer than an African or a South Asian. (Fig. II).(2).

3. Further differences are exhibited in the pattern of disease. Developing countries suffer mainly from illnesses arising from lack of development — communicable diseases such as diarrhoea, malaria, schistosomiasis and onchocerciasis. In developed countries, by contrast, the greatest toll is taken by the so-called degenerative diseases, mainly cardiovascular diseases and cancer, which are, to some extent at least, the result of inappropriate development, including overnutrition. For instance, in the Americas, North and South, in 1980, 31 per cent of the deaths in the developing countries were from communicable diseases, compared to only four per cent in developed nations, while 75 per cent of the deaths in the richer northern countries were from degenerative diseases, compared to only 26 per cent in the poorer southern nations.(4)

4. While the report will concentrate on those health problems that arise from human activities impinging on the environment, it should not be forgotten that health conditions may result from environmental situations which are not caused by man but

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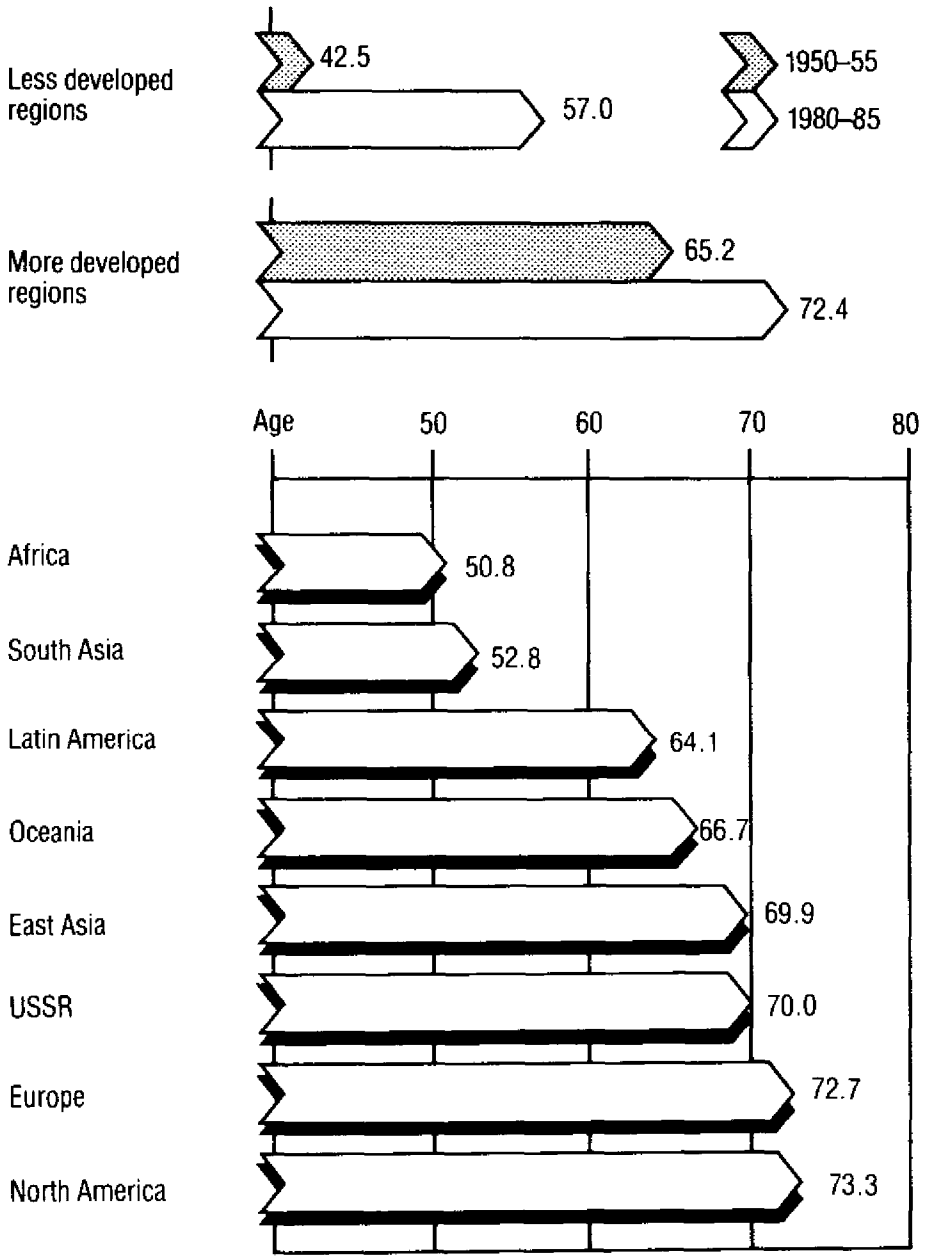
* While all the data used in this chapter are derived from official, mostly WHO, sources, one cannot over-emphasize the fact that systematic mortality and morbidity figures from most of the world are not available. The figures given are therefore, in most cases, estimates based on a number of limited surveys and must not be expected to be precise beyond the order of magnitude. They do, however, make it possible to broadly compare the importance of various categories of illnesses and of the circumstances that bring them about. They do not, in general, make possible the detection of time trends. In too many cases data on one point in time only are available. When data on more than one point can be found, their quality usually precludes meaningful trend analysis.

2 Life expectancy at birth



Source: Holdgate, M. W., Kassas, M., White, G. F., *The World Environment, 1972–82, a report by the United Nations Environment Programme*, Tycooly International, 1982.

which may be in his power to ameliorate. One of the oldest known examples is iodine deficiency due to inadequate supply of iodine from food grown in iodine-poor soils. Endemic goiter (perhaps 200 million cases world-wide) (5) and cretinism are the results, but they can be and have been remedied by the systematic addition of iodine to the diet, usually by mixing it with salt. Natural waters have varying contents of fluorides. Low-fluoride waters (less than one milligram per litre) promote the formation of dental caries. It has therefore become increasingly common to add suitable amounts of fluoride to drinking water supplies in order to protect children's teeth. By contrast, prolonged exposure to drinking waters with fluoride levels higher than 10 milligrams per litre gives rise to mottling of the teeth and, in extreme cases, to bone deformities. (6)

5. Kashen and Kashin-Beck diseases are two other conditions attributed to natural environmental situations. The former has been observed in certain low-selenium-intake areas of China. (7) It consists of acute or chronic heart damage that can be prevented and/or alleviated by various means, including the administration of selenium. The Kashin-Beck disease, on the other hand, is a crippling condition of the limb joints prevalent in a population of some 30 million people and affecting close to two million of them from early childhood. (8) While the agent has not been identified, it is known that the incidence of the disease drops when food imported from outside the area replaces local food, and that cases have been reported in people living outside, but consuming food imported from, the affected area. The Kashin-Beck disease is highly localized in large areas of China and in smaller areas of neighbouring countries. (9)

6. Finally, it must be remembered that everyone on earth is exposed to ionizing radiation from natural environmental sources — e.g. radioactivity in the earth crust and cosmic rays from outer space — and that these natural and inescapable sources give rise to the highest average doses to which the human population is exposed. (10, 11) Natural radiation doses provide a useful yardstick against which radiation doses from other sources can be evaluated.

Communicable diseases

7. It is estimated, that every year 4,600,000 children of under five years of age die of diarrhoea in developing countries. (12) In purely numerical terms, therefore, eminently preventable, easily curable, diarrhoeal diseases are the major cause of death among children — and this appalling decimation is only the most dramatic manifestation of the toll they take. In all, the 340 million children under five who live in developing countries (excluding China) are estimated to suffer almost a billion diarrhoeal episodes a year — an average of three such attacks for every child. (12) Repeated attacks of diarrhoea not only threaten children's lives, but tend to cause malnutrition and thus stunt their physical and mental growth.

8. Diarrhoeal diseases can be due to a number of causes but are mostly the result of water-borne viral and bacterial infections. Infants are especially prone to acute diarrhoea, particularly if, for one reason or another, they are not breast-fed. If not treated, acute diarrhoea may kill rapidly, mainly through dehydration. The problem is extremely serious in developing countries, particularly in rural areas where the quality, availability and accessibility of water is poor, and storage facilities are inadequate. Only very crude comparisons between countries can be made because of differences in reporting practices, but the message of such figures as we have is quite clear. In 1980, the proportion of the population supplied with adequate water in developing countries varied, on a region to region basis, from 66 to 83 per cent in urban areas, and from 22 to

41 per cent in rural areas.(13) By contrast, the coverage in most countries of the European region of WHO was close to 100 per cent in both urban and rural areas.(14) Much the same picture emerges from an examination of the availability of sanitation services: a larger percentage of the population in developing countries — particularly the poorest ones — lacks sewage facilities, let alone treatment plants or other forms of sanitary excreta disposal. When these facilities are available they are often inadequately maintained and offer little protection against widespread faecal contamination. The relatively straightforward task of providing clean water and adequate sanitation — followed by proper maintenance — effectively prevents the spread of the diseases and their devastating toll in lost and impaired lives.

9. The toll is doubly unnecessary because, even when water supplies and sanitation are poor, the simple and inexpensive oral rehydration therapy (ORT) introduced by WHO and UNICEF in the 1970s is very effective.(15) The treatment is now being administered on a large scale.(16) It is expected to bring about a major reduction in diarrhoeal mortality, but it is still too early to detect an unequivocal decline in the over-all figures.(17) Even if proved highly efficacious on a large scale, ORT will never be a substitute for the improvement of the environmental situations that are at the root of the problem. It should be no alibi for not pursuing vigorously the aims of the International Drinking Water Supply and Sanitation Decade in both rural and urban environments. Here, as in other areas, prophylaxis is preferable to therapy.

10. Poor sanitation facilities are not the privilege of developing countries alone. Cities such as Naples in Italy suffer from an outdated and poorly maintained sewerage system which is quite inadequate in serving the needs of certain parts of the town. Around the Mediterranean — a sea with very weak tidal activity — most cities dispose of their effluents through offshore outfalls. In places, the winds and currents often bring the sewage back to shore. This causes widespread contamination of beaches and their closure to bathing, and makes local shellfish unfit for human consumption. Regional seas programmes aim at reducing and eventually suppressing such situations through the adoption of concerted policies of rational effluent management.

11. Another major cause of communicable diseases is the poor quality of some food. Animal products infected with various types of bacteria or infested by parasites may give rise to serious diseases. Thus brucellosis is due to the consumption of unpasteurized milk from sick animals; acute fever results, followed by a chronic stage with relapses of fever, sweating, diffuse aches and pains and general weakness that may recur for months. Salmonelloses originate mostly from poultry products, and give rise to serious gastroenteritides. Tapeworm infections arise from contaminated pork, beef and freshwater fish. Vegetables and fruit may carry amoebas when irrigated, sprayed or washed with water containing the parasite, or handled by asymptomatic carriers of the disease, which in its overt form is an acute dysentery and in the long term may lead to the development of liver abscesses. While distributed worldwide, these diseases are most frequent where food inspection practices, veterinary care and the hygienic supervision of food handlers are inadequate.

12. Malaria continues to be one of the most serious public health problems in a large part of the developing world. Over two billion people are estimated to be at risk. There are some 100 million clinical cases,(18) and possibly as many as two million deaths annually. In Africa, about half of all the children under the age of three are infected, and a million are estimated to die each year;(19) malaria is thus the most important single disease in the continent.(20) poor drainage of stagnant waters and swampy areas, ill-conceived irrigation schemes and irrational use of pesticides and chemotherapy

agents all contribute to an increase in the population of mosquitoes that carry the malaria parasite, and to the development of their resistance to insecticides. The parasite itself has become increasingly resistant to chemotherapy, so that the weapons (chiefly chloroquine) that used to be effective until recently are now largely blunted in many areas of the world. Hope now rests, in the short term, with the rational use of existing anti-malaria drugs and the judicious introduction of such new drugs as mefloquine and artemisine. In the much longer term, there are plans to develop and produce effective and inexpensive anti-plasmodium vaccines.(19) At least until then, however, environmental management techniques must continue to be applied in a determined and sustained fashion. These range from the planning stage of water development schemes (so as to avoid the creation of new breeding grounds for the insects), to the surveillance and correction of existing schemes, both small and large scale (with the aim of reducing the mosquito population or its contact with man through various techniques, including the rational use of appropriate chemicals). These various techniques are highly developed(21) and must increasingly become an integral part of any malaria control programme.

13. Schistosomiasis is due to a parasite with a complex life cycle. During one stage of the cycle it develops in certain types of water snails from which it contaminates water and penetrates the skin of people using, or wading through, it. The parasite then multiplies in human tissues and, during a further stage of development, is excreted by people to re-infect snails that may be available in the water environment. Six hundred million people in Africa, America and Asia are exposed to one or more of the three species of *Schistosoma* that are infectious to man. Two hundred million are estimated to be infected. There is evidence that the parasite is still gaining ground, in some of the 74 countries where it is endemic,(19) in the wake of new water development and irrigation schemes. Often these schemes are on a very small scale and are therefore difficult to control. The symptoms of schistosomiasis are generally less dramatic than those of the diseases mentioned so far, but can lead to a chronic debilitating condition with loss of productivity that may significantly impair development in high-prevalance countries. Control can be, and in some cases has been, achieved through a combination of chemotherapy, use of molluscicides and environmental management of ponds, lakes, streams and waterways. It is also essential to provide adequate sanitation and to educate people to make full use of the facilities in order to prevent the spreading of the parasite through human excreta.

14. The case of onchocerciasis (a small worm carried by a fly that breeds in swift waters, often downstream of large impoundments) is quite different, although also linked to water development schemes, at least in Africa. The population at risk is smaller — about 50 million altogether — but the consequences of the infection are much more serious. Among other things, it can totally blind its victims, removing them entirely from the production circuit at an early age. However, a determined collaborative effort to eradicate the illness from the Volta River basin was started in 1974. Up to 18,000 kilometres of rivers over an area of 700,000 square kilometres were treated with larvicides (temephos, occasionally chlorphoxim and, more recently, *Bacillus thuringiensis)* at frequent intervals (weekly, at certain times of the year). Some 10 million people lived in the area and close to 100,000 were blind when the campaign started.(22) ten years of efforts have now reduced the risk of blindness to virtually nil in 90 per cent of the previously infested areas, opening them up to agriculture and socio-economic development.(4) If extended to other areas and equally successful, the results of the Onchocerciasis Control Programme in Africa will be comparable to those achieved over small-pox in 1980. Clearly, such success will depend on the flies not developing resistance to pesticides.

15. The diseases reviewed so far are all, in one way or another, water-borne. They all have strong environmental components in so far as their spread can be mitigated by human interventions on the environment. They are also, to varying extents, caused or exacerbated by certain human activities. They all therefore require, if ever they are to be prevented or controlled, a thorough and constant concertation among different authorities within national administrations. This will enable a dialogue to be established and maintained between those responsible for health and the environment and those responsible for agriculture, water development, planning, public works, education and information. At present this is all too often lacking.

16. Sleeping sickness(23), a human disease caused by trypanosomes injected into the human body through the bite of various species of flies of the genus Glossina (tse-tse flies), is confined to East and West Africa. Its clinical and epidemiological features differ in both parts of the continent. In West Africa, for example, the typical form is transmitted from person to person by flies of the *Glossina palpalis* group, though animal reservoirs of the trypanosomes, long discounted, are now suspected of playing a role. The spreading of the disease — a chronic, incapacitating encephalitis that is frequently fatal if not treated at an early stage — follows the distribution of the fly population which live predominantly in riverine and lacustrine forests.

17. In East Africa, wild animals (especially the bushbuck but also other antelopes and such large carnivores as lions and hyenas) and cattle provide a reservoir for the trypanosomes which are then transmitted to man by the bite of flies of the *Glossina morsitans* group. Their habitat is the dry woodland savannah. The disease they inflict on man is a much more acute (and usually rarer) encephalitis than the West African type and may cause death within weeks of infection.

18. As reported in 1979, the incidence in 37 African countries declined from 8,000 cases in 1969 to 6,000 in 1975, with the highest number of new cases in Nigeria, Tanzania and Zaire.(23) A more recent estimate(19) suggests that 50 million people in 34 African countries are exposed to trypanosomes, of whom 10 to 20 per cent have access to some form of protection or treatment, and that the current frequency of reported new cases is in the order of 20,000 per year. Even that figure may well be an underestimation, and could be boosted from one year to the next by fresh outbreaks, as have been known to occur even in recent years.

19. The occurrence, in 1900 and 1901, of an epidemic, probably introduced passively by European travellers, which claimed 300,000 victims in Uganda where it started, and half a million in the then Congo Free State(24, 25), is a reminder of what might happen, particularly in times of internal strife and famine, when large population groups are forced to settle in new areas. This is likely to expose them to much higher risks than those incurred by the original local inhabitants.

20. The social and economic costs of the human disease and the misery it occasions are already very high. They are compounded by the concomitance in the same areas of a widespread trypanosomiasis of cattle transmitted by much the same vectors. While the cattle do not necessarily succumb to the infection, their productivity in terms of milk and meat as well as draught power is much impaired. Safe access of livestock to fertile but tse-tse infested grazing grounds is thereby precluded, thus closing to human exploitation some 10 million square kilometres of the continent.

21. Opening such areas to cattle ranching would require a major combined effort. It would have to control both the vector (through pesticides, sterile male techniques and

the use of newly developed insect attractants) and the parasite reservoirs where they exist. It would also involve the development of new drugs and, eventually, of vaccines to protect man and animals — and the clearing of the vegetation that provides the habitat for the flies. This would require a vast outlay of national and international intellectual, human and financial resources well beyond the capabilities of some of the most affected countries. Where its sheer magnitude precludes the undertaking of such a programme, a viable alternative would be the development of game ranching schemes, a number of which are already in existence. While the yields of meat can be higher than if cattle had been raised in similar, but tse-tse-free, areas, the possibilities of marketing game meat may limit the scope of such schemes.

22. One last category of communicable diseases must be mentioned because of the toll they claim on small children: more than one quarter of all deaths in children below 5 years of age, i.e. more than 4 million a year, are due to acute respiratory diseases, and 90 per cent of those deaths occur in developing countries. They are largely the result of a higher prevalence of severe respiratory infections than in developed countries, as a consequence of a crowded and unhealthy home environment, including the exposure to domestic smoke pollution often combined with poor nutritional conditions and lack of medical facilities (Fig. III).

The health effects of chemical and radioactive pollutants

23. Most of the activities and situations discussed in the next chapters involve some degree of pollution. This is true of virtually all the human activities that involve chemical or nuclear transformations, including combustion, the use of radio-active material, or the deliberate release of chemical substances for specific purposes, as in the case of agro- chemicals. The variety of the pollutants is endless, and only for a very limited number of them can levels be systematically measured in the environment.

24. For many, knowledge of effects is uncertain, and only some of the best known and most widespread will be considered here, particularly those whose presence in food causes most concern, i.e. cadmium, lead and mercury, pesticide residues, polychlorinated biphenyls (PCBs), and mycotoxins.

25. Cadmium is normally present in soils, and therefore in food, at very low concentrations. Disposal practices of a number of industries such as electroplating and battery manufacturing have steadily added to the environmental levels in recent decades. In Europe, and possibly elsewhere, phosphate fertilizers provide a significant agricultural source of cadmium. The importance of cadmium lies in its effect on renal function which it impairs at levels of intake that are close to those already reached in a number of areas.(26) Monitoring of cadmium and restraint in its industrial uses are therefore imperative.

26. Lead has been in use for centuries and man has been exposed to it through the use of lead-lined plumbing and cooking utensils and more recently through other uses that all have contributed to human exposure through air, food and water. A relatively recent addition to the exposure results from the use of lead-containing petrol by motor cars. Lead-carrying particles are released through car exhausts to the atmosphere but eventually fall out to the ground and contaminate both soils and vegetation. Crops then take up the metal either by absorption through the root system or from direct deposition on the leaves and inflorescences. Concern about environmental levels of lead, particularly in food, stems mainly from the possibility that the nervous system of

3 Incidence of disease and death

DISEASE

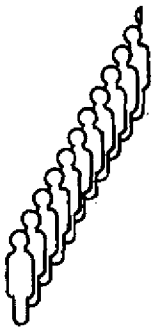
Incidence of illness

Diarrhoeal diseases 1 billion

Schistosomiasis 200 million (prevalence)

Malaria 100 million

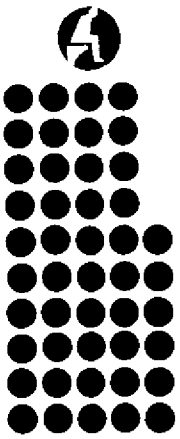
Comparative population



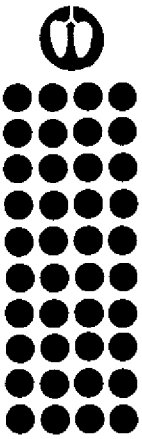
Japan 112 million

DEATHS

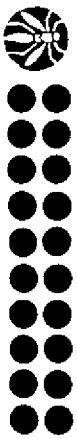
per year



Diarrhoeal diseases 4.6 million children



Respiratory diseases 4.0 million children



Malaria 2.0 million

Comparative population

Jamaica 2.0 million

children might be affected, resulting in irreversible damage. In adults, occupational exposure to high levels gives rise to a number of serious manifestations involving the blood system, the gastro-intestinal tract, and the nervous system. A recent welcome development is the trend towards the use of lead-free petrol in a number of countries. It is much too early to say how this development will affect the intake of, and therefore the exposure to, lead.

27. Mercury is released to the environment in significant amounts by chlor-alkali plants and pulp mills among other industrial facilities. Once discharged into waters, mercury is stored in sediments where, under the effects of micro-organisms, it undergoes transformation into methylmercury. Weekly intakes of a few milligrammes of methylmercury may bring about signs of central nervous system impairment (sensory and co-ordination functions). A number of cases of acute poisonings have been reported as a result of exposure to highly contaminated fish, as around Minamata Bay in Japan, or of consumption of bread made of seed grain dressed with methylmercury as fungicide. Intakes are higher among fish eaters. Levels of mercury in certain types of fish are higher in the Mediterranean than elsewhere. The higher levels appear to be mainly of natural rather than of anthropogenic origin.(27) Few reliable data are available on levels of mercury in the bodies of local fish eaters and on the possible health effects.

28. The effects of these metals have been reviewed in criteria documents by the UNEP/ILO/WHO International Programme on Chemical Safety and in 1984 by the International Register of Potentially Toxic Chemicals (IRPTC). Data on levels in food and human tissues have been collected in a number of, mostly developed, countries under the aegis of the Global Environment Monitoring System (GEMS) by UNEP, FAO and WHO.

29. Pesticide residues are a common cause of poisoning both in the field and in the home and a widespread but largely unassessed source of chronic professional exposure. They also can expose people at low levels through ingestion of food contaminated at concentrations far below those giving rise to overt toxic symptoms. Data in a number of foodstuffs collected by GEMS(28) make possible the observation of time series over a period of years in a limited number of mostly developed countries. DDT complex levels in the fat of cow's milk showed a marked decline in Japan and the Netherlands during the 1970s, and a similar trend is observed in Japanese and United States finfish. Likewise, levels of hexachlorophene in the fat of cow's milk have been steadily declining in Japan where, however, levels have remained consistently higher than in samples from Europe and North America. Levels of heptachlor and its epoxide have generally been very low throughout the period, often close to detection limit. Those of aldrin and dieldrin have been falling consistently in both cow's and human milk in Japan, the Netherlands and Switzerland.

30. PCBs are a group of chemicals that have a number of uses owing to their unique electric and thermal properties and their low inflammability, but which spread and persist in the environment for a long time. They spread from their emission point mostly through the atmosphere and, when deposited, contaminate human food through terrestrial and marine food chains far away from their source of emission. Though few reliable data on their possible health effects (cancer, liver, skin and nervous system damage) are available, their widespread presence in human food, and particularly in human milk, has caused such concern that their uses have been limited, in a number of countries, to a few only. These uses are confined to closed-system operations in which the low inflammability of PCBs makes them difficult to replace. As a result, production of PCBs has declined sharply, by 40 per cent since 1973 in OECD countries, and is expected to drop by as much in the coming years.(29)

31. Aflatoxin contamination of food represents a major hazard in warm humid countries when food storage facilities are inadequate or crops are allowed to remain in the field under moist conditions before harvest. Other mycotoxins have been responsible for a number of isolated, and sometimes very serious, poisoning incidents in temperate countries. At present, however, aflatoxins, produced by *Aspergillus flavus*, in cereals, peanuts and soya beans far outweigh in importance other types of mycotoxins. Few reliable data are available on the levels of aflatoxins in food, but they indicate that contaminations of the main staples in Africa and Asia is widespread. A number of outbreaks of acute poisonings have been reported,(30) but the main significance of aflatoxins may well be in the long-term exposure to them, since it is suspected that, together with exposure to hepatitis B virus, exposure to aflatoxins may be an important aetiological factor of primary cancer of the liver — one of the most common cancers in Asia and perhaps the most common of all cancers in Africa south of the Sahara, where the annual incidence appears to be more than six times higher than in Australia, Europe and North America.(31)

32. Food contamination by aflatoxins is thus a major problem that can only be remedied by adopting rational and systematic policies of food storage at national level and by promoting intensive education about harvesting and storage at community level.(30) Household and community granaries that offer good protection against infestation can be built inexpensively and farmers must be alerted as to the consequences of not following sound practices in the preservation of their produce.

33. Contamination by pesticides and aflatoxins has more remote consequences than those on the local consumers. For those countries that rely on export of food crops to countries with stringent and tightly enforced food quality control practices, even low levels of contamination may mean rejection of consignments, with direct adverse economic consequences for the exporting country.

34. In general, the effects of pollutants on human health are almost as diverse as the pollutants themselves and defy comprehensive description in a report of this nature. Some were mentioned above. Others range from minor rashes to early death or to cancer in the exposed (including foetuses exposed in utero) and to various defects in their descendants. The evidence concerning effects on health is basically derived from two sources — from animal experiments and from human observation.

35. Experimental data can be obtained — often at great cost — from broad ranges of exposure levels and under a variety of conditions, and they provide a basis on which the toxicity of a given agent can be roughly assessed. However, because the same agent does not necessarily have the same effects in all species, the extension to man of knowledge obtained from animal experiments requires great care, particularly when the results are negative in the experimental species studied. Yet animal observations are, with respect to most pollutants, the only source of information as to their effects.

36. For some, however, information can be derived from studies of groups of people exposed accidentally or occupationally. These groups are fortunately rather infrequent. Most have been exposed to levels which, although higher than those of concern for the general population, are still low enough for effects to be difficult to observe because they are mild, rare or long-delayed. In many cases, levels of exposure cannot be assessed altogether, making quantitative relations between them and frequency or intensity of effects difficult or impossible to determine. In other cases the exposed have received such higher amounts of an agent than those that are of interest for the general population, that the use of the observations as a guide for action at lower levels is not

straightforward, for it requires assumptions on the type of relation between exposure and the effects obtained within the range of interest.

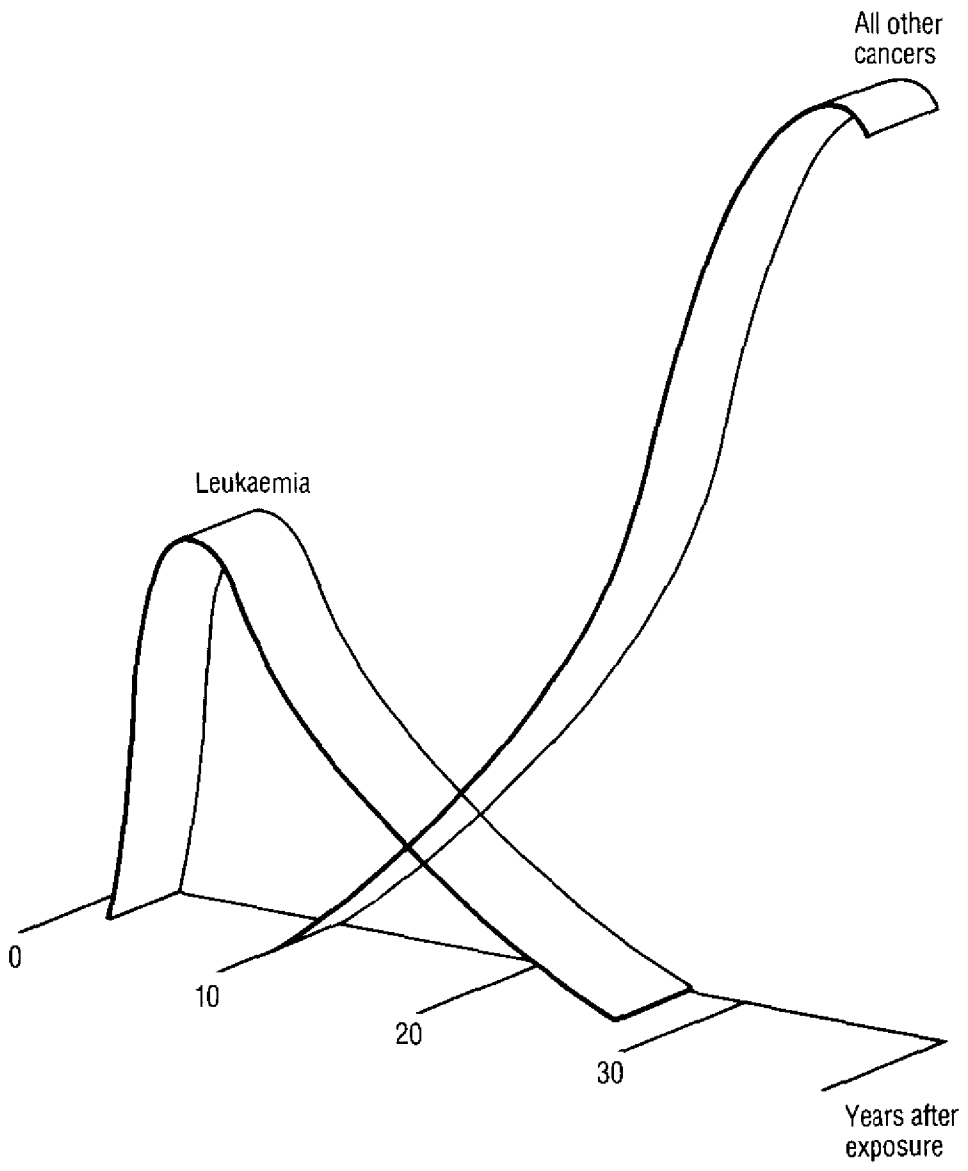
37. These remarks apply to any type of effect, whether acute, i.e. occurring within a few weeks of exposure, or delayed by months or years. But nowhere are the difficulties of grappling with the effects of pollutants at low levels of exposure more apparent than with regard to carcinogenesis.

38. Ionizing radiation offers the best example of these difficulties, since historical circumstances make it the best studied environmental carcinogen. Laboratory tests in a number of animal species do show that radiation can induce cancer even at relatively low doses, but no amount of experimental studies, valuable though these have been in determining how biological and physical circumstances can affect the rates of induction, could have revealed the wealth of information that is now available from groups of people exposed to reasonably well known doses of radiation. Primary among them are the survivors of the 1945 atomic bombings as well as people irradiated for medical reasons. Our knowledge about these groups has been steadily increasing with time. By 1960 what had been learned from them was only the beginning of a story that is still unfolding. At that time leukaemia appeared to be almost the only malignancy whose incidence increased in those who had been exposed to radiation in comparison with those who had been less or not at all exposed. Twenty years later, not only had the yearly excess number of leukaemia cases in the exposed increased to a peak and then fallen almost to the level of the non-exposed, but a much larger and varied crop of cancers had started to develop among the irradiated people, including cancers of the thyroid, breast, lung, stomach, liver and large intestine, giving an entirely new dimension to radiation hazards (Fig. IV).

39. This greater knowledge, however, has been obtained among people irradiated for a short period of time, though in some groups repeatedly, at doses orders of magnitude higher than those to which the general public is normally exposed. The relevance of the observations to very low-dose long-lasting exposures was thus open to question and required detailed investigations of the mechanisms of cancer induction by radiation. It is now generally accepted(10) that the assumption that the rates of induction (excess number of cancer cases induced by radiation per million people exposed) are proportional to the doses does not underestimate the risk. In fact some investigators believe that assuming simple proportionality may overestimate it. This assumption is at the base of the radiation dose limits recommended by the International Commission on Radiological Protection (ICRP) and is reflected in the radiation protection legislation of most countries.

40. Experimental studies and observations of occupationally exposed groups of people have likewise established, though with much less detail, that a score of chemicals can induce cancer in man (Table 1).(32) These represent a tiny fraction of all cancers occurring in the population and, like those due to radiation, are indistinguishable from cancers arising in the unexposed. The number of cancers due to the same agents, including radiation, at the levels of exposure of the general population, while virtually impossible to ascertain, must be extremely low. In addition, based on experience in the United States, the fact that cancer rates, with the major exception of lung cancer, have not tended to increase since 1950(32) argues against the presence of new chemicals in the environment having a major effect on the incidence of cancer so far. As the experience with radiation teaches, however, because of the long delays in the onset of cancer, one cannot rule out that some significant increase in cancer may be apparent in the future due to recently introduced agents. Much the same can be said for other effects

4 Cancer and time



Source: Sinclair, W. K., a paper from *The proceedings of the Twentieth Annual Meeting of the National Council on Radiation Protection and Measurements, April 4–5, 1984.*

such as impairment of some major body function (e.g. nervous, excretory) that may result from long-term exposure to newly introduced agents.

41. In order to develop the strategies required to limit the releases of agents harmful to man to amounts that do not give rise to unacceptable risks, it is important that efforts towards the assessment of their short- and long-term toxicity be encouraged and strengthened. At the international level, activities such as those of the UNEP/ILO/WHO International Programme on Chemical Safety and the IARC review of carcinogenic substances are responsible for ensuring that information collected throughout the world is gathered and assessed uniformly without parochial bias, while the International Register of Potentially Toxic chemicals (IRPTC) has the unique role of making possible rapid and complete exchange of information on all chemicals of environmental concern.

42. A review of the effects of environmental pollutants on human health would not be complete without mentioning the role of carbon dioxide, a natural component of the atmosphere with no direct effects on human health. There is, however, major concern lest the continued rise in atmospheric carbon dioxide concentrations due to fuel combustion, and in the concentrations of other trace gases, lead to a warming of the atmosphere with consequent major changes in climate, and therefore in the biosphere, that would affect man, including his health, in a major way. This might occur not only because of food shortages due to reduced agricultural yields in currently fertile areas, but also because certain human diseases now confined to the tropics or subtropics might spread polewards to areas that have never known them or from which they had been eliminated decades ago (e.g. malaria).

43. The recent UNEP/WMO/ICSU assessment of the role of carbon dioxide and other radiatively active gases in climate variations and associated impacts forecasts that an increased concentration of those gases equivalent to the doubling of atmospheric carbon dioxide concentrations from pre-industrial levels would lead to an increase of between 1.5 and 4.5°C in the global mean equilibrium temperature by the year 2030. The increase would not be uniform over the earth's surface, but it is not yet possible to describe regional differences, except for the fact that the increases will be larger in the north than in the tropical areas. It is therefore not possible to predict accurately what would be the ecological, agricultural, economic and social consequences of such a change, much less its effects on health.

44. It is significant, however, that the rise in temperature would be accompanied by a rise — between 0.20 and 1.40 metres — of the sea level. This would profoundly disturb the state of coastal areas, drowning for instance existing wetlands and creating new ones, upsetting the disposal of domestic wastes into the sea and creating entirely new problems for coastal areas in the case of storms, tidal waves and other natural disasters. In those areas alone the consequences for human health might be momentous indeed. Clearly, should a significant temperature shift materialize, it would be of the utmost importance to be able to predict its consequences, including those affecting health, not only with confidence, but well ahead of their occurrence, so as to give us time to achieve the preparedness that such a situation would require.

Chapter II

SOME MAJOR ACTIVITIES WITH AN IMPACT ON THE ENVIRONMENT AND, THROUGH IT, ON HEALTH

1. The previous chapter briefly described some of the main impacts on human health attributable to environmental factors, ranging from the gigantic toll on young lives taken by preventable communicable diseases to the less certain, less severe — but particularly controversial — effects of man-made radiation. This chapter will turn its attention to some of the environmental activities that give rise to these impacts, and to their relationship with development.

2. Like all other living beings, man has to rely on the environment for his survival and welfare. He cannot live without its natural resources, and he cannot raise his standard of living without increasing his use of them for food, energy, shelter, clothing — and for the disposal of waste material. These activities are necessary, because they make life possible; but shortsighted greed, wastefulness and the craving for superfluities have often damaged health, killed people, and even threatened the future of whole societies.

3. This is the best-known of the interactions between the environment, development and health: inappropriate development of this sort places an undue burden on the natural resources of the environment, and thus damages human health. Examples abound in both developed and developing countries. Indiscriminate spraying of pesticides in an attempt to grow more food may douse farmworkers and populations in toxic spray, with adverse health effects. The expansion of irrigation or hydropower, often considered merely as development activities, may lead to an increasing prevalance of schistosomiasis and malaria. The growth of industry may result in unwarranted increases in emissions and inappropriate disposals of wastes — and thus pose severe, if difficult to quantify, hazards to human health.

4. Yet, as the last chapter showed, the greatest toll of disease and death is taken, not by the effects of inappropriate development, but by the environmental consequences of lack of development. The 4,600,000 small children who die every year from diarrhoeal disease — and the countless millions whose lives are ruined by the malnutrition that results from repeated attacks — are victims of poverty, which remains, as it always has been, the worst form of pollution. Most of the communicable diseases which beset so many hundreds of millions of the poor pose, by and large, no great problems to medical science. Their origins, aetiology, and epidemiology are well-known and well established; their prevention and/or cure presents few difficulties. More important still, the diseases could virtually be eliminated by simple preventive measures such as the improvement of water supply and sanitation. This has happened in developed countries; it has yet to take place in most of the developing ones. The reason why the preventive work has not been done is because not enough money has been spent on it; in other words, there has been a lack of development.

5. Yet, in most cases, at least in developing countries, these two main interactions between health, the environment and development are inextricably intertwined; most damage to health through adverse impacts on the environment is caused by both inappropriate development and a lack of development. A poorly devised irrigation scheme, for example, may well lead to the spread of schistosomiasis — but the disease depends on the absence of sanitation which is one of the most serious problems of underdevelopment. The effects of routine pollution from industries — and of catastrophic accidents such as occurred at Bhopal — are greatly magnified because poverty often forces thousands of people to live in rudimentary shacks on the very periphery of the plants. And if lead emitted from car exhausts does affect the mental development of children in developed countries, as an increasing number of scientists believe, what will be its impact on the children of poor families living on pavements or in roadside shacks in Third World cities? The combination of pollution and malnutrition might be devastating indeed. Furthermore, the link between inappropriate development and lack of development holds true, if to a lesser extent, even in industrialized countries. By and large it is the poorest citizens who live closest to sources of pollution and who are most affected by it — and, since poverty is equal to powerlessness, they are also the least able to secure improvements to their environment.

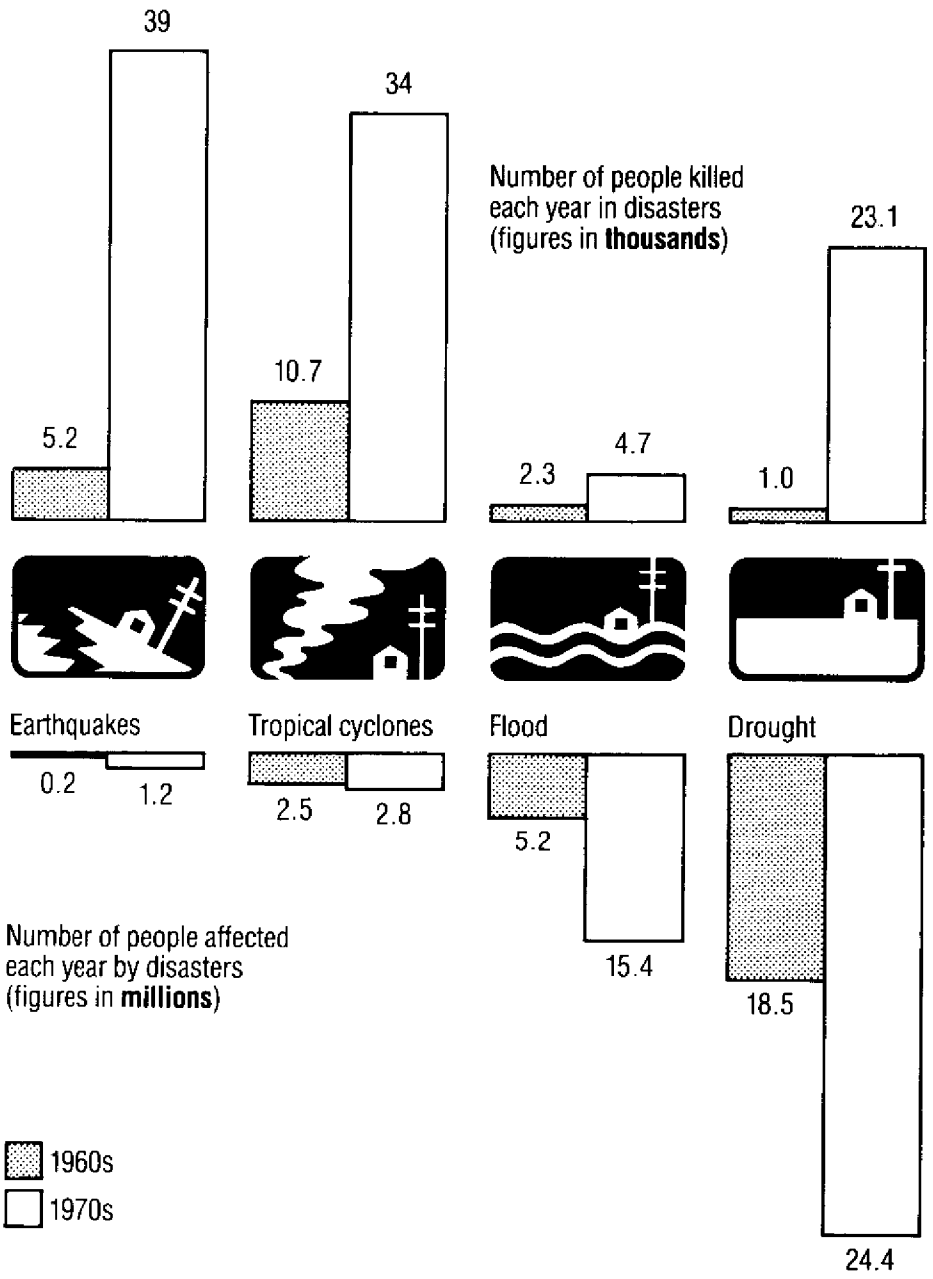
6. Even so-called 'natural disasters' are often intimately bound up with environmental and developmental factors. They, too, are frequently aggravated by inappropriate development or lack of development — or both. We are accustomed to calling floods, earthquakes and storms 'acts of God'; but their impact is often, at least in part, determined by the activities of man. There have, of course, been disastrous floods since long before Noah built his ark. But the frequency and severity of flooding in many parts of the world has been greatly increased by the destruction of vegetation on watersheds by poor people desperate to clear more land for food or cut wood for their fires; the increase in floods in Bangladesh as a result of the denuding of the Himalayas is merely the best known example. And when floods take place, their impact is often heightened by inappropriate development. Settlement on flood plains increases the number of people exposed to the hazard; better planning and siting of settlements can greatly reduce the number of people killed and made homeless by floods. Earthquakes, too, are mainly naturally occurring phenomena, but the amount of damage they cause is greatly affected by the quality of the construction of buildings in the affected areas (Fig. V).

7. This chapter will review the environmental factors which affect health — through both inappropriate development and lack of development — in several large categories. The subject is so broad, embracing almost all human activities, that only a few major issues can be addressed in a report of this length. The criteria adopted for selecting these issues are given in the introduction. Many of the major polluting industries will not be covered. Likewise, some important consequences of agricultural practices, for instance the salinization of irrigated land, also will not be considered in the report despite their effect on land productivity. On the other hand, even such activities as are described — e.g. the use of pesticides or the utilization of energy — have implications that go well beyond, and sometimes outweigh, those affecting health, although these implications are not considered in the report.

Crop production and other agricultural activities

8. The twentieth century has seen a rapid increase in the world's population. The rate of growth has varied from one country to another but has been, and still is, greatest

5 Natural disasters in 1960s & '70s



Source: El-Hinnawi, E., *Environmental Refugees*, UNEP, 1985.

amongst those who can least afford it, namely, the members of the developing world. For instance, projections for Africa, the continent whose population is growing most rapidly (currently by 3 per cent a year), indicate that the 1980 population of less than 500 million will have almost tripled within a 45-year span to reach close to 1.5 billion by the year 2025 under the most conservative assumptions.(33)

9. This rapid population growth is one of the greatest challenges for man, creating difficult problems for all those managing development: economic planners, agriculturists, health workers and many others. It places pressure on limited resources, and requires increasingly larger supplies of produce to meet the demand for food, fibre and energy. For this the world has come ever more to rely on greater agricultural yields obtained by expanding arable and grazing land through reclamation of formerly forested, swampy or otherwise unproductive areas, and by increasing land productivity by irrigation of potentially fertile land, the introduction of high-yield varieties of plants and the intensive use of agrochemicals — chemical fertilizers, herbicides and pesticides. Increased demand has also required large-scale food storage and transport that have magnified the health problems resulting from waste and spoilage. Finally, as in all other human activities, increased production has led to a growing waste-disposal problem.

Land reclamation

10. Land use patterns have varied in time and from place to place. The ancestral, pre-industrial practices followed in poorly populated areas were environmentally sound. Small areas of land were brought under cultivation and, after exploitation, allowed to remain fallow for a period of time during which, at least under certain climates, natural regeneration took place. This practice is still followed in some societies but is becoming less and less possible.

11. Where there is no possibility to expand into new and uncultivated land, the only course left is better, if costlier, management of what land is available, through the use of irrigation, of improved seed varieties, and of artificial means of enhancing the soil's richness. However, the possibility to expand still exists in many areas, so that, to meet man's increasing grain needs and to provide for his expanding stock of animals, pressure is placed upon forested areas, woodlands and grasslands. But the shifting cultivation that was once so successfully practised persists in only a few communities. Intervals between cultivation have become shorter, the capacity of the land to regenerate itself has been overstretched, and soil fertility has been reduced.

12. A major problem arises from tree felling or deliberate bush fires. Tree felling is undertaken not only for land clearing, but also to provide household fuel, timber and pulp. Of all these activities, the provision of fuel has been the most devastating, so that in several countries wood gathering has exceeded land clearing as a major cause of deforestation.(34) At present, there is no practical alternative to wood gathering in semi-arid areas until other inexpensive sources of energy become available on a suitable scale.

13. Loss of tree cover sets in motion a sequence of events which in many countries may herald the process of desertification. Rain formation results from moisture-laden air masses that have been blown over the continent from the oceans, and/or from clouds formed by water evaporated from the land and transpired by plants. Loss of vegetative cover gives rise to increased run-off into the ocean via rivers. Should such run-off be large enough, the amount of water retained on the land would be reduced to such an

amount as to significantly reduce evapotranspiration, cloud formation and precipitation.(35)

14. Overgrazing makes its own contribution to the loss of vegetation cover. In Africa, for example, there has been a population explosion of stock animals due to a reduction of animal morbidity and mortality through improved animal health care, including immunization campaigns, despite an increase in zoonotic diseases, particularly brucellosis, in semi-arid areas. The period from 1950 to 1970 is particularly important since the favourable rainfall provided more land both for grazing and for cultivation. The livestock population in Africa increased from 295 million in 1950 to 521 million in 1983.(36, 37) South of the Sahara, the northernmost, formerly arid, areas became capable of sustaining cattle which meant that the limits for grazing shifted northwards. Intensive grazing gave rise to loss of perennial grasses which were replaced by annuals, less resistant to drought. As in the case of denuded forests, the scene was set for events that were to contribute in a major way to desertification.

15. Thus, felling and overstocking significantly accelerate environmental deterioration, first by degrading the land through loss of vegetation cover and consequent wind and water erosion with loss of top soil. Secondly, by aggravating the meteorological circumstances that give rise to drought, providing the essential ingredients to the process of desertification.

16. The tragic example of the recent drought across sub-Saharan Africa has been brought home by the media to the whole world. Even after a massive international relief operation and the return of the rains, some 30 million people in 12 countries with a total population of about 120 million (4.5 million of them displaced persons) were still severely affected in October 1985.(38) No figures are available on the toll exacted by the famine in the 20 countries originally affected, but it is known to have been particularly heavy on women, especially pregnant women, children and the aged. Food shortages led to widespread malnutrition among the former, with the common appearance of cases of marasmus and, perhaps in combination with other factors such as parasitic infections, of kwashiorkor.

17. In addition, people debilitated by malnutrition have been forced by the emergency situation to seek relief away from their areas of origin and often in crowded refugee camps, deprived of essential water supply and sanitation. Inevitably, this has led to the spread of enteric, respiratory and other infectious diseases. Again, the emergency situation has precluded a uniform and systematic reporting of diseases, so that it is not possible to quote public health statistics on a country basis. Records in one camp, however, indicated an over-all death rate of 18 per cent in the last quarter of 1984, with 70 per cent of the dead being children under 15 years of age. The latter figure is a fairly close reflection of the age composition of the camp population, since 64 per cent of the inhabitants belonged to that age group.(39)

18. Data from another camp (population size not available) give a crude idea of the relative importance and severity of the illnesses prevailing among its people by showing, for a typical month, the relative proportions of cases presented for admission to hospital (349 in all) and of deaths (167) by causes among the same patients (Table 2). Among outpatients, the five most common diagnoses were, in decreasing order of frequency, measles, diarrhoea, malnutrition, unspecified fevers and pneumonia, though it is likely that people suffered from multiple infections that might not even have been recognized.

19. With the progress of the relief operation and the improvement of the agricultural situation, morbidity and mortality are bound to decline, but it is feared that the malnutrition experienced by small children over a long period of time may leave behind a legacy of serious functional impairments.

20. The lesson of this tragedy is that poor management of the land due to lack of foresight in times of plenty and lack of preparedness in times of want does have long-term consequences in vulnerable areas such as the sub-arid lands of the world. If not irreversible, they will require large investments in environmental reclamation, provision of appropriate seed varieties, water distribution and re-stocking, and particularly a major effort in education if further, and perhaps larger, disasters than the one that has recently been witnessed are to be averted in the future. The preservation of the health and the very survival of people, as this latest episode shows, may come to depend more on environmental management and education than on the provision of health services or even primary health care (Fig. VI).

Water Projects for Irrigation

21. Proper irrigation is an effective means of increasing yields of both subsistence and cash crops. When properly designed and supervised, irrigation schemes frequently afford communities the potential for significant economic development, but projects which are ill-conceived in their planning and management may not achieve the expected goals. Irrigation was practiced even in ancient times. The great civilizations which existed around the Euphrates, the Indus, the Nile and the Tigris thrived on it, but history has shown that all too often problems did arise, including ill health associated with irrigation waters.

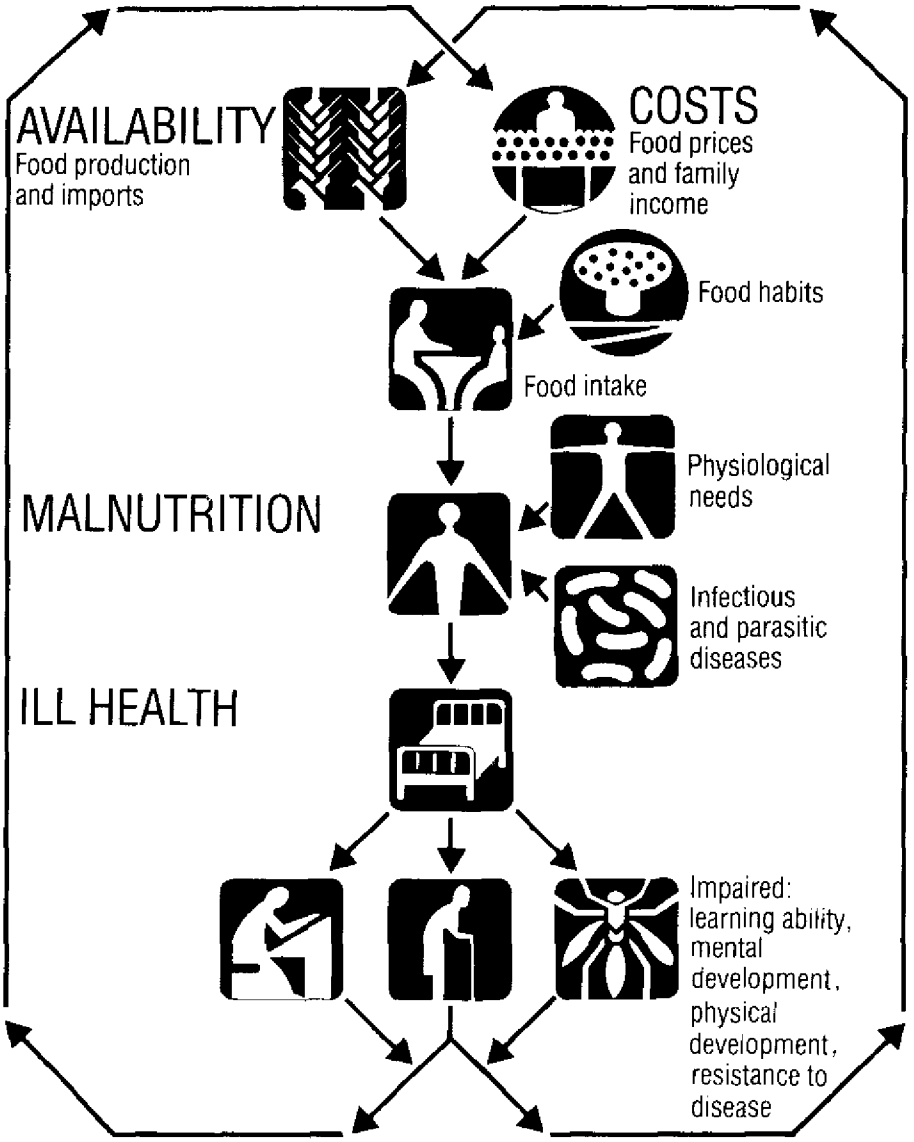
22. Water projects for irrigation and other purposes have become even more important today where the needs of an ever increasing population dictate that more food be produced for its survival. The availability of water resources poses an obvious limit to the expansion of irrigation schemes. However, unanticipated adverse health effects from environmental changes brought about by such schemes may be a further or major limiting factor in the achievement of expected goals.(40) This has been particularly marked in tropical countries where such adverse effects have been amply documented.(41-43) Schemes for large-scale distribution of water to the land under cultivation have received the greatest attention, but equally serious ill-effects may arise from small-scale irrigation schemes at the community level, which are developed with little or no technical supervision, since usable guidelines for their development and maintenance are not available.

23. A wide range of health problems have been identified which may be associated with irrigation. For the purposes of this report, the discussion will be confined to only a few serious diseases, namely, malaria, schistosomiasis and onchocerciasis.

Malaria

24. Irrigation schemes have made their positive contribution to the survival and propagation of the mosquito that carries the malaria agent. Because the different species of mosquitoes are selective of the type of habitat in which they breed, understanding of these differences makes it possible to design systems of irrigation that assist in controlling the insect. It is with such an understanding that, for example, the Tennessee Valley Authority in the United States designed impoundments which, through good

6 Nutritional status, environment and development



■ Square areas are affected by environmental factors

Source: Nasser and others. *MIT/Cairo University Health Delivery System Project Publication*, MIT 3/80. 1980.

sanitation and control of water level fluctuations, were able to ensure that malaria transmission did not take place.(44)

25. Irrigation schemes, by increasing the acreage of land under water, may provide more possible breeding sites. They also tend to reduce the diversity of habitats, thus favouring one species of mosquito rather than another. For instance, in West Africa, in a terrain with a moderately fast-flowing river and a wet and a dry season, the favoured mosquito would be *Anopheles gambiae,* which breeds in pits, pools, roadsides and gutters that get filled up with stagnant waters during the rains. Here, malaria transmission would occur mainly during the wet season. If, now, the river were to be dammed, the streams draining into the man-made lake would be slowed down and the surrounding land might become swampy, thus creating a habitat for *A. funestus* which could replace the previous species. *A. funestus* breeds all year round with the result that malaria, which is a seasonal disease, would have become permanent.(45-47) Similar changes in the incidence of the disease may occur in areas with a prevalence of different insect species, if environmental changes similar to those that brought about the shift in species composition in the example above had also taken place.

Schistosomiasis

26. Of all the diseases associated with irrigation, schistosomiasis is perhaps the best documented. It is not merely a problem of irrigation schemes but also a problem of human sanitation, behaviour and culture, the latter sometimes creating resistance to the introduction of better sanitation practices. Man becomes a victim of his own filth. He fouls with his excreta the same water he uses for recreation, for washing his clothes and utensils and even for drinking. Wherever poor sanitation is associated with large or small impoundments and irrigation schemes in tropical and subtropical countries and the intermediate host snail is present, it can be anticipated that schistosomiasis will give rise to problems. This is true for both large and small-scale irrigation schemes, though the most extensive information comes from large impoundments (Table 3).(48)

27. The very nature of irrigation systems is such that they tend to create conditions which will encourage the survival of the snails that host the parasite during a phase of its life cycle. This includes the growth of weeds on the banks of rivers and streams and on the shores of lakes, as well as the slow down of the water flow to a velocity that allows the snails to thrive in those habitats. In such a situation, once suitable snails which adhere to man's clothing, to the webs of waterfowl or to animal hairs are introduced to the area, they are able to thrive in the lush vegetation along the banks of streams and canals and use it as food and as a repository for their eggs. Where the condition is already endemic the process is likely to be rapid, but even in non-endemic areas the rate of introduction can occur at a brisk pace.

28. Prevention can be achieved through management of the snails' habitat and provision of sanitation services. The former includes controlling the slope of the irrigation canals, swift waters being unfavourable to the snails' breeding, and the vegetation on the banks of canals and ponds on which the snails feed by lining them with cement or fibre glass and toiletting them regularly, filling depressions where water collects and deepening reservoirs. Sanitation services should provide for safe, accessible and inexpensive disposal of human excreta so that the man-snail cycle is interrupted. All these measures are easier and less expensive to carry out if introduced at the planning stage of the irrigation project rather than during or, worse still, after its development. Experience, however, shows that it is the latter situation that is most common.

29. Once the cycle is established, control becomes a major operation involving, in addition to purely environmental measures, large-scale chemotherapeutic campaigns and the destruction of snails, through the use of molluscicides, and of their breeding areas through the use of herbicides. Such multiple approaches are being used successfully for example in Brazil, Egypt and Puerto Rico. In Egypt,(49) where the disease has been endemic for millennia, the Fayoum Governorate, with a prevalence of the disease of 47 per cent in a population of 1.16 million people, showed, after nine years of relentless efforts at multiple control, a prevalence of only six per cent. This dramatic change may not be easily replicable in other Egyptian Governorates which do not have the isolated position of the Fayoum Governorate. However, at present, a multiple control programme is being carried out in the Middle and Upper Egypt Governorates, with a population of nearly 10 million, at a cost of $US 1 per person protected per year. Time will tell whether these measures will be equally successful.

Onchocerciasis

30. Onchocerciasis (river blindness), endemic in some parts of Africa, Latin America and Yemen, has been responsible for villages grinding to a halt, leaving only blind people who can hardly support themselves. Its importance in irrigation is mainly in connection with large-scale impoundments although, particularly in America, some species are known to be associated with still waters as well. The worm causing the disease is transmitted by black flies belonging to the genus *Simulium,* which require swift-flowing, well-oxygenated fresh water for the survival of their larvae. Different species of black flies require different velocities, but *S. damnosum* — the most common in Africa — requires a velocity of around 0.5 to 2 metres per second.(50)

31. The outcome of dam construction is dependent on the ecology of the surrounding area. Lakes Kainji in Nigeria and Akosombo in Ghana are two examples of impoundments in endemic areas that had different outcomes. At Lake Kainji, submersion of the breeding sites was beneficial to the settlements within 15 kilometres of the river — no black flies were found in areas which previously had a prevalence of 49 per cent. In Lake Akosombo, on the other hand, breeding took place in the river rapids, and although these sites were drowned as the lake filled, transmission continued to take place by flies travelling long distances from tributaries of rivers which emptied into the lake, and breeding continued to take place below the dam.(51)

32. The nature of the ecological changes to which it will give rise must be studied in order to predict the effects of an impoundment on the breeding of black flies. Of special concern is the spill-way which could be a source of problems should the waters reach the optimal velocity needed for the breeding of the fly.

The use of agrochemicals

33. The ever-increasing demand for food and cash crops has led not only to the proliferation of large and small irrigation schemes, but to the increasing use of agrochemicals — mineral fertilizers to improve soils, pesticides to control insects, arachnids, rodents, fungi, molluscs, weeds and post-harvest pests as well as plant growth regulators, pheromones etc. The use of agrochemicals is relatively recent, and there are still examples, even in developed countries, such as the Pennsylvania Dutch in the United States, of communities who cultivate their agriculture and obtain high yields without the use of agrochemicals. In general, however, agricultural development is now unthinkable without adequate inputs of agrochemicals. Irrational use of these, however,

is at the origin of a number of environmental and health problems, particularly in the countries that have not yet developed the technical means to monitor and control the distribution and rational use of these products.

Fertilizers

34. The world-wide consumption of the major categories of fertilizers (nitrogen, phosphorous and potassium compounds) rose by about 10 per cent per year between 1980/1981 and 1983/1984.(52) Both levels of consumption per hectare of agricultural land and rates of increase have been uneven, however, with both generally very low in South and Central America and in Africa, levels of consumption higher but nearly steady in North America, sharp increases in Asia and very high levels in Europe. Little is known of the direct effects of the intensive use of fertilizers on health, probably because they are generally insignificant. Indirectly, run-off from land treated with chemical fertilizers, particularly phosphates, contributes to the eutrophication of fresh and ocean waters. Eutrophication induces changes in the species composition of the aquatic fauna and thus affects fisheries. In some cases, it leads to the occurrence of algal blooms whose effects on man may vary from the production of noxious odours to the exposure to toxins arising from the multiplication of certain phytoplankton organisms. The consumption of shellfish contaminated with certain types of toxin-containing dinoflagellates has led to severe outbreaks of paralytic shellfish poisoning.

35. When nitrates present in fertilizers or arising from the oxidation of other components of nitrogenous fertilizers contaminate well waters, they are difficult and costly to remove. If the amounts are large enough, they will give rise to methaemoglobinaemia in children, sometimes causing death.(53) The possible ingestion of vegetables containing high levels of nitrates, as reported from Brazil(54) and elsewhere, is also a cause for concern. By contrast, phosphate and potassium fertilizers do not appear to have direct effects on human health. It has recently been reported, however, that because phosphates of different origin contain varying amounts of cadmium, the use of phosphates on agricultural land in Europe provides one of the major sources of cadmium intake for the European population.(55) The same is likely to apply to other areas where phosphates of the same origin as those used in Europe are applied. If the current trend in the use of phosphates in agriculture continues, cadmium intakes in Europe are expected to rise above the tolerable weekly intake in a few decades. On the other hand, the presence of fluoride-containing dusts in phosphate minerals has caused destruction of forests in Brazil, leading to soil instability and landslides involving potential dangers to the population.(56)

Pesticides (including herbicides)

36. Coupled with the use of fertilizers, the use of modern pesticides, originally introduced to control vector-borne diseases (malaria and typhus), has been an essential contributor to increases in crop yields throughout the world. In addition, pesticides have played a major role in reducing pre- and post-harvest food losses. In general, pesticides have been one of the major weapons in the struggle against food shortages. Their production, concentrated in a limited number of countries,* has increased at the rate of 4 per cent a year over the past few decades,(58) and their consumption has risen apace, first in developed and now in developing countries. Ninety per cent of the pesticide

* Fifteen industrial producers in five countries accounted for more than 90 per cent of the $13.3 billion total world-wide sales of pesticides in 1982.(57)

production is used for agricultural purposes (primarily on maize, cotton and rice) and most of the rest for health protection.

37. The success of pesticides, however, has exacted a price in terms of side effects, some of them involving human health. Perhaps the most dramatic of these has been the increase in the number of strains and species resistant to certain pesticides and the now frequent emergence of multiple resistance. Among other things, this has allowed a dramatic return of malaria cases in numbers that are close to those recorded prior to the use of DDT, a return that is also partly due to a relaxation of the efforts in the fight against mosquitoes and to the increased resistance of the malaria agents to chemotherapy.

38. In the past, spraying of food crops has also caused levels of persistent (organochlorine) pesticides to rise in foodstuffs in certain countries (e.g. Guatemala, Iran),(59) with unknown effects on health, particularly in children who may be highly exposed through consumption of mother's milk. A recent case of major cow milk contamination through the use of feed cakes contaminated with heptachlor has been reported from the United States. It led to the destruction of large batches of milk.(60)

39. The application of pesticides, and particularly of herbicides, may result in fish kills with potential consequences on the food supply of those people who traditionally derive their main source of protein from fish.(61) In addition, the presence of highly toxic dioxin in some herbicides used on a large scale has been, in some areas, the cause of heated controversy between forestry and health authorities.(62)

40. Although not all cases of pesticide poisonings can be described as environmental in nature, no review of environment and health would be complete without mentioning that the use and availability of organophosphorous and carbamate insecticides and acaricides has been accompanied by an increasing number of cases of chronic occupational poisoning among field workers, and of acute accidental poisoning both among workers and the public. Reliable statistics are lacking, however. The most recent estimates(63) suggest that the number of unintentional acute pesticide poisonings is of the order of one million cases per year with an overall fatality rate of between 0.5 and 2 per cent. While the figures represent only 4 per cent of fatalities due to all types of unintentional acute poisonings worldwide, it must be emphasized that most of them are avoidable and that their geographical distribution is likely to be non-uniform, with the greatest number of cases in developing countries making intensive use of the products on cash crops without observing the necessary safety precautions. No estimates of the possibly much larger number of cases of chronic pesticide exposures and their long-term significance are available.

41. The negative aspects of pesticides have resulted in an accelerated search by industry for new, but often more expensive, active chemicals that are less toxic to non-target organisms, including man, and less persistent in the environment. These aspects have also made clear the need to use pesticides, and especially insecticides, more sparingly by relying on ultra-low volume formulations and controlled droplet application of concentrated formulations. These are not without their risks to the workers when the hand-held equipment is not properly maintained. On the other hand, the indiscriminate spraying of pesticides from aircraft must be viewed with concern as it might affect the people in the area, particularly children and lactating mothers. Some of the drawbacks in the use of pesticides will be reduced through the development of integrated pest management, which includes the use of pesticides and, when available, biological

methods of control, the management of vectors' habitat (e.g. through proper drainage and control of breeding sites), and the introduction of adequate training and education.

42. The WHO/FAO/UNEP Panel of Experts on Environmental Management for Vector Control (PEEM)(17) supervises trials on the effects of environmental management, both alone and as part of integrated control, and evaluates operational strategies for vector control, including those applicable to urban areas and those used in the management of water development projects. The Panel also promotes the training of personnel in integrated control techniques and in the safe use of pesticides. Training, education, and competent supervision are essential to reduce the occurrence of accidents to workers. Education and effective labelling of, and warnings on, consumer products are essential to reduce cases of household poisoning. The International Code of Conduct on the Distribution and Use of Pesticides(64) and the accompanying comprehensive set of technical guidelines recently adopted by FAO, and developed with the co-operation of all concerned, from UNEP and WHO to industry, if widely observed, will go a long way towards reducing the environmental and health consequences of these products, particularly in developing countries.

Food spoilage

43. In a world that finds it increasingly difficult to feed its people, it is a sobering thought that pests and human mishandling account for a 10 to 30 per cent post-harvest loss of cereals and for about twice as much in the case of leafy and root vegetables.(65) The magnitude of the problem is such that in 1975 the General Assembly adopted a resolution calling on governments and international organizations to make efforts to reduce such losses in developing countries by 50 per cent by 1985. As a consequence, the FAO established in 1977 a programme for the prevention of food losses and, in 1983 UNEP published guidelines for the reduction of such losses. (66)

44. The highest rates of losses are found in developing countries and are due to a concurrence of circumstances related to poor protection of harvests against rodents, insects and moulds, which in turn result from a lack of storage facilities both on the farms and at the central collection centres, particularly in bumper crop years. In many cases spoilage already occurs in the field, especially when meteorological or other circumstances prevent the drying of the harvest or lead to its wilting on the ground before ripening. The net result is a reduction of harvest yields which is reflected in the food supply of countries that can least afford even the slightest additional shortage. Food losses have therefore direct consequences on the nutritional state of people in the areas where such losses occur. Indirectly, food losses are a major factor in underdevelopment, as they divert resources to food import or to the acquisition of costly technologies to increase yields, while simple and inexpensive measures within the means of the farmer at community or even homestead level would reduce losses significantly.

45. Important as physical food losses are, the spoilage of harvests also has consequences of an entirely different nature when it is due to contamination by certain moulds — *Fusarium* in temperate areas, *Aspergillus* in tropical ones. The requisite for the growth of the moulds, on cereals and pulses particularly, is exposure to moist and warm conditions. When these are optimal for the production of toxins, dramatic consequences for the consumer may ensue. These were briefly reviewed in Chapter I.

Disposal of wastes

46. Agricultural activities, from cultivation to cattle breeding, give rise to wastes in proportion to the intensity with which the activities are carried out. Agricultural wastes seldom give rise to health problems and therefore need not be dealt with in this report. One exception is the disposal of animal manure. Traditionally, manure is recycled, first by storing it, so it may undergo fermentation, and then by spreading it onto the fields at appropriate times, as fertilizer. In some societies, cattle dung is still used as fuel or as building material. Problems arise when the cattle density is such that the production of dung exceeds the demand for its utilization or when its availability leads to its excessive use in the fields, thus giving rise, as in the excessive use of chemical fertilizers, to contamination of the water table by nitrates. So far the problem is largely one of concern for developed countries but has not yet found satisfactory solutions.(53) One possibility would be to use it as a source of biogas, but the economics of the transport of manure to central power stations has so far prevented its development. This possibility has been successfully-exploited in some developing countries to produce biogas for domestic or village consumption.

47. Of particular concern is the excessive use of slurry (the fluid collecting at the bottom of and around manure heaps) as fertilizer in the fields.(53) Since, unlike manure, slurry has not undergone fermentation, it may give rise, in addition to nitrate and phosphate contamination of the soils and the water table, to the spread of pathogens — bacteria, viruses, and parasites in various stages of development.

48. The disposal by slaughterhouses of carcases, offal and meat unfit for consumption, if not carried out safely, may, when these wastes are illegally or unwittingly consumed by man, cause serious poisoning and diseases such as anthrax. The disposal of these types of wastes should therefore be subject to very tight supervision.

49. Finally, a problem of increasing importance is the disposal of unused pesticides. This has been particularly severe in some Pacific islands where the exiguity of the land available and the cost of shipping back surplus chemicals, coupled with lack of local expertise, has created major difficulties for the health and environment authorities.(67)

Provision of fuel and energy

50. Energy use is essential for health and development but often has adverse side effects. In developed countries, the debate on health impacts centres mainly on such issues as nuclear fuel wastes and combustion by-products of fossil fuels. In energy-poor countries, environmental concerns include biomass consumption leading to deforestation and desertification, and the effects of using low-grade coal. Indoor heating and cooking is a concern in developed and developing countries, as is hydropower — an important energy source with unique hazards. This review examines the major environmental health consequences resulting from fuel cycles: fuel gathering; transport; storage and processing; use; and, waste reprocessing and disposal.(68)

51. In considering how energy use alters the environment and hence affects health, two points emerge. The first is that its beneficial health and social impacts far outweigh the adverse, a point reflected in the historical growth in energy consumption. The second is that the significant known risks to health through energy-related

environmental alterations, while considerable in scale are relatively few in number: e.g., desertification, deforestation and the effects of hydroelectric impoundments. Further risks are those from air pollution (including climate change; see chapter 1, paragraphs 42-44) and from the nuclear fuel cycle. Energy risks, however, are not unique to the energy cycle: most industrial activity produces routine occupational and public risk of a generally similar nature. What is needed is an early identification of environmental health problems, followed by options for cost-effective mitigation before irreversible commitments are made, thus avoiding the need for costly and often ineffectual corrective measures.

Fuel gathering

52. Fuel gathering includes all activities for extracting fuel from the earth or collecting energy; e.g., coal and uranium mining, gathering of fuel wood, drilling and operating wells for oil, natural gas and geothermal energy; and constructing solar or tidal power facilities. These may damage health, either directly, by both routine and exceptional incidents; or indirectly, by altering environments on which man depends. Health damage varies by fuel type (e.g. coal vs. oil) and by activity (e.g., underground vs. surface mining).

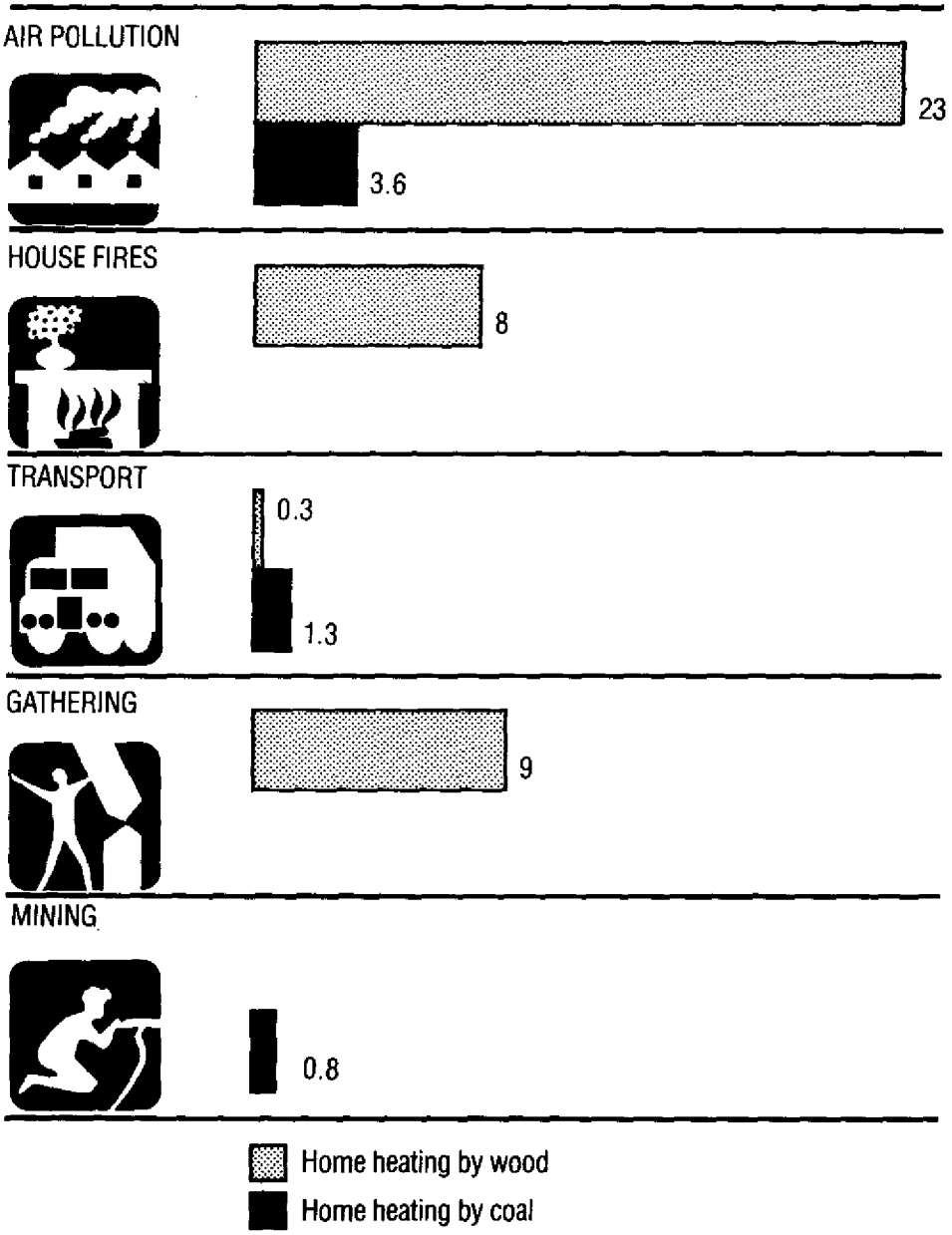
53. Routine occupational accidents constitute the main health risk. Workers are exposed to numerous physical hazards in underground coal and uranium mining, as well as in the offshore extraction of oil and gas. Actuarial data show that underground coal mining is a high-risk activity. The United States fatality rate is about four per million man-working-days,(69) as opposed to three in mining and quarrying and 0.3 fatalities in manufacturing.(70) The construction of energy gathering facilities, e.g., a large hydroelectric dam (71) or a photovoltaic system,(72) gives rise to occupational accidents, the extent of which depends on the type and nature of construction and on safety standards. The mining of oil shale and tar sands, as well as new energy technologies, may pose an occupational fatality risk substantially greater than that of coal mining.(73, 74)

54. It has been suggested (75) that public fuelwood gathering presents large risks to individuals, and may be much larger per unit of energy than risks to workers in occupations commonly recognized as hazardous (e.g. underground coal mining) (Fig. VII).

55. Probably the most severe accidents have been catastrophic failures of hydroelectric dams, and, more rarely, of coal-waste-pile impoundments. These low-probability/high-consequence events have produced 1,800 fatalities as a result of the hydroelectric dam failure at Vajont, Italy, and at least 120 from the coal-waste-pile impoundment dam collapse at Buffalo Creek, West Virginia.(76)

56. Besides accidents, pollutants may be emitted during collection or extraction of fuels. Uranium miners suffer from increased incidence of silicosis and cancer.(77) Increases in chronic respiratory diseases, including coal-worker pneumoconiosis and chronic industrial bronchitis, are commonly observed in underground coal miners.(75) Geothermal well-fields release hydrogen sulphide, other noxious gases and hazardous brines. These present acute and chronic occupational risks to health and to the public exposed to these pollutants through air and water pathways.(78) Hydrogen sulphide is also generated from rotting vegetation in dams in tropical countries (e.g. Brazil) and presents a serious health hazard to workers.(79, 80)

7 Deaths per million dwelling years in USA



Source: Hamilton, L. D., *Overview of Health Risk Analysis and Assessment for Selected Energy Systems*, Brookhaven National Laboratory, New York, 1985.

57. The relocation of populations from hydroelectric impoundment areas could provide new habitats for disease vectors and may also result in health problems as a result of a lack of sanitary and medical facilities or food shortages.

58. Fuelwood gathering, which is extensively practised in developing countries (Fig. VIII), may also alter environments. Deforestation around settlements, a common occurrence in semi-arid areas, leads to soil erosion and thus to desertification. It also requires longer and longer journeys for gathering firewood. This causes fatigue and stress to the women whose task it usually is and who thus have less time to care for their children and families. As a result, the nutritional state of the former may deteriorate, thus increasing their susceptibility to infectious and parasitic diseases. Tired, overworked women have smaller babies, which fail to thrive. Absence from home makes breastfeeding difficult. Shortage of fuel, on the other hand, means fewer cooked meals, which may lead to undernutrition, and has often the additional consequence that water is not boiled, thus favouring the occurrence of infections.

59. The disposal of urban refuse and sewage sludge by conventional means is increasingly expensive and can be damaging to the environment and hence to health. The use of such wastes for energy purposes may, in some circumstances, have a positive environmental effect, beside supplying energy. At present, most urban waste in developed countries is tipped in landfill sites, though a small amount is incinerated for bulk reduction and hygiene, rather than for energy production. Some countries, however, already use a large proportion of their refuse for heat production. In Denmark, for instance about 60 per cent of the waste stream is used in this way. Some developing countries are using biogas plants to supply gas, derived from sewage, to local residences with specially adapted cookers. One such example is in Parai do Sul, Brazil, where the biogas sewage plant processes municipal organic waste which will eventually be supplemented with vegetation grown for agro-energy and biodegradable industrial waste.(81)

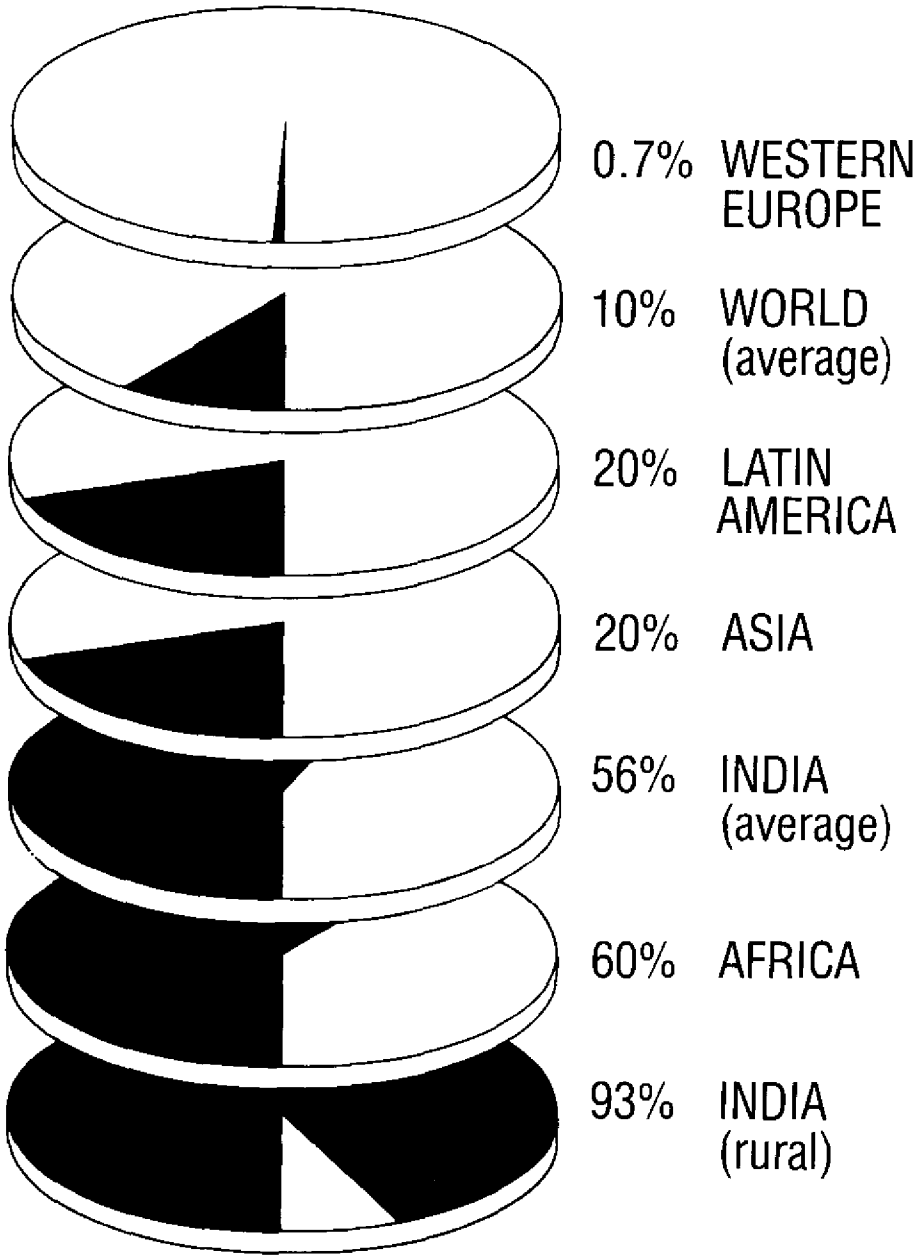
Transportation and storage

60. Although electric power plants and industries are sometimes located near their fuel source, fuels are usually transported from source to processing location to end-user. Health risks during transport are principally from accidental injuries, fires, and explosions. These include routine traffic accidents involving trucks, trains, and barges hauling fuel; catastrophic accidents involving gas-tank cars, trucks and tankers; and rupture of pipelines.

61. There are probably more deaths and injuries in routine traffic accidents involving fuel transport than in catastrophic accidents. In the United States, it has been estimated that over 100 deaths per year are associated with accidents involving coal-transporting trains, mostly in collisions with automobiles. Routine accidents were estimated to result in 3 deaths and 30 injuries annually in the transport of nuclear fuels in the United States.

62. Despite this, the social impact of catastrophic accidents may be more important. Explosions from ruptured or leaking distribution pipes can have devastating effects in dense urban areas. In the United States in the period from 1970 to 1975, there were 5,324 gas distribution pipeline failures, resulting in 11 deaths and 208 injuries to workers, and 141 deaths and 1,520 injuries among the general public. A ruptured oil line recently caused a catastrophic fire in Brazil, killing 508 people. In Mexico City,

8 Share of fuelwood in total energy consumption (%)



Source: Hamilton, L.D., *Overview of Health Risk Analysis and Assessment for Selected Energy Systems*, Brookhaven National Laboratory, New York, 1985.

explosions at the PEMEX liquefied petroleum gas facility in 1984 caused an estimated 650 fatalities, with thousands seriously injured. While there have been few major accidents involving natural gas (e.g., 40 fatalities at a 1973 storage tank explosion in Staten Island, New York), numerous studies have addressed the potentially catastrophic results of such an accident.

63. Controversy surrounds the potential consequences of transporting spent nuclear fuels.

Processing

64. Fossil fuels frequently require processing; e.g., coal cleaning, coking, oil refining, and a variety of synthetic fuel technologies. The main impacts are from coal coking and oil refining. Potential impacts from fuel processing are particularly important in developing countries where:

(a) New coal deposits are being exploited;

(b) Efforts are being made to increase processing of fuels locally and to export refined products;

(c) Urban population may grow rapidly around new processing facilities.

65. Coke ovens emit into the air volatile and particulate organics which present known cancer risks to workers and potential risks to the population. Public risk rates are much lower than occupational ones, but the cumulative effect might be greater because of the much larger population exposed. The United States Environmental Protection Agency has estimated an upper-bound lifetime risk of six cancers per million people for a continuous ambient air exposure of one microgramme per cubic metre of coke-oven emissions.(82) Average public exposure to such emissions in the United States has been estimated to be one fifth of that limit.

66. Although oil refineries emit potentially carcinogenic organic pollutants, epidemiological studies of refinery workers have shown mixed results; some suggest excess leukaemia and tumours of the brain and other parts of the body, while other studies show no excess.(83) There have been fewer studies of populations living near oil refineries, but they too have produced ambiguous results.

67. Besides emissions, oil refineries pose a threat of fire and explosion. It has been reported that 11 workers are killed and 8,000 injured every year at oil refineries in the United States.(84) In December 1985, an oil refinery explosion in Naples, Italy, resulted in 2 public and 2 occupational fatalities.

Energy production: fuel combustion

68. The most critical health hazards in fuel use are from the combustion of organic materials — fossil (coal, coke and lignite; petroleum products, including crude and refined oils, gasoline, kerosene, diesel and aviation fuel; propane and natural gas) and non-fossil (wood and charcoal, peat, dung). These hazards arise from inhalation of primary or chemically evolved combustion by-products either at close range or in the form of generalized atmospheric contamination, and from the risk of accidental fires and burns.

69. Three important areas of potential concern worldwide are the localized effect of poorly-vented fires for heating and cooking, especially in the less industrialized countries; the air pollution effects of large stationary combustion sources such as centralized electricity generation and industrial energy facilities; and the impacts of emissions from motor vehicles.

Indoor air pollution

70. Health impacts from domestic fuels vary with fuel composition, completeness of combustion, and effectiveness of ventilation. In many areas of the world where people still cook food and heat dwellings in much the same way as early man used to do, these variables are less controlled than in a modern domestic oil furnace. But high-technology domestic combustion in air-starved, energy-efficient wood and coal stoves can also yield substantial concentrations of partially-combusted organics, while the widespread use of unvented gas cookstoves in industrialized countries poses a possible health threat as a result of nitrogen oxide emissions.

71. Organic fuels — firewood, dried cattle dung and agricultural waste products, typically burnt in open hearths — provide much of the energy for the developing countries of Asia, Africa and Latin America. Here smoke and toxic gases are a major air pollution problem. Gaseous pollutants include carbon monoxide, sulphur dioxide, nitrogen oxides, ammonia, hydrochloric acid and hydrocarbons. Particulate constituents include condensed volatile hydrocarbons, soot and fly-ash particles (Fig. IX).

72. The most important health effects of exposure to them, as reviewed by WHO in 1984,(85) are chronic obstructive pulmonary disease and nasopharyngeal cancer. Chronic obstructive pulmonary disease is the most common health effect in India and probably in a number of other countries. Nasopharyngeal cancer is common among young adults exposed to high concentrations of carcinogens since infancy. Exposed infants and children develop acute bronchitis and pneumonia which may be fatal in some countries with inadequate medical facilities. Chronic carbon monoxide poisoning was seen in a few places. This may affect the cardiovascular and nervous systems of the adult.

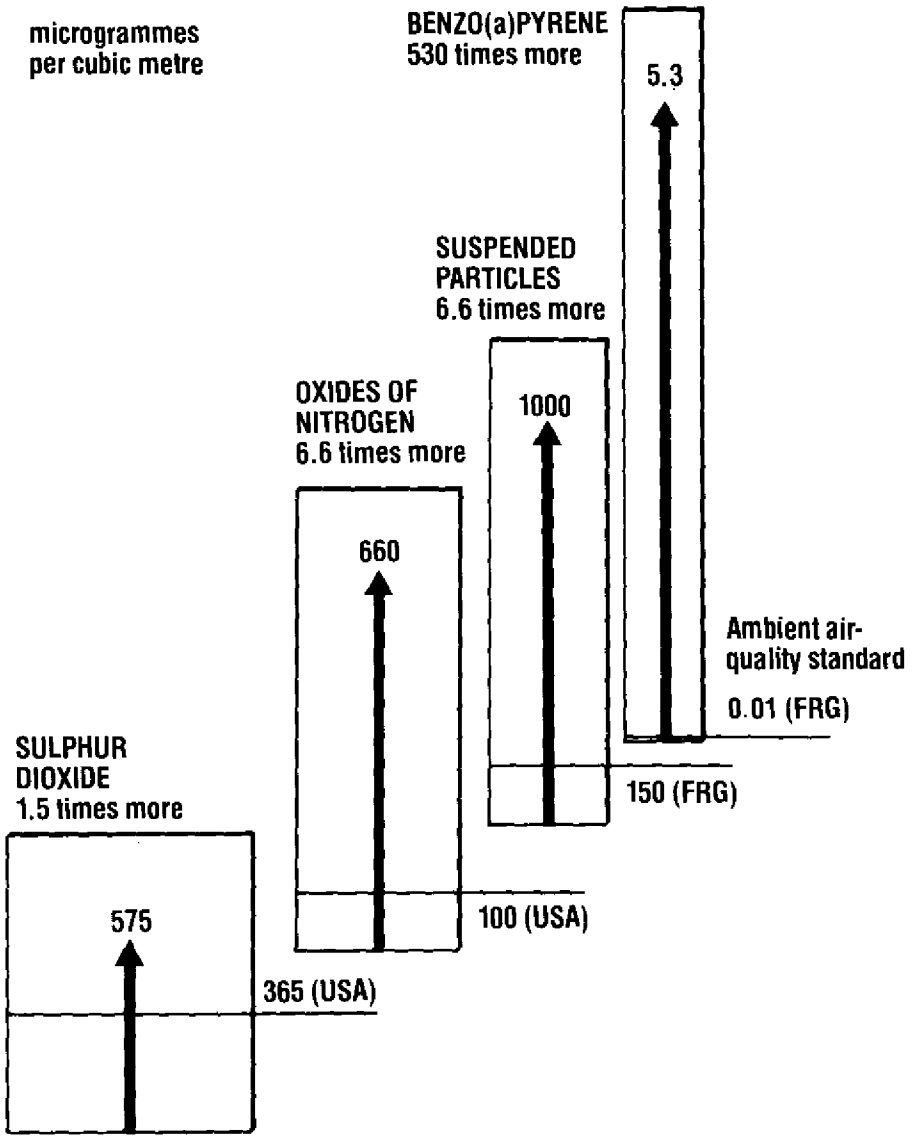
73. The victims are most often women cooking for households in rural areas. They suffer from impaired health and premature death due to prolonged exposure to the harmful pollutants from domestic cooking fuels. When pregnant, they may also expose the foetus to the hazards of development defects. Exposure to biomass fuel emissions is thus probably the most important occupational health hazard known.

74. The association between upper respiratory cancer and a history of exposure to biomass fuel emissions is clear from the incidence of nasopharyngeal cancer in Kenya. In the highlands, where cooking is done indoors because of the cool, damp climate, the incidence is higher than in the hotter areas where food is cooked out of doors. The climate of the highlands also forces children to stay indoors most of the time (Table 4).

75. A conservatively estimated 300-400 million people world-wide, mostly in rural areas of developing countries, are affected by these problems.(85)

76. In parts of the more developed world there is a resurgence of interest in home heating by fuels such as kerosene, coal, and wood. Moreover, cooking in these countries often involves unvented combustion of natural gas or propane. Indoor hazards include

9 Comparison of mean air content in 2000 houses surveyed in Gujarat State, India, with national ambient air-quality standards



Source: Hamilton, L.D., *Environmental Pollution from Power Generation, its Health Impacts and Control Strategies*, WHO 1985 (Based on a paper by K. G. Vohra).

carbon monoxide, organic by-products of kerosene heaters, and nitrogen oxides from gas cookstoves, together with increased risk of house fires. Outdoor hazards include those from low-level emissions by air-starved wood and coal stoves.

77. While wood is considered a clean fuel, its combustion emits particles, polycyclic organic matter (POM), carbon monoxide and possibly nitrogen oxides at higher rates per unit energy than oil or gas. Domestic combustion of coal in residential stoker-fed bituminous coal furnaces also creates high emissions of POM, up to 2,000 times higher than for gas, and 4,500 greater than for oil.(86) The use of smaller, air-starved units yields even higher levels.

78. Rising energy costs in the last decade have stimulated efforts to conserve home heating fuel by a variety of measures. Efforts to make building envelopes "tighter" by reducing air exchange with the outdoors can have the unintended effect of increasing indoor concentrations of air pollutants, including nitrogen oxides, carbon monoxide, smoke particles, formaldehyde, polycyclic aromatic matter, the radionuclide radon-222 and its "daughter" decay products.(87) Radon, a chemically unreactive gas, collects in buildings after its formation by radioactive decay of naturally-occurring radium in the soil. Indoor air concentrations thus depend on the amount of soil radium beneath the structure, a highly variable quantity (Fig. X).

79. The risk from indoor radon is not yet well quantified. Based on conservative assumptions, the average exposure of the public to radon and its decay products in the United States would give a lifetime risk of death from lung cancer of 180 per 100,000, i.e, about 1/5 of the incidence of lung cancer in non-smokers. It would add to the risk of lung cancer in smokers.(88) Unacceptable radon decay product levels, and therefore higher risks of lung cancer, may occur under conditions of high radon infiltration rates and/or low ventilation rates. In these cases, mitigation methods are available. One technique is that of sealing cellar floor and walls to inhibit radon-222 entry in the first place. A second is installation of a heat exchanging ventilator. The latter option also addresses the problem of other air pollutants. Yet another possibility involves ventilation of crawl spaces.(10, 11)

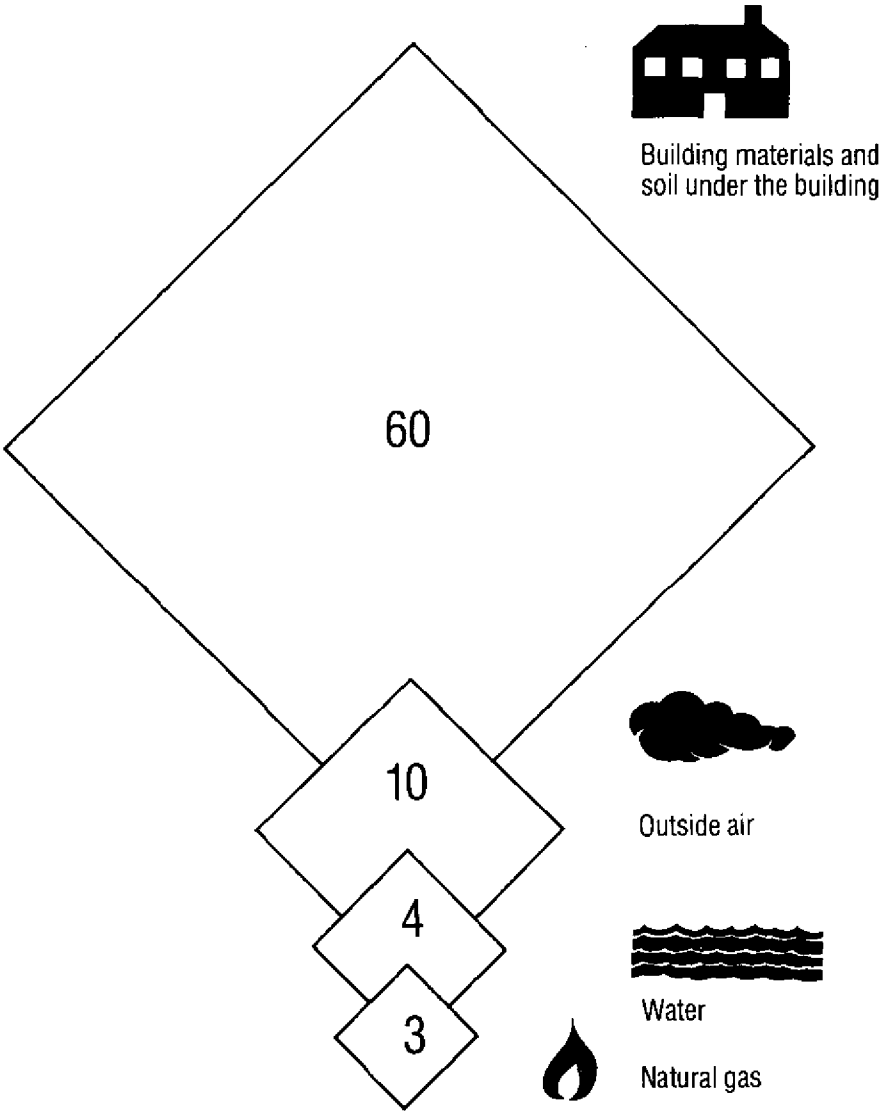
80. The potential health problem from radon and other important indoor pollutants due to tightening the buildings' envelopes is not primarily an energy issue, but one that must nevertheless be considered in assessing health impact from energy conservation measures. If risks are exacerbated by conservation, the increase strongly depends on the geographically variable radium distribution in soil, on the properties of the soil, and on the type of construction, about which there is as yet insufficiently detailed information.

Outdoor air pollution from stationary sources

81. Fuel combustion is the principal source of common air pollutants: carbon dioxide and monoxide, particles, sulphur oxides, nitrogen oxides, and ozone. Combustion emissions have plagued man since the first use of fire. Severe air pollution episodes in 1930 in the Meuse Valley, Belgium, in 1948 in Donora, Pennsylvania, and in the 1950s in London clearly demonstrated the health effects — increased cardiovascular and pulmonary deaths — of air pollution. These episodes were characterized by high concentrations of sulfur dioxide and particles from soft coal combustion. It is impossible to determine the specific pollutants causing the effect from these episodes, but fine particles, particularly sulphate particles, seemed likely candidates. In the late 1950s and 1960s a new kind of pollution episode — photochemical smog — was discovered in

10 Radon in buildings

The relative contribution of different radon sources in a reference house.



Source: *Ionizing Radiation: Sources and Biological Effects*, UNSCEAR 1982.

California, characterized by oxidizing pollutants (nitrogen oxides, ozone, peroxyacetylnitrates) from emissions of internal combustion engines in automobiles. This same type of smog has since been reported from other areas and countries.

82. Animal and clinical studies have shown that acid sulphate particles and ozone at such episode levels produce health effects in susceptible populations. With a few exceptions, ambient concentrations no longer reach the levels seen in the pre-1970 episodes, and animal, clinical, and epidemiological studies have not proven that any of the effects seen at high concentrations occur at the current, much lower, levels.

83. Major stationary sources of air pollution include electricity generating stations, industrial furnaces and large commercial heating plants using fossil fuels — coal, oil or natural gas. Of these, coal yields the greatest air emissions per unit of useful energy. The principal air pollutants from the combustion of fossil fuels are sulphur and nitrogen oxides, particles, and trace metals. Other constituents include carbon monoxide, hydrocarbons and trace amounts of radionuclides present in the fuel. A possibly important, but little studied, source of atmospheric pollution is the gas burn-off from oil fields rigs.

84. Stationary sources may be clustered in highly industrialized regions (such as, the Ruhr in the Federal Republic of Germany, the Ohio Valley in the United States, the Midlands in the United Kingdom, Helwan in Egypt, and Sao Paulo in Brazil), resulting in chronic area-wide elevated air pollutant levels that may be further exacerbated by adverse weather. Similarly, dense urban areas are a focus for emissions from electrical generating stations, factories, commercial and residential heating plants. Again, the micrometeorology of cities can exacerbate pollutant concentrations.

85. Data on air pollution in urban and industrial areas are available on a very large scale throughout the world, but comparisons are made difficult by the fact that they are collected according to different siting criteria and sampling schemes and the analytical procedures are often different. Comparable data collected by WHO and UNEP under GEMS over a period of at least five years on a limited scale (65 sites in 20 cities), however, were analysed in 1984 (89) and showed that the predominant trend in sulphur dioxide and suspended particulate matter concentrations was generally downward in the late 1970s. Lower concentrations at the end of the period were observed at 50 per cent of the sites for sulphur dioxide and at 45 per cent for suspended particulate matter, while about 75 per cent and 50 per cent of the sites, respectively, reported annual average and maximum daily concentrations of the two pollutants within or below the exposure limits suggested by WHO for the protection of human health. There is obviously scope for further efforts at pollution reduction in a number of cities.

86. Occasionally, major installations such as power plant complexes are intentionally sited in remote areas, but this is the exception, partly because of the drawback of transmission losses to end-users. Regardless of origin, the air pollutants emitted may travel long distances, crossing regional and national boundaries. While aloft, these primary pollutants undergo a series of complex chemical and photochemical reactions to produce a family of secondary air pollutants harmful to the environment and with possible health effects due to mobilization from the soil of such trace elements as cadmium.(90)

Transport

87. A broad range of pollutants is associated with the exhausts of urban motor vehicles, both petrol and diesel. By-products include ozone, nitrogen oxides, carbon monoxide, hydrocarbons, sulphur dioxide, aldehydes, particulate matters and lead. According to EPA estimates for 1977,(91) mobile sources contributed about 84 per cent of the carbon monoxide, 80 per cent of the lead, 40 per cent of the hydrocarbons, and 39 per cent of the nitrogen oxides emitted to the United States atmosphere. In Europe, the motor vehicle exhaust contributions are in the same range with the exception of nitrogen oxides, for which the contribution rarely exceeds 20 per cent. In both cases, automobiles are the largest single contributor of each of these emissions. These figures are similar to those from Brazil, where mobile sources used to contribute about 96 per cent of the carbon monoxide, 83 per cent of the hydrocarbons, 89 per cent of the nitrogen oxides and 26 per cent of the sulphur dioxide emitted to the atmosphere of Sao Paolo.(92) However, the alcohol programme implemented in Brazil for light-duty vehicles is changing these figures. Lead concentrations in urban atmosphere decreased from 1.6 milligrams per cubic metre in 1978 to 0.3 in 1983. Carbon monoxide has also decreased, to a lesser extent, but oxidant levels are rising, probably as a consequence of aldehyde emissions which are five times higher in the exhaust of alcohol-powered vehicles.(93)

88. Actual health impacts from transportation emissions are difficult to quantify. Concentrations can depend a great deal on local meteorology and traffic patterns, and the air-pollution mixture can vary from country to country depending on the make-up of the vehicular fleet and on control standards. Moreover, the health effects from long-term exposure to many of the constituents of motor vehicle emissions (e.g., carbon monoxide and ozone) are not well understood. Nevertheless, the history of transportation-related air pollution and the extent of governmental efforts to regulate it are indicative of society's recognition that potential effects are a matter of social concern. In this connexion it is worth noting that in the Federal Republic of Germany and other central European countries, concern about the suspected effects of nitrogen oxide emissions from cars on vegetation, and particularly on coniferous forests, has led them (and more recently the Commission of the European Communities) to encourage the fitting to new cars of catalytic converters in order to reduce emissions. Since this requires the use of lead-free petrol, lead emissions are reduced simultaneously, thus decreasing human exposure to lead. Similar measures had been taken earlier, for different reasons, in the United States and in Japan. In a number of developed and developing countries reduction in transportation emissions is urgently needed, by use of more efficient lean-burn engines or effective emission control devices.

Energy production: nuclear fission

89. The operation of nuclear reactors inevitably involves releases of radioactive material to the environment. Operational releases are tightly controlled and give rise to very small doses to man, compared with the doses received through natural irradiation (see Chapter I, paragraph 6).(10, 11) As recent events have shown, the situation can be quite different when, owing to a malfunction of some element of the plant, uncontrolled amounts of radioactive material are emitted.

Operational releases (10, 11)

90. Under operational conditions, radioactive releases vary from power plant to power plant. Almost all the radioactive material associated with power production remains in the reactor site or in special storage facilities, but small releases do occur in the course of the operation of any plant. Some of the nuclides released are long-lived and become globally distributed, thus contributing to the radiation doses received by the world population today and, depending on their rate of disintegration, for varying times in the future. A crude calculation (exact estimates cannot be obtained) indicates that the over-all average radiation doses from the fuel cycle as a whole, including operational releases from power plants, amounted in 1980 to one thousandth of one per cent of the average yearly doses from natural background. While over-all doses have been slowly increasing as nuclear power has been developing, those from individual reactors, particularly the most recent ones, have tended to decrease owing to technical improvements in the plants and the adoption of ever more stringent radiation protection measures.

Accidental releases

91. Until recently, two major accidental releases had been recorded. In 1957, the fuel in the Windscale reactor in the United Kingdom overheated and was on fire for three days, releasing substantial amounts of radionuclides, especially radio-iodine. Iodine tends to concentrate in the thyroid and, when it is radioactive, irradiates it, thus raising the risk of occurrence of thyroid abnormalities, including tumours, depending on the amount of radio-iodine, and therefore on the radiation dose, absorbed by the gland. Thyroid doses in adults, measured in Leeds and London, amounted respectively to one-half to one-fifth of the annual dose received by adult thyroids from natural background. Maximum doses might have been five times those from background for the adults and up to 20 times for children. (10)

92. In 1979, a failure of the water cooling system combined with a series of human errors caused severe damage to the fuel elements of the Three Mile Island reactor in the United States. Owing to an additional failure of the sealing system of the building, substantial amounts of radioactive material escaped into the atmosphere and gave rise to irradiation of the public. Individual doses to the public averaged less than one hundredth of the dose from natural background, while the maximum dose to the public was estimated to be somewhat less than the yearly dose from background. (10)

93. Neither at Windscale nor at Three Mile Island were people exposed to doses approaching those that would result in effects observable in the short term.

94. On 26 April 1986, under circumstances still being investigated, fire broke out at one of four reactors at Chernobyl, Ukrainian SSR, and continued for a number of days. As a result, significant amounts of, mostly volatile, radionuclides were released to the atmosphere. Because of the fire, the radio-active plume rose to high altitude, thus presumably reducing the exposure of the local population, and subsequently was dispersed by the winds that prevailed, causing the radioactive material to wander over several areas of Europe at different times and in different amounts. At Chernobyl itself, two workers were killed outright and some 300 persons were hospitalized, of whom 25 were to die later of the consequences of irradiation. Even as efforts were under way to bring the fire under control, mass evacuation started. Eventually, some 90,000 people were evacuated from a 30 km radius around the plant. No information is yet available on the exposure they underwent.

95. Measurements of total radioactivity and individual radionuclides in air, precipitation, drinking water and food were carried out intensively throughout Europe. It is too early to assess those data even superficially, although a technical consultation convened 10 days after the accident by the WHO Regional Office for Europe has resulted in a useful preliminary overview of the early information available.(94) The few details on the Chernobyl accident mentioned above were obtained from that review but supplemented by some obtained from the media.

96. Unlike the earlier accidents, which gave rise to local contamination only, the latest one has starkly brought home the fact that nuclear accidents may be the concern of more than the people living around a power plant. This accident has, indeed, given rise to serious and widespread alarm well beyond the confines of the country where the accident took place. It has also created international awareness of the need for improved safety of nuclear power plants and for better information exchange on the safety procedures in use at different nuclear sites and for the development of warning systems that would immediately alert the international community of any local atmospheric release of radioactivity, so that any necessary counter-measure may be taken by other countries in a rational, timely and orderly fashion.

Waste reprocessing and disposal

97. While many energy conversion systems produce wastes that require controlled disposal (e.g., spent oil shale, coal ash, bagasse, and geothermal brines), the potential hazards of spent nuclear fuel represent the largest risk. Radioactive wastes are generated in practically all areas of the nuclear industry in the form of liquids, solids, and gases with a wide range of radiation levels. Most are low-level radioactive wastes formed in mining and milling. The more radioactive materials are derived from reactor operation and fuel reprocessing. In the course of reprocessing, currently carried out at three commercial plants, effluents release radionuclides to a river — the Rhone, from the Marcoule plant in France, or to the sea — from La Hague, also in France, and Windscale (Sellafield) in the United Kingdom. Of the three, Marcoule is the least and Windscale the most polluting, although the amount of radioactive material discharged to the sea by the latter has decreased significantly in recent years.(10, 11)

98. Low-level wastes include mill tailings that contain the radioactive substances left behind in the ore after uranium extraction. Tailing piles are not major sources of public exposure. But some tailings were used in the foundations of homes, resulting in larger public exposures. In these situations, mitigation included ventilation or relocation. Other low-level wastes are enclosed in steel drums and buried at licensed sites.

99. Of greater concern to health and safety is the management and disposal of high-level and transuranic wastes and spent fuel. Spent fuel contains uranium, plutonium and other heavy nuclides, and accumulated fission products. "High-level waste" is that fraction which remains after chemical reprocessing. To minimize exposures to the public, seabed and land-based repositories have been proposed. In France, the Federal Republic of Germany, Sweden and the United States, it has been accepted that repositories placed deep underground, in dry geologic formations present the best solution to this problem. These repositories could provide both engineered (e.g., corrosion-resistant sealed cylinders) and natural (e.g., burial over 600 metres beneath the surface) isolation of the radioactive materials for the time periods required. If this strategy is adopted, public health risks will be reduced but occupational risks during repository construction and operation will be larger because of routine construction hazards.

Mitigation of energy-related health damage

100. Modern civilization is based on easy availability of energy, and many of the health gains in less-developed countries are derived from increased energy use, e.g., pumping water. Energy production and use, however, can adversely affect the environment and, either directly or indirectly, health. These effects can be minimized by producing and using energy efficiently and with due regard for environmental consequences. All else being equal, if less energy can do the same job, adverse impacts are decreased. The considerable potential for energy conservation in developing countries is addressed by UNEP.(95, 96)

101. In developed countries, industrial growth during the past century has been linked to increasing energy use. But in the past decade it has become clear that much of the increase in energy use has not been a necessity for economic growth, but has reflected inefficient design and operation. Conservation of energy could be achieved, and has already in fact been achieved in some countries, without sacrificing economic growth through increased energy efficiency, e.g., in manufacturing, heating and cooling of buildings, and in automobile design. Energy use could be further curtailed in end use — for example, by decreasing automobile use through fewer and shorter trips or shifting to public transportation, and maintaining buildings at higher temperatures in summer and lower temperatures in winter.

102. In developing countries, the situation is different. Energy use is much lower. Improvements in health and amenities require increased energy, so that there is little or no room for curtailment. Indeed, decreases in availability of energy can have direct adverse health impacts.

103. However, because of inappropriate adoption of some technologies from the developed world and inadequate maintenance, developing countries frequently produce, deliver, and use energy at low efficiencies, particularly for transportation. Yet, improvements are possible and can yield important benefits such as decreased demands for scarce (often imported) raw fuel, making more energy available for end-use, and decreased environmental impact. These benefits are multiplied as energy consumption increases. Effective use of new and renewable sources of energy, solar, wind, mini-hydro, where appropriate, economically feasible and non-damaging to the environment, should be encouraged.

104. In those areas where indoor use of biomass fuel creates health hazards these can be reduced through improved efficiency of fuel use and stack removal of harmful agents from indoors. Some of the improved fuel-wood and charcoal stoves developed recently should replace those providing inferior combustion.(85) Also, energy in dung and agricultural wastes can be used more efficiently with less health impact than in direct combustion by extracting biogas from the residues and returning the nutrients remaining in the sludge to the soil as fertilizer cleaned from harmful micro-organisms.

105. Developed countries are reducing pollution from fossil fuels by fitting costly pollution control equipment to installations already operational. This strategy is generally beyond the means of developing countries, and often unnecessary since large centralized power systems are less common. Nevertheless, appropriate measures, included during planning, and the adoption of low-waste technologies, can forestall or mitigate environmental impacts from new energy centres at low cost.

Industrial activities

106. All industrial activities inevitably affect the environment, either directly or through the products they create. The industrial sector (defined as comprising mining, manufacturing, construction, electricity, water and gas) contributes a remarkably consistent proportion of GDP — an average of 35 per cent in industrial market economies, 37 per cent in upper middle-income countries, 36 per cent in middle-income economies, and 34 per cent in low-income nations. The last figure is heavily influenced by a high percentage in China and a lesser, but still substantial, percentage in India. (Sub-Saharan Africa, for example, gets an average of only 17 per cent of its GDP from industry.(97)* Broadly speaking, industry generates a disproportionate amount of pollution: it is, for example, responsible for 60 per cent of the national biochemical oxygen demand (BOD) load (see paragraph 111) on United States water resources.(98) It also produces almost all the world's emissions of toxic substances, including hazardous wastes.(99)

107. The impacts vary from industry to industry. Mining and milling of mineral ore, besides grossly modifying the earth's surface, give rise to major pollution problems. Like the construction industry, they suffer high accident rates, mostly of a physical nature. The textile industry emits particulates, odours, sulphur oxides, and hydrocarbons into the air, suspended solids, salts, sulphates and toxic metals into the water, and sludges from effluent treatment into the land. The leather industry discharges suspended solids, sulphates and toxic metals into water and produces chromium sludges for waste disposal. Non-ferrous metal industries, such as the aluminium industry, are often major local air polluters that release flourine, solids and hydrocarbons into water. The iron and steel industries are especially heavy polluters emitting sulphur oxides, particulates, nitrogen oxides, hydrocarbons, carbon monoxides, hydrogen sulphide, and acid mists into the air; suspended solids, oil, metals, acids, phenol, sulphides, sulphates, ammonia, and cyanides into water; and producing slag, sludges and other solid wastes.(99) The asbestos industry has taken a particularly heavy toll of worker's lives in mines, mills, dockyards and the like, in both developed and developing countries, and continues to pose hazards both to workers and the general public. An estimated 8 to 11 million workers in the United States alone have been exposed to the mineral since 1945.(100) The cement and brick-making industries are major polluters in some areas. But increasingly the pattern of industry is changing. Traditional industries, such as these, are declining in OECD countries in the face of increased competition, particularly from newly-industrializing countries: the OECD countries' share of total world steel output declined from 66 per cent in 1970 to 52 per cent in 1983.(99) In their place there is a growth of new industries, which present new, emerging, health problems. The microelectronics industry can emit toxic gases to air, and contaminate soils and ground water with toxic chemicals, including chlorinated solvents. The new biotechnologies have raised fears of hazards from the release of micro-organisms into the environment.(99) On a happier note, the pollution control industry is also an emerging one: it was estimated to employ some 1.5 million people in 1980 in the European Communities alone.(101)

108. In a report of this length it is impossible to cover all the impacts on the environment, and their health effects, from such a large and diverse number of

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* Figures for East European non-market economies are not available, except for Hungary, where the contribution was 37 and 42 per cent in 1965 and 1983, respectively.

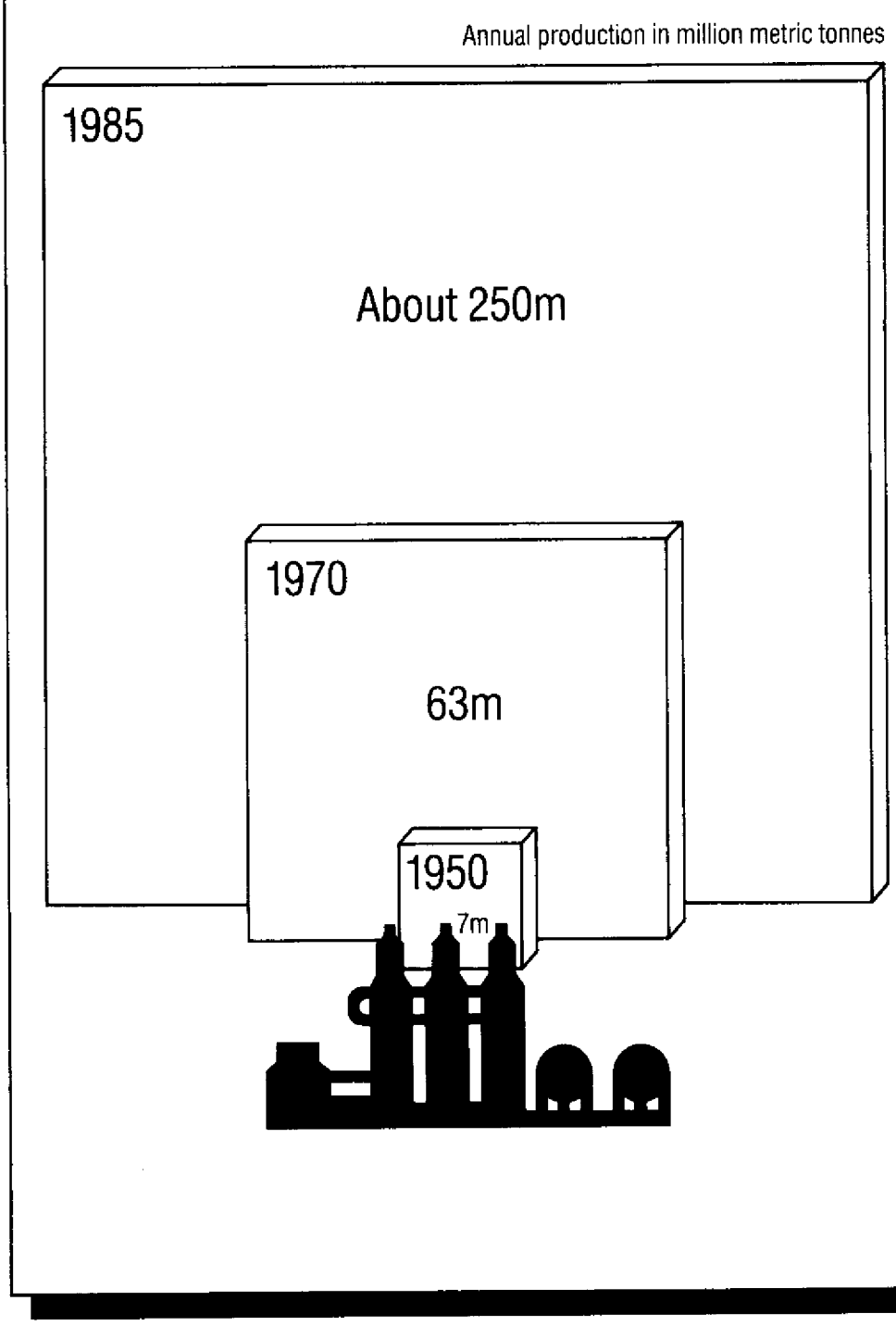
industries. It was therefore felt necessary to single out one -- the production of chemicals — to illustrate the more general issue. The chemical industry is particularly important for several reasons. It has grown rapidly: in 1950 world production of organic chemicals was 7 million tonnes; by 1970 it had reached 63 million tonnes and today it is around 250 million tonnes (Fig. XI). It is extremely diverse: it is estimated that there are now about 80,000 organic and inorganic chemicals in commercial production, with a further 1,000 to 2,000 new ones appearing on the market each year.(98) The chemical industry poses a range of hazards, both known and unknown. Its diversity makes it possible to consider a number of problems arising from exposure to chemical substances that are common to a number of other industries (e.g. tanning and dyeing and the innumerable industrial activities making use of chemical solvents). The same feature, however, makes it difficult to obtain systematic information, from consumption figures for raw materials to statistics on the production and sales of individual chemical substances or, in developing countries, on the importation of chemicals, especially those that are toxic or hazardous. Such figures are often considered as confidential in a number of countries; in others they are just not available. In addition, the exchange of information is not facilitated by the lack of uniformity in the terminology used by the industry and in national legislation. Finally, it should be clearly borne in mind that the production of chemicals is responsible for only a part, and possibly not the major one, of the release of chemicals into the environment. An equally, and perhaps more, significant contribution is made by discarded or misused consumer, including household, products containing chemicals.

Operational releases

109. Virtually all industrial chemical transformation activities involve the release to the environment of substances of various degrees of toxicity or unpleasantness which contribute to pollution of air or water and sometimes of food, and thus to peoples' exposure. In terms of amounts of pollutants released, the chemical industry is far from being the main contributor to environmental pollution. For instance, despite the importance of the production of such inorganic substances as sulphuric and nitric acid by manufacturing industries, the amounts of sulphur and nitrogen oxides they release are only a few per cent of the total anthropogenic emissions. The relative contributions of chemical industry to arsenic, cadmium and lead pollution are negligible. In the production of inorganic substances, an exception is that of chlor-alkali plants for the production of caustic soda and chlorine. These plants represent the major source of anthropogenic mercury pollution of air and waters. Yet the current trend is towards the adoption of the membrane process that uses no mercury, and improvements to the plants using the older technique are also reducing emissions.

110. Comparisons are more difficult in considering emissions from the organic chemicals industry because of the variety of chemicals that may be released, many of which, being intermediate compounds between feedstock and consumer products, are released by the operation of organics plants only. In general, under operational conditions, air pollution from these plants is less important than water pollution. Indeed, in 1976, United States chemical industries contributed only six per cent to the total emissions of volatile hydrocarbons,(102) the rest originating mostly (33 per cent each) from motor vehicles and from the industrial and other uses of solvents. Industry, however, is engaged in developing new vehicle-coating systems that will substantially reduce the industrial emission of organic solvents,(103) themselves the end-products of the chemical industry. This observation underscores the importance, for source

11 Organic chemical production, worldwide



assessment purposes, of the distinction between production of a chemical, which in itself may not give rise to environmental problems, and its use, which may result in major ones.

111. Water pollution from organic chemicals and petrochemical plants is due to highly variable mixtures of complex, mostly organic, substances including toxic by-products. Most of them share the property of being degraded to simpler compounds by the action of oxygen-consuming micro-organisms present in natural waters and sediments. The collective load of these substances is therefore measured in terms of the amount of oxygen required by these organisms for the breakdown, under specified conditions, of the compounds present in the waters — the biochemical oxygen demand (BOD). The BOD of the effluents from organic chemicals plants may be high. Yet it is normally small compared to the BOD of effluents flowing into domestic sewage treatment plants or from such plants as alcohol distilleries or pulp and paper mills. From the point of view of human health, the operational emissions into waters of individual chemicals that may have toxic effects on those who are exposed to them are of greater concern than BOD.

112. Effluents from inorganic, organic and petrochemical plants as well as from industries (e.g., tanning and electroplating) that make use of chemicals, contain persistent toxic chemicals that may seep with surface waters into the ground and thus contaminate the water table and impair the long-term supply of drinking water. For instance, chromium and trichlorethylene in ground water have become a major cause for concern to the city of Milan, Italy. Under good manufacturing practices emissions ought to be negligible. Exposure should result mainly from the use, rather than from the manufacture, of consumer products. That this be so is ensured by the variously stringent control measures adopted. Their effectiveness varies from country to country. It depends on the vigour with which they are enforced and the amount of co-operation among industry, health and environment authorities. While some low-waste processes may, in fact, achieve savings, most control measures add to production costs. In addition, their enforcement requires specialized personnel — and these may be in short supply. It is therefore tempting for poor countries to minimize such measures so as to reap maximum economic benefits with scant regard for environmental and health consequences. Indeed, they may invite industries from developed countries to set up plants in these so-called "pollution havens". Eventually, it can result in environmental degradation and human hardship and, in the end, require the adoption of costlier control devices and procedures. It can even lead to loss of the investment by forcing the discontinuation of operations which, if they were to be made harmless, would become entirely uneconomic.

Occupational exposure

113. Any release of chemicals in the workplace involves exposure of workers. This is usually through inhalation of or skin contact with gases, vapours, fluids, dusts and aerosols. Ventilation of the workplace, filtering of incoming air, use of closed-systems of production and the wearing of personal protective equipment reduce the possibility of exposure. Unfortunately, the inadequacy of monitoring schemes, laxity of enforcement, misdirected attempts at reducing costs, lack of understanding and co-operation on the part of the workers (often due to inadequate training), all tend to reduce the effectiveness of protection measures, particularly in developing countries. In addition, in warm climates, protective measures developed in temperate areas, especially the use of personal protective equipment, may become an insufferable burden on the worker. He may well prefer facing a risk he poorly understands to the constraints that would limit it.

114. In all areas, there is necessarily a lag between exposure to a risk and recognition of its existence by means of human observation or experimental data sufficiently firm to justify the adoption of measures to reduce it. Vinyl chloride provides a good example. Manufactured since 1939 and initially regarded as a harmless chemical except at very high concentrations, its production increased very fast, reaching 2.5 million tonnes in the United States by 1973. Since production is highly automated, the number of workers exposed is relatively small — about 1000 are engaged in vinyl chloride manufacture at any one time in the United States itself. A much larger number are engaged in the manufacture of the polymer polyvinylchloride (PVC).

115. In early 1974, exposure to vinyl chloride over a number of years, mainly during the manufacture of PVC, was unequivocally linked to the occurrence of a rare form of cancer of the liver in a few of the workers at a number of plants in the United States producing the chemical. Steps were immediately taken to reduce vinyl chloride concentrations in the workplace by a factor of 10. A mandatory standard was laid down about a year later, cutting air concentrations in the workplace to a level 500 times lower than that accepted before the discovery of the link between the chemical and liver cancer. Other countries, however, were slower in following the example. Thus, both Canada and the European Communities adopted similar standards only in 1978, although major producers had taken measures at a much earlier date on their own initiative.

116. However fast the action that led to the adoption of control measures was, the fact remains that thousands of man-years of exposure elapsed before it was realized that the working conditions in the vinyl chloride industry were conducive to the development of cancers. More cases are probably still occurring from exposure in past years. This is a general feature of the industries that work with chemicals: they are usually regarded as safe (by such criteria as number of working days lost, injuries and deaths) until proved otherwise. The negative evidence may only emerge after years of unimpeded exposure. Those unintended exposures, both at high doses for short periods of time in the course of occupational accidents and at lower doses over periods of months and years, have provided the bulk of the information on the acute and long-term effects of chemicals in man (see Chapter I).

Management of wastes

117. The production of chemicals is normally accompanied by the production of unwanted products requiring disposal.(104) The industry has begun to realize the value of reducing the production of unwanted substances by utilizing the feedstock material more efficiently, and finding uses for substances previously regarded as valueless. Coupled with efforts at volume reduction of liquid wastes, this has led in some instances to a substantial decline in the amount of wastes to be handled per unit weight of end product and has led to significant savings in the production costs of some expensive chemicals. The trend is towards a continued reduction of the amounts of wastes arising from the industry. Nevertheless, chemical wastes and their management will remain a problem for the foreseeable future. The large number of small businesses that do not have the knowledge, the incentive or the resources to deal adequately with their production of small amounts of wastes pose particular difficulties.

118. There are two aspects to the problem. One is a legacy of the past, when wastes, even highly toxic ones, were disposed of rather haphazardly in landfills (sometimes the same that are used for household refuse), in streams and in the oceans. This practice is

still followed in countries with weak, poorly enforced or non-existent legislation on treatment and disposal. What was released to inland waters or to the sea is generally irrecoverable. Its effects may linger for a long time, when a toxic substance disposed of in shallow waters is adsorbed in sediments and slowly released over a period of time with consequent risks for living beings, including man.

119. Past disposal practices on land can have particularly serious consequences. Seepage and leaching from an unsupervised repository may contaminate the underlying water table and eventually drinking water. Alternatively, toxic material may be taken up through the root system of vegetables grown on a site that had been used for disposal in earlier times and which has since been forgotten. Examples of such sites abound in most industrialized countries. Their identification, the assessment of the risks to the people and the remedial measures to be taken, including, sometimes, relocation, are a major responsibility for local health and environment authorities.

120. The other aspect is the current problem of waste management and its ultimate fate. As with other environmental aspects of the chemical industry, what renders the issue difficult to handle in a systematic way is the complexity and diversity of the mixtures of chemicals of which the wastes may consists. These differ not only according to the feedstock used and the end product obtained, but also according to the process employed and the tightness with which waste-limiting technologies have been applied. A special problem is posed by the movement of hazardous wastes across national boundaries. This takes place with high frequency on a large scale to enable the disposal at sea of wastes produced by land-locked countries, or because treatment and/or disposal facilities are not available in the country of origin. It is sometimes used to take advantage of loopholes in the legislation of a particular country. Compliance with national legislation on the treatment and disposal of wastes can be very onerous, making the ferrying of wastes to countries with weak or no legislation at all on the subject economically attractive, despite transport costs.

121. Regardless of the nature of the wastes, certain general principles of sound waste management are becoming increasingly common. These are reflected in national legislation and discussed in international forums with the aim of making national approaches as consistent as possible with each other.(105)

122. National legislation has been the major driving force behind the improvement of waste management. Some national laws, at least in developed countries, prescribe declarations on the nature of the wastes, notifications of all the stages of the life cycle of the wastes and their whereabouts, and licensing of sites where hazardous wastes are stored, treated or disposed of, as well as of the attendant transport activities. The legislative provisions are part of a whole planning programme that, starting from estimates of the future output of wastes, determines how best these should be apportioned among treatment facilities (often within the originating plant), including appropriate incineration facilities, and among disposal sites on land or at sea.

123. At international level, the *Ad Hoc* Working Group of Experts on the Environmentally Sound Management of Hazardous Wastes convened by UNEP adopted the Cairo Guidelines on the subject.(106) The Guidelines, which will be considered, and possibly adopted, by the Governing Council of UNEP in 1987, are addressed to governments with a view to assisting them in the process of developing relevant policies. The Guidelines cover the management of hazardous (but non-radioactive) wastes from their generation to their final disposal, including the problem of their transfrontier transport.

124. Other United Nations bodies, such as ECE, IMO, and WHO, have been concerned with various aspects of waste management problems. The Council of the European Communities has adopted a directive on the supervision and control within the EEC countries of the transfrontier shipment of hazardous wastes,(107) and the OECD Council has adopted a resolution on international co-operation concerning transfrontier movements of hazardous wastes.(108)

Accidents

125. Three major accidents in chemical plants have been reported in the last twelve years. Twenty-eight workers died and 36 were injured as a result of an explosion in a chemical plant at Flixborough in the United Kingdom in 1974. In 1976, at Seveso, Italy, 700 people had to be temporarily evacuated, some houses dismantled and topsoil removed from an area of about 100 hectares, following an accidental release of dioxin into the atmosphere. Hundreds of domestic animals were killed, and, while no human fatality was attributed to the exposure, 191 children suffered from a disfiguring skin disease (chloracne). Accurate epidemiological surveys carried out soon after the accident and again later revealed no immediate or short-term pathological effects in the population in the workers employed in the reclamation operations. The development of long-term effects will not be known until a further survey is completed, by 1997. In 1984, at Bhopal, India, the worst chemical accident in history occurred. Methylisocyanate — an extremely toxic intermediate product in the preparation of an insecticide — was released into the atmosphere causing at least 1400 deaths(109) and tens, perhaps hundreds, of thousands of injuries, including a number of cases of eyesight impairment and pulmonary fibrosis among the people living in the vicinity of the plant, and complete disruption in the social fabric of the city.

126. Much needs to be learned from the experience. A stark and obvious but often forgotten lesson that applies to all industries that present potential hazards is that their safety record prior to a certain time is no guarantee against the future occurrence of accidental events. Another general lesson from Seveso and Bhopal is that it is unwise, and may have tragic consequences, to site plants handling hazardous products in populated areas or to allow the settlement of people around them. Many more technical points can also be made in connection with the three accidents about the efficiency of monitoring and control systems, the adequacy of the training provided to the workers, the contingency plans both inside and outside the factory, and the wisdom of storing, for economic but otherwise unnecessary reasons, much larger amounts of toxic material than are required for day-to-day operations.

127. These lessons are still being digested at the national and international level.(109) Six years after the Seveso accident, the Council of the European Communities adopted a directive that laid down the basic elements of a comprehensive accidental hazard prevention and control scheme.(110) Guidelines for risk management and accident prevention in the chemical industry have been issued by UNEP.(111) ILO is now developing methods for the prevention of major hazards in industry. The Code of Conduct on the Distribution and Use of Pesticides (see paragraph 42 above) also contains provisions for the prevention of industrial accidents involving the manufacture and formulation of pesticides. Finally, the UNEP/WHO/ILO International Programme on Chemical Safety is increasingly involved in problems of emergency responses and is organizing training courses to improve the safety of chemical operations, particularly in developing countries.

Provision of housing, shelter and household services

128. The continued growth of world population brings with it the necessity to ensure that basic environmental health needs can be met by a combination of individual and private action with public or governmental initiative.

129. Where additions to the human population occur in rural areas or smaller communities where overall densities are comparatively low, the environmental health problems may be less severe. It is the unplanned crowding together of people into dense agglomerations that provides new opportunities for disease transmission.

130. Such a process of increased crowding is proceeding at a rapid, and in some regions, accelerating pace. Healthy environments can be created in large cities. The medical knowledge and the technology required are both available and well known. Application of such knowledge to create healthy environmental conditions in large cities is expensive, however, and has only been achieved in recent decades in many of the cities of the developed world. There are still cities, in the Mediterranean region for example, where urban environmental health conditions are poor despite all the development that has been achieved.

131. Forty years ago, at the end of World War II, a common and correct perception of the world was one in which the industrial economies of Europe and North America were organized in cities, and the agricultural and raw material producing economies of the emergent colonial and ex-colonial countries of Africa, Asia and Latin America were for the most part organized in villages, in dispersed mud settlements and in small towns. Even capital cities were commonly no more than administrative and trading stations with small populations. This pattern is now well on the way to complete reversal. Cities are growing rapidly in the developing world, while in developed countries many of the older cities are losing population to smaller towns and distant satellite communities (Fig. XII).

132. In 1986, a great question mark is seen to hang over the future of the environments in which a majority of the world's population will soon be living. These most man-made and man-controlled of environments should afford healthy, productive and fulfilled lives for their inhabitants. Unless present trends are reversed or greatly modified, they threaten to be, at least in part, chaotic concentrations of poverty and disease.

133. There are both positive and negative indications in presently observable patterns and trends. The state of human settlements in 1986 holds some promises for the achievement of healthy environments, but there are also severe and threatening problems which demand urgent attention and renewed and strengthened efforts, if they are not to become overwhelming.

134. The problems are most severe in developing countries, but they are not limited to them. In developed countries, a potential crisis in environmental health is threatening the high standards of health that generally prevail. It is these problems that will first be discussed below.

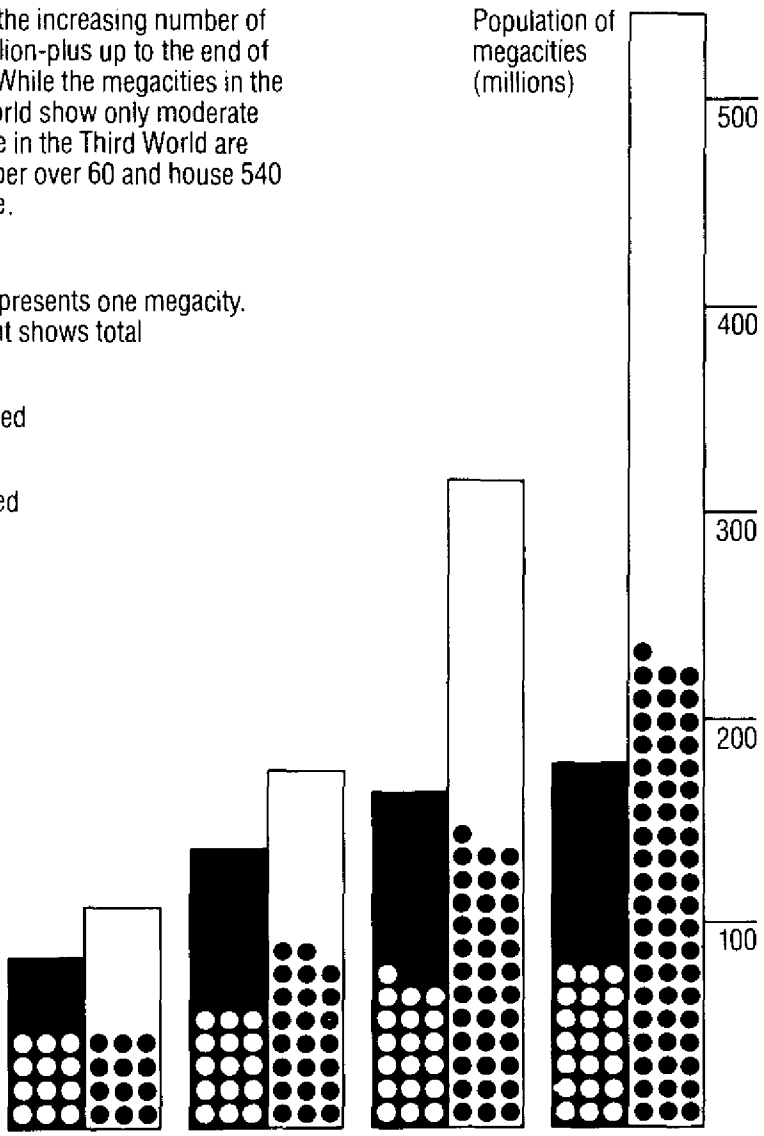
12 Growth of the megacities

Chart shows the increasing number of cities of 4 million-plus up to the end of this century. While the megacities in the developed world show only moderate growth, those in the Third World are likely to number over 60 and house 540 million people.

Each circle represents one megacity. Column height shows total population

More developed regions

Less developed regions



Years	1970		1980		1990		2000	
Cities	12	12	15	23	19	37	21	61
Total population	(83m)	(108m)	(135m)	(176m)	(164m)	(315m)	(179m)	(540m)

Source: Harrison, P., Rowley, J., *Human numbers human needs*, IPPF 1984.

The urban environment in developed countries and its health problems

135. The emerging problems in the cities of Europe, North America, and other developed areas stem in part from their very success in controlling many of the traditional infectious diseases. The industrial cities of the 19th century were very unhealthy places. Typhoid, cholera and influenza were some of the major causes of morbidity and mortality. The cities grew as a result of immigration, but not through natural increases.(112)

136. The urban environment was not designed for health. Water supplies were contaminated with sewage, crowded and congested living conditions promoted the transmission of diseases, and the very air was often thick with smoke and dust. More people died in such cities than were born in them.

137. Today, water supplies are treated and are free from bacteriological contamination. The atmosphere is much cleaner as a result of smoke control and air pollution regulations. Living conditions are much improved and houses are less densely crowded and better ventilated.

138. As a result, the major traditional causes of death have changed dramatically. The leading causes of death are now cardiovascular diseases — diseases of the heart and circulatory system. The second cause of death is malignant neoplasms — cancers of all kinds. Bronchial and lung diseases are still important, but the major infectious diseases are largely a thing of the past. This can be attributed in large part to improved environmental conditions made possible by economic development.

139. Accidents account for less than 5 per cent of all deaths, but are the leading cause of death among young people in the 15-25 years age group.

140. The "new" diseases — heart disease and cancer — do not appear to be susceptible to the same kinds of control as infectious diseases, and at the same time they are extremely expensive to treat, requiring costly medical equipment, teams of highly trained physicians and laboratory personnel and sometimes long periods in the hospital. As populations age, a higher proportion of people become susceptible to the "new" diseases and the costs of treatment soar.

141. The health crisis of the developed industrial countries, therefore, is more a crisis of costs of treatment than anything else. In consequence, new approaches are being developed, which emphasize prevention rather than cure and aim at the control or elimination of the risk factors causing the disease. These factors have much to do with the environment of human settlements and the kinds of life that people lead within these settlements.

142. Risk factors are thought to include those things which contribute to the stress of urban life, including noise, pollution, the "fast pace" of living, congestion, and the behavioural responses to the urban environment, including overeating, overweight, lack of exercise, smoking, alcoholism, and so forth. These environmental and behavioural characteristics are complemented by a growing culture of violence, in which street crime and vandalism in public places are matched by a rising incidence of intra-family violence, including wife and child beating, rape, murder and suicide. The extent to which these social pathologies can be linked to poor environmental conditions is a matter of expert debate, and interpretations vary, sometimes widely. These

problems of the inner cities in developed countries are often complicated or exacerbated by ethnic conflicts caused by the hostilities of established populations to immigrant groups coming from different cultural and religious backgrounds.

143. The problems of the "new diseases" and the social and environmental deterioration of the inner cities are now being recognized. Major social trends are under way towards a reduction in smoking and alcohol consumption, increased exercise and a better diet. At the same time, efforts at pollution control are directed at the growth of chemically toxic contaminants in food, water and the air. These are encouraging signs. As yet, there is only very modest progress to report on the improvement of social and environmental conditions of the inner cities. But the problem is recognized, and policies are being developed. Their application is nevertheless impeded at the moment because of prevailing high rates of unemployment, especially among the young.

Environmental health problems of rapidly growing cities in developing countries

144. The environmental health problems of the rapidly growing cities in developing countries can be explained in straightfoward terms. The urban industrial economy in most cities is not growing rapidly enough to provide employment for their populations, nor is enough wealth being created to provide for the water supply, sewerage, transportation, housing and other items of urban infrastructure that are needed. As more people move to the city, and as high birth rates continue within the city, there is a surge of population growth that cannot be adequately provided for with existing resources. In consequence, conditions deteriorate, and more and more people inhabit illegal squatter settlements, or live on the streets, eking out a bare livelihood from an informal street economy and resorting to begging, scavenging and petty crime.(97)

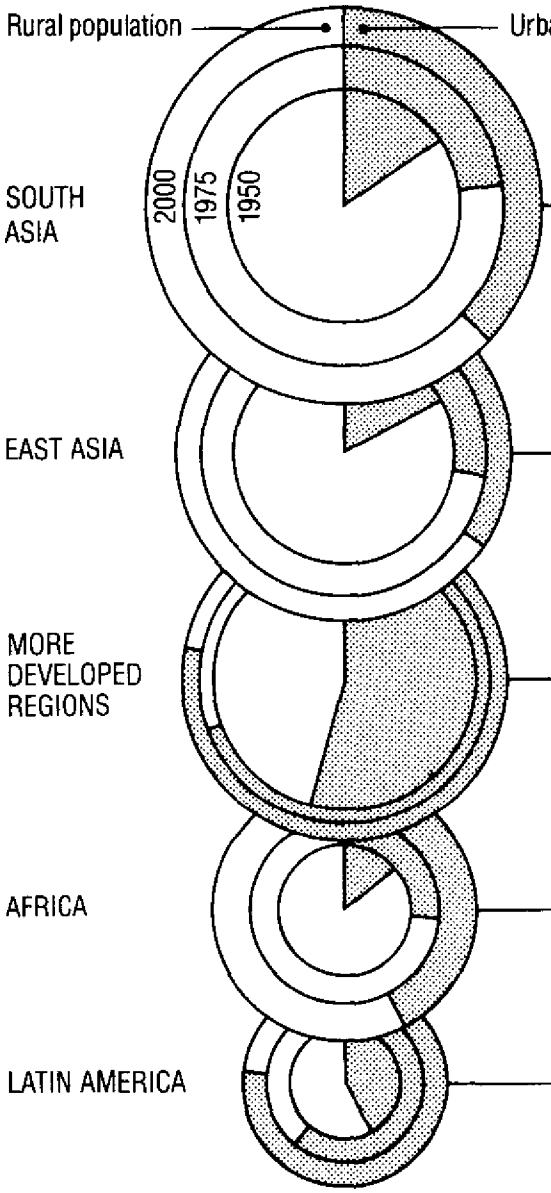
145. In these circumstances, health conditions are poor and, on the whole, deteriorating. Small islands of adequate housing and environmental and health standards remain in most cities, but the general urban scene is one in which a higher and higher proportion of the population are at risk from environmentally-related diseases and have little or no access to primary health care.

146. If conditions are so bad in the cities, why do people continue to flock to them? The answer lies in the condition of the agricultural hinterlands. Although conditions vary in different regions of the world, the poverty and desperation of the rural poor is often such that any prospect of improvement seems attractive. In the city, there are often opportunities, poor though they may be, which exceed anything that is available in the rural areas.(113) In addition, government policies are often seen to be directed in favour of the cities. Domestic agriculture investment is sometimes given lower priority in favour of industrialization, while, at the same time, subsidies are used to keep the prices of basic (often imported) foods (bread, rice) low for the urban population (Fig. XIII).(114)

147. At the same time, a lack of adequate revenues to pay for social services (education, health care) and the absence of a government-sponsored system of social security, encourages the persistence of "rural" attitudes and ways of life within the city, including the propensity to have a larger number of children, both to provide for a degree of social security in old age, and to ensure that enough of them will survive the high mortality years of infancy.

13 The urban magnet

Chart shows the pace of urbanization (and urban population growth) in Third World and more developed regions.



A Year	B Total urban population (in millions)	C % of regional population in urban areas
SOUTH ASIA		
1950	108	16%
1975	291	23%
2000	764	37%
EAST ASIA		
1950	112	17%
1975	298	27%
2000	503	34%
MORE DEVELOPED REGIONS		
1950	460	54%
1975	753	69%
2000	989	78%
AFRICA		
1950	30	14%
1975	105	26%
2000	370	42%
LATIN AMERICA		
1950	67	42%
1975	198	61%
2000	423	77%

Source: Harrison, P., Rowley, J., *Human numbers human needs*, IPPF 1984.

148. Despite these conditions, it remains true that standards of health and life expectation are generally better in the cities than in the rural areas, and fertility is lower. The comparison with rural areas is perhaps not the most valid one, because there are other "quality of life" factors that are far superior in rural areas, including less crowding and less exposure to the stresses of urban living.

149. A more useful comparison of the conditions in the cities might be made with the standards that need to be achieved if the cities are to play a leading role in the economic development of a country. A healthy, educated and skilled population with low birth and death rates is an important, probably essential, component of successful development. Unless and until the environmental conditions in cities can be improved, a pattern of vigorous and successful growth will be seriously impeded.(112) Attention is therefore being given (and more is needed) to five areas of the urban environment that stand in need of improved management if adequate standards of health, and thus development, are to be achieved.

Siting and layout

150. The topographical siting of cities and the location of buildings is important in determining the vulnerability of people and property to extreme events of nature. Floods, landslides and mudflows, earthquakes, volcanic eruptions and avalanches are an increasing source of physical property destruction and loss of life.

151. Indeed, natural disasters continue to claim a high number of victims each year throughout the world, mostly through physical injury (10,000 people killed in 1982, 5,000 in 1983 and 7,000 in 1984, and 9.6 million, 0.7 million, and 1.8 million respectively rendered homeless in the same years).(115) Both the number of disasters and the number of victims are highest in the poorest countries. The aftermath of a disaster is often accompanied by malnutrition and infectious diseases due to disruption of essential services (water and food supply, sanitation) and to the precarious conditions of crowding and exposure in which the survivors find themselves for varying periods of time. In addition, the economic costs of the disasters may be such as to have major effects on development. Thus, it has been estimated that the cost of repairing the damage of the 1976 earthquake in Guatemala would amount to one half of its GNP in reconstruction work alone(116). Effects of that magnitude cannot but have significant consequences on the provision of health and sanitation services and, as a result, on health itself.

152. By definition, natural disasters are beyond man's control. Yet it has been customary to list among them events which have a large man-made environmental component. Typical examples are those floods and landslides that would not have occurred if precipitation had not been allowed to run off slopes denuded by deforestation and overgrazing, sometimes far upstream. Earth-quakes, on the other hand, can seldom be attributed to human activities (the exceptions being the tremors that occur around large water impoundments). Yet the number of their victims could be significantly reduced by the systematic use of appropriate anti-seismic building techniques. If the considerable financial resources required were available, the additional construction costs that these techniques would involve could well be repaid in strictly monetary terms by limiting the destructiveness of the disaster. Tropical storms are another type of natural environmental disaster that exacts a heavy toll in human lives. Here also the use of appropriate construction techniques, the planning of the siting of human settlements in exposed areas and, even more important, the availability, reliability, timeliness and

acceptability of warning of the impending event would contribute in a major way to reducing their impact.

153. Increasing attention is now being focused on those problems (by, for example, UNDRO), and guidelines for planners and urban management are available. Unfortunately the rapid growth of cities, often in an unorganized fashion, has led to an increasing population living in hazard-prone areas. These are often — but not only — the poorer, lower-income, unorganized or squatter settlements which are forced out into the less safe urban development sites.

154. The location of densely crowded housing in close proximity to factories or power plants can also create health problems. This close proximity exposes people to routine or accidental releases of toxic substances, explosions and the dangers of radiation. A few dramatic events with high death tolls have recently highlighted this problem of environmental health. Probably more important in the long run are the longer-term exposures to routine emission of pollutants into the atmosphere and water bodies.

155. Another aspect of urban design is the congestion and layout of spontaneous unplanned settlements. Often drainage is impeded, creating breeding sites for mosquitoes and other carriers of disease. The narrowness of paths between dwellings and the inaccessibility for vehicles means that emergency and public service vehicles (fire, ambulance, police, street cleaning) are denied to residents and unsanitary conditions prevail. Accumulated domestic solid waste adds to fire risk and provides habitat for insects and disease vectors.

The building itself

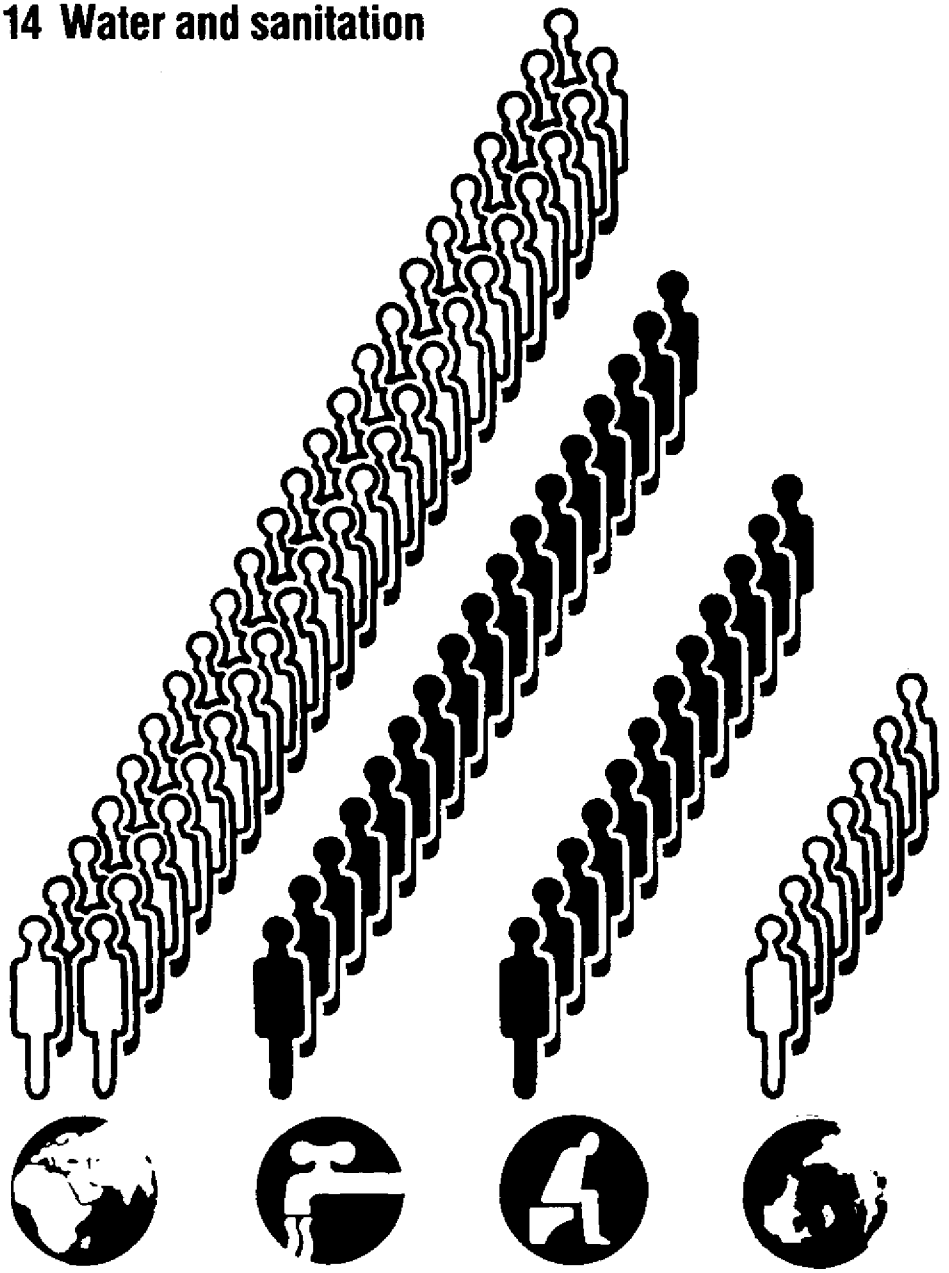
156. The quality of the design and construction of the walls, roofs, floors, windows and other apertures of human habitations all have implications for human health. An important consideration is the quality of indoor air. Where buildings are made weather-proof against external conditions of cold or wetness, indoor air pollution contributes to bronchial disease and other respiratory infections. These are likely to be greatly exacerbated in crowded living conditions, and where open stove heating and cooking facilities are used, or where the proximity to smokers exposes non-smokers, including small children, to passively inhaled tobacco smoke.

157. Poor quality of housing construction also enhances the vulnerability to natural hazards, and allows the penetration of noise and insect vectors. In the case of American human trypanosomiasis (Chagas' disease), the thatch and mud of traditional construction provides nesting sites for the insect vectors. There are an estimated 24,000,000 infected persons in the Americas.(117)

Sanitation and related facilities and services (Fig. XIV)

158. In most cities of developing countries, the supply of piped water to dwellings has not kept pace with population growth. Such supply depends on the availability to dwellings of appropriate systems of water disposal, which are all too often lacking. Whole settlements therefore have to rely on standpipes from which water must be collected and stored. It is in this process of storing that contamination may take place, but can be avoided through the use of appropriate vessels.(118, 119) Too many agglomerations still rely on excreta disposal systems (e.g. cesspits) that cannot meet the needs of densely populated areas.

14 Water and sanitation



Source: *The State of the Environment 1984*, UNEP 1984.

159. Lack of abundant water for washing and cleaning, and poor means of sanitation provide ample opportunity for infection and reinfection in the cycle of oral-faecal contamination. Incidence of diarrhoeal diseases is high in the unorganized and squatter settlements, and is frequently the largest single cause of death, especially among young infants and young children. One study showed that the incidence of diarrhoeal diseases was five times higher for settlements lacking piped water in the houses.(119)

160. New efforts at improving drinking water supplies are under way, spearheaded by the 1981-1990 International Drinking Water Supply and Sanitation Decade, and the mid-decade report indicates some slow and modest progress.(13)

Residential density

161. The character of expanding human settlements in developing countries as well as the "inner city" areas in mature industrial societies is such that people are often crowded together in high density buildings. There is no doubt that such high density is conducive to the spread of infectious diseases, including pulmonary tuberculosis and other bronchial diseases. It is also argued by some that associated lack of privacy may lead to stress, lack of sleep and irritability conducive to various forms of psycho-social pathology. This latter point is not universally agreed upon, however, and it has been shown that there is a high degree of cultural variation in tolerance to crowding and that where densities are highest, socially adaptive behaviours come into play.

Resettlements

162. Resettlements of populations from large areas have been an especially dramatic feature of the African drought and also of episodes of warfare and civil strife in a number of countries. On a smaller but nevertheless widespread scale, resettlements have also resulted, during the last few decades, from the development of land and water resources either to support the development of the resource by attracting a work force from elsewhere, or as a direct result of the project, as when populations have to be removed from areas to be flooded because of the construction of a dam.

163. Hastily or poorly planned resettlements inevitably have the same consequences as those described above in connection with squatter settlements around cities. Like them, resettlements seldom attract the attention of national authorities, which often do not recognize them officially. The planning of resettlements should be an integral part of development projects to ensure that adequate housing, water supply and sanitation facilities as well as public health services are provided, lest they become festering centres of ill-health, and eventually sources of serious diseases to the rest of the country's population.

The need for economic growth and wide allocation of financial resources

164. For the next few decades at least, the continued growth of population in most developing countries and the increasing concentration of population into larger cities and towns will require expanded investment in housing, urban infrastructure and health care services. The capacity of housing authorities and other governmental agencies to cope with urban development problems must be significantly expanded.

165. There are two essential conditions for a measure of public control to be regained over the chaotic and deteriorating situation in human settlements. These apply to the

cities in both developed and developing countries. The reasons, however, are quite different, and the scale of the need and acuteness of the problems are far greater in the developing countries.

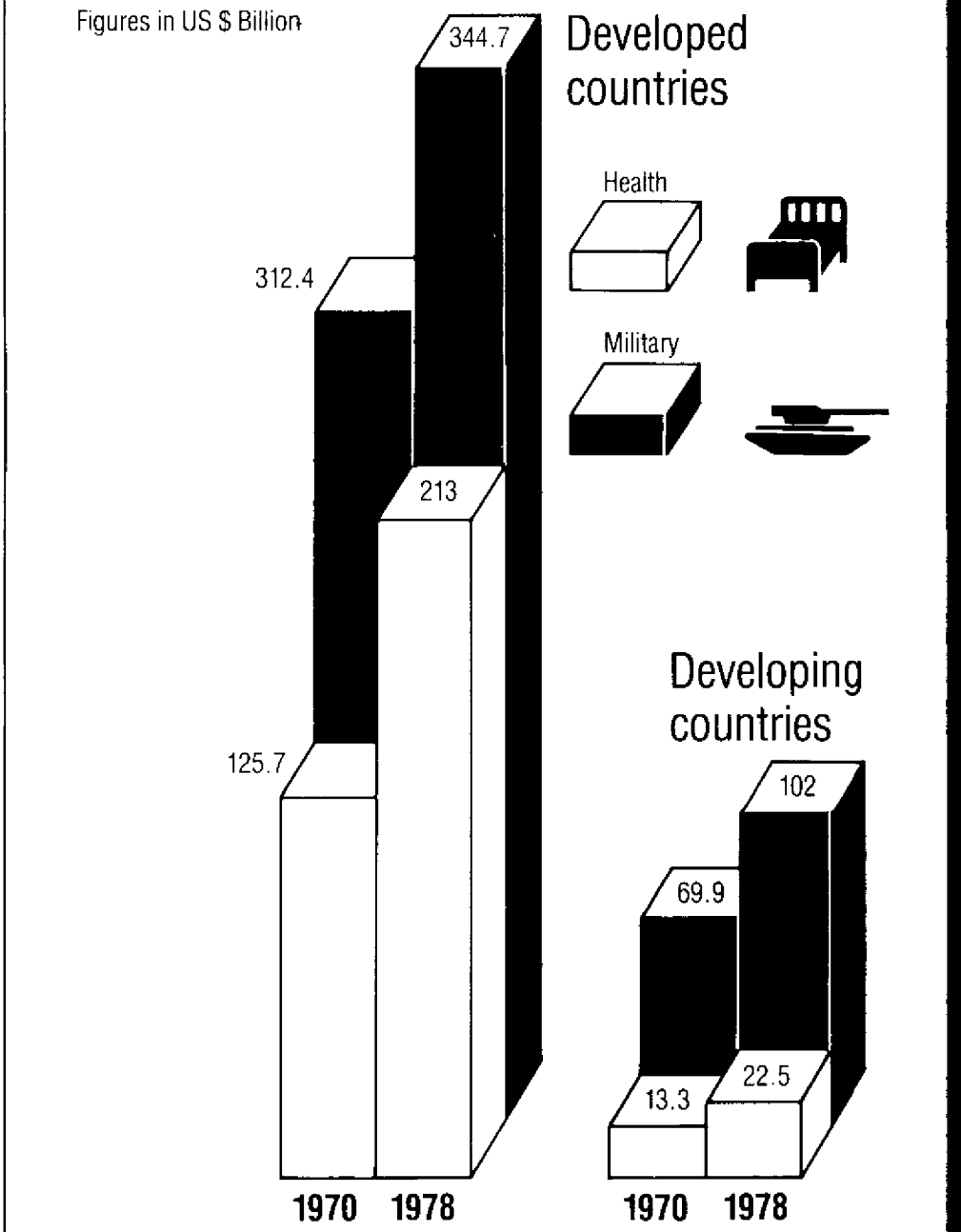
166. The first requirement is economic growth and development to create the necessary wealth, both at the individual or family level (for people to spend on improving their own environments) and at the public or governmental level (to support public housing and infrastructure projects). Unfortunately, the world-wide recession between 1980 and 1983 has severely limited the availability of funds, while the magnitude of the problem has continued to grow. The economic recovery since 1984 has not been strong enough to make the dramatic difference that is needed in the economic fortunes of most developing countries. At the same time, the growing burden of international debt has forced austerity measures in many countries and severely reduced the capacity to spend money upon desperately needed housing and urban infrastructure. In 1985 and 1986, it has to be said that the problem of housing and human settlements, especially in the developing countries, is growing at a faster pace than the ability of authority to cope.(97)

167. More and more people are being forced into a self-reliant, do-it-yourself pattern in which human settlements "spontaneously" spring up and expand without benefit of public help or expert advice. While the enterprise and initiative of the people involved is laudable and impressive for its display of ingenuity, the human settlements being created contribute to the net deterioration of health and environment in many places and are creating enormous problems for the future.

168. Given the scarcity of local, national and international financial resources, it has become especially incumbent upon responsible authorities to allocate funds widely and effectively. Unfortunately, large allocations to military purposes continue and show no signs of abatement (Fig. XV). These are often highest among countries with the most severe problems and the least resources. This association may not be entirely accidental. When living conditions become increasingly intolerable, it is to be expected that problems of internal and external security will grow.

169. The current economic recovery of the developing countries, encouraged by the fall in oil prices and a slight decline in interest rates, offers an unusual opportunity to consolidate the gains made so far in dealing with environment-related hazards. It may enable a number of developing countries currently suffering from massive indebtedness and slow development to stop mining their natural resource capital and to take a fresh look at the nature and direction of the development effort so as to avoid adverse environmental consequences and their resulting health impacts.

15 Expenditure on arms and health



Source: Holdgate, M. W., Kassas, M., White, G. F., *The World Environment, 1972–82, a report by the United Nations Environment Programme*, Tycooly International, 1982.

Chapter III

DEVELOPMENT, ENVIRONMENT AND HEALTH

The development economics of environmental protection and enhancement

1. Earlier sections have described in some detail the nature and extent of the social damage that is incurred through man's activities in pursuit of development or through the over-use or misuse of natural resources caused by the urgent necessity to meet basic human needs (i.e. lack of development). It has also been noted that the environmental degradation thus caused leads to impairment of health, and that correlations can be established with morbidity and mortality rates. Evidence has been presented that changes induced in the environment are a major reason for the spread of a number of serious diseases and their increased incidence in some places.

2. This section will attempt to examine the complex interactions between development, environment and health in terms of the decisions that have to be made about the degree of environmental health protection that is to be provided. The basic premise is that development or its lack can have negative effects on the environment in ways that may lead to detrimental impacts on human health and welfare. This report is, however, not concerned with the economics of health as such but rather with the economics of protecting and improving the environment so as to avoid adverse health impacts.

3. In each of the three pathways that link environment to health (adverse effects of development, lack of development, and natural hazards and accidents), decisions are required about how much expenditure of public funds can be justified to reduce environmental health impacts.

4. One way to look at the problem would be to regard public health expenditures as a priority item on the agenda of national policy, and to allocate the funds required for the purpose accordingly. Public health expenditures, i.e. the damage control costs, could thus be placed on the same footing as military expenditures related to higher national purposes and not susceptible to justification on purely economic grounds. For example, access to a supply of safe drinking water and the provision of a nutritionally adequate diet could be defined as a "human right" rather than as a "public good".

5. Such a policy determination may, indeed, induce positive changes in attitudes to the environment, which may be seen as contributing to the sustained health of the population, instead of representing a constant danger. A change in outlook of this kind may help in the creation of a more self-confident and far-sighted population.

6. On humanitarian grounds, it is difficult to deny that every human being possesses, or should possess, a basic human right to have access to enough safe drinking water. Beyond such basic needs, however, the quality, quantity and accessibility of the supply are subject to almost infinite variation, ranging from a public standpipe in the city street

or village centre, to multiple taps in the house and many water-using machines and facilities. It is in the choice of the appropriate level of service and the degree of environmental protection and enhancement that economic analysis is necessary as a guide to sound judgement.

7. In such an analysis, it is not only necessary to establish the magnitude and parameters of the damage cost to society but the rationale for incurring the necessary damage control costs, i.e. the cost of avoidance of detrimental impacts on health or of remedial measures. The present situation is one where damage control costs are often perceived by decision makers to be too high to justify investment in programmes that could reduce transmission through environmental disease carriers. Many investments undertaken in the name of economic development actually serve to spread environmental diseases.

8. In the experienced judgement of many environmental and health professionals, public expenditures on damage control or limitation are far too low. Such assertions have the character of special pleading and, beyond the question of basic human rights, are not fundamentally different from the demands of the generals for more military hardware. It is not sufficient to assert therefore that the failure to attack seriously the major tropical parasitic diseases results from a neglect or underevaluation of their importance. Value-judgements can and should be supported by proper estimates of impact and the costs involved in damage reduction.

9. Proper analysis of costs and benefits is also required to achieve a greater degree of social equity. It is well recognized that in some circumstances those most at risk from low quality environments include the politically less powerful and disadvantaged members of a society. It is often asserted that those at greatest risk are people living without access to safe water supplies, satisfactory waste disposal and adequate housing. Economic analyses are needed not only to demonstrate this assertion but to assist in the judgemental decision-making about how much improvement can be made and by what sequence of incremental steps.

10. The inability to fully appreciate environmentally-related diseases is due to various reasons. One is a failure to define rigorously the notion of the disease (absence of mortality or of acute symptoms may be equated with health). Most of these diseases are usually chronic rather than acute, and thus produce organic changes and affect physical functions slowly and cumulatively. On the other hand, malaria produces acute fevers of short duration and may have little cumulative effect.

11. During the 1980s, there has been further progress in recognizing the importance of integrating, at the management level, programmes in development with those in health and environment. Development plans now routinely refer to the need to safeguard the long-term productivity of the environment, and recognize that a healthy population is essential for development. From recognition of the need for closer integration to an actual realization of it in practice, the road is proving to be long and poorly signposted.

12. Various activities and programmes have therefore been launched to help bring about health and environmental benefits in development projects and, conversely, to safeguard against damage to health and environment due to the side effects of development activities. These activities have reinforced the need for precise specifications of the relationship between environment, health and development. There is an important distinction in this connexion between the correction of adverse health

impacts after development activities have taken place, and the prevention of adverse health impacts by prior planning. It has become painfully evident in development experience that the costs of correcting adverse health impacts after the fact are normally much higher than the costs of taking proper precautions and preventive measures at the planning and implementation stages.

Operational methods of analysis

13. Economic growth is certainly needed if financial resources are to be generated to meet objectives in health status and environmental quality. Whatever the size of the national resources, it is axiomatic that they will always be scarce in relation to competing needs. A key issue is thus the question of resource allocation. What share of the national resources should be allocated to health and environment? This question applies at the national planning or macroeconomic level. At the project or programme level, a related question is how health and environmental benefits may be maximized and costs minimized within an overall project evaluation framework.

14. It is unlikely, however, that in the near future such a policy determination would either be firmly made or even envisaged. Budgetary resources are by definition scarce and the opportunity cost of their alternative uses (e.g. infrastructure, defence, food and agriculture, education, industrial development, etc.) must be evaluated and assessed by policy makers in terms of future economic growth, employment, balance of payments, inflationary pressures, productivity, and so forth.

15. What is needed is to define, assess and identify the damage costs to society, which the earlier sections have described, and to compare them with different levels of damage control costs (i.e., expenditures on the amelioration of environmental concerns that impair health) so as to arrive at an estimate of net benefits to society. In this way, policy decisions can be taken objectively and the implementation of environmental/health policies can be harmonized with economic policy goals.

16. Cost-benefit analysis cannot be regarded in isolation or as a unique methodology. It is one of a whole range of analytical tools that should be used to obtain effective results. It is necessary, for instance, to begin with the preparation of an adequate environmental impact assessment statement that will specify the effects and consequences of alternatives to establish the lowest implementation cost. Cost-effectiveness analyses are always necessary, despite the most detailed cost-benefit study, since they are important for ensuring that the benefits are produced in the most cost-effective manner possible.

17. It is necessary to emphasize that these techniques will be useful tools only if the concepts behind them, the data requirements, and their strengths and weaknesses are carefully weighed and assessed in terms of the valuation problems they are expected to solve.

Application of operational methods of analysis to health impacts of enviromental changes

18. In so far as environment-related health hazards are concerned, the specification problem has been largely overcome. As the material outlined in this report indicates, considerable data have been collected and the causal relationships between

interventions in nature, of whatever sort, and their impact on the environment leading to detrimental health effects have been established. Greater precision in the available data and a more clearly defined estimation of the physical functional relationships between environmental degradation, contamination and adverse health effects, on a sector by sector basis, would be helpful but it is possible to make do with what is available at the present.

19. In contrast, the economic valuation of health hazards caused by environmental degradation has not advanced very far because of a lack of analytical tools and statistical measurements for such estimates.

20. For instance, the benefits of disease control are often assessed on the basis of an estimate of the number of lives saved. Thus, estimates of the number of lives saved in malaria control projects have been provided.(120, 121) Clearly, such a measure does not capture much of the benefit from improved health among people who live longer, and therefore other measures are also employed, such as the decrease in the number of sick days, the increase in the number of persons protected against a specific disease, the decrease in absenteeism from work and in health insurance contributions, and the reduction in the number of cases (or the prevalence rate) of a disease.

21. The mitigation procedures to be used depend in part upon the nature of the disease and the likely or known impacts of the control measures.(117) It has become the convention to distinguish between direct and indirect benefits.(122) Direct benefits include, principally, the reduction in cost of medical care services used to treat the disease or health problem as a result of lower incidence or prevalence of a disease. Indirect benefits include principally the increase in economic output, resulting from: (a) the net productivity of people who work but who would otherwise have died, and (b) the increased net productivity of people who lived but who would have been partially to totally incapacitated by disease.

22. In the eleven empirical studies cited by Dunlop,(122) emphasis is on the estimation of these direct and indirect benefits. There is potentially a much wider range of benefits which, in spite of the new techniques that have become available, continue to be difficult to capture or estimate in monetary terms. These include what are referred to as the "public good" benefits which accrue to all members of a society when a disease is eradicated or reduced. The positive changes in attitudes to environment and to human capital are by no means the only benefits to be derived from environmental health improvements. In addition to those public-good benefits — potentially shared by the whole population — there will be other benefits more restricted to those affected by disease. First, the process of living and enjoying one's place of residence, and the normal activities of daily life is a "consumption benefit", which presumably is greatly enhanced without the afflictions of disease. Second, the lives of others who have been spared from the contraction of the disease, have also benefitted. Other family members and friends are not required to engage in physical or psychological care, and their own consumption is enhanced along with that of the no longer sick. Third, family members may no longer be required to assume the tasks of those ill. There is evidence that, especially in farming communities, the farm labour is undertaken by other family members when someone becomes ill.

23. In what other ways do improvements occur for society as a whole when disease is reduced? Several possibilities may be suggested which have traditionally not been included in empirical studies of health benefits. There may be reduced costs of disease

control, e.g. spraying or other methods of vector control, together with reduced costs of consumption of prophylactic medicines. Control of disease vectors may allow increased migration and settlement in areas previously inhospitable. Other associated environmental improvements may include increased use of water resources, for example, for recreational use where schistosomiasis has been eradicated.

24. Whatever further refinement is developed to deal with the residual specification and evaluation difficulties of measuring environment-related health hazards, it is abundantly clear from the data already available and the causal relationships established that the damage costs are exceptionally high and growing. This becomes patent if we select at random a number of health hazards, for example, schistosomiasis, malaria, river blindness, chemicals and radioactive pollutants, and examine the damage costs involved.

25. One way to look at the total cost for environmental/health concerns that a community or a country may be called upon to bear is to consider that cost in terms of risk management.

26. The environment-related health consequences of interventions in nature are complex, interrelated and not fully known. What is clear from the preceding sections, however, is that most of the impacts have an inherently high risk component. Secondly, that some of the impacts are irreversible (and thus of maximum risk potential) and many are synergistic (very high risk potential). The damage costs identified earlier in the report are, thus, of very high risk content and need careful and considered management.

27. The bottom line for the interaction between development, environment and health, whether we consider chemicals or management of wastes or fuel uses or irrigation or agro-chemicals, is risk management. The risks arising from the impact of development activities (or lack of them) on environment and, through the environment, on human health are very high, and proper risk management must make provision for this.

The interrelationships

28. Certain conclusions follow from this brief consideration of the economic rationale for an adequate level of damage control costs in both developed and developing countries:

- Some poorly planned development activities are a source of environmental deterioration which in turn leads to health problems in both developed and developing countries. There appears a cycle of interrelated causes. In pursuing development, governments do not consider it necessary or worthwhile to attack the causes of health problems (i.e. environmental degradation) because they consider such problems to be of low priority. This prevents the pursuit of a proper development process which in turn produces negative health impacts.

- Under-development leads to a similar cycle. Developing countries do not consider it economical, in the light of their financial difficulties, to deal adequately with such problems as water supplies and sanitation, which in turn lowers the net benefits of their development effort and further depresses their financial viability.

- In the present situation, developed and developing countries alike are prevented from maintaining an adequate level of damage control costs to deal with the cycles noted above because of a number of interrelated reasons:

(a) For developed countries:

- Economic recession;

- Greater interest in creating employment as such, without realizing that efforts at ameliorating environmental concerns also create jobs.

(b) For developing countries:

- Poverty and the need to meet basic human needs remains a strong inducement to continue with development efforts often regardless of their negative impact on the environment;

- The need to service the present debt burden also remains a major incentive to degrade the natural resource base and aggravate environment-related health problems.

29. In these circumstances, the effective application of cost benefit and risk assessment analyses on a case by case basis could influence decision- makers in all countries to integrate environmental concerns in the development process from an early or conceptual stage.

Chapter IV

SUMMARY

1. The preceding chapters have tried to give a selective review of the human health costs of certain productive activities affecting the environment and to suggest how all could be mitigated by adequate protective, preventive or remedial action. It must have become clear, however, that the estimates of these particular costs of the interactions between environment and man are based on very inadequate information, since reliable vital and health statistics are simply not available from most developing countries. Yet it is precisely those statistics that are needed to obtain not only a meaningful picture of the health state of a country in relation to the environment and to compare it with that of other countries, but also to monitor its progress.

2. From the information we have, and which seldom provides more than order-of-magnitude figures, we can readily form an idea of the cost of environmental neglect in terms of human suffering.

3. Natural disasters continue to claim an increasing number of victims, their number having grown many times between the 1960s and today (although part of the increase may be spurious and due to better reporting) when the number of fatalities, though fluctuating greatly from year to year, averages in the thousands, with a heavy concentration in the most crowded and lowest-income countries.

4. With 4.6 million children under 5 years of age dying each year of diarrhoea and almost as many of respiratory diseases, with 100 million acute cases of malaria and 2 million deaths, with 200 million cases of schistosomiasis, and with cases of onchocerciasis and the various trypanosomiases in numbers unknown but running in the millions, the toll of the environment on human health in developing countries is clearly extremely high and would be higher still if one could add to it the burden of the host of other communicable diseases linked to the environment that afflict the people of the tropical and sub-tropical areas.

5. Malnutrition, undernutrition and outright starvation, due partly to poor land management, partly to meteorological circumstances and partly to food distribution problems, all in concomitance with a rapid population increase, have exacted a highly fluctuating and poorly estimated price in human lives, but have also left a legacy of qualitatively and quantitatively inadequate food supply that will require years to rectify, if one is not to rely forever on aid from the outside. In addition, chronic malnutrition of children and their mothers alike portends in some areas the rising of a generation with a high incidence of physically or mentally handicapped people.

6. In both developed and developing countries, operational releases of pollutants to the environment have created, and continue to create, major problems for their control. However, their visible health cost appears much less than that of communicable diseases in warm countries. The major cases involving fatalities have been episodic, due to a concurrence of causes, and resulted in over-all mortality figures four orders of magnitude lower than the annual numbers of deaths from some tropical communicable diseases.

7. It is far more difficult to assess the burden of long-term exposure to pollutants released operationally to the environment. Effects are little known and often non-specific. These very uncertainties have created, particularly in developed countries, an acute concern lest exposure to certain pollutants might in the long term result in carcinogenic, teratogenic or genetic effects. A similar concern is now emerging in developing countries particularly, but not only, in connection with pesticides and the possibility that their levels might be rising in food as a consequence of their widespread use in agriculture. Such data as are available on pesticide residues in food are far from alarming but concern almost only commodities and diets consumed in developed countries.

8. At least in developed countries, the working environment has in general become safer in the last decade, after a period when a large but unassessable number of workers became the victims of situations whose inherent hazards, particularly with regard to exposure to chemicals, had not been suspected or had been overlooked. Safer industrial processes in new plants, close monitoring of the factory environment, and tighter training and supervision of the work-force have reduced the number of personal accidents inside the plants. In the chemical industry in particular, the wearing of protective personal equipment has reduced the exposure to toxic chemicals. In addition, extensive toxicity testing programmes undertaken nationally, and often under the aegis and at the expenses of industry itself, have made possible a prior identification of chemicals hazardous to man.

9. Large-scale industrial accidents involving both workers and the population will remain a possibility in both developed and developing countries, but the lessons of the recent accidents in chemical plants have shown that all of them were due, sometimes with the concurrence of circumstances beyond man's control, to lack of foresight, or to ignorance or to negligence, or to a combination of all three. They were therefore man-made, and their likelihood should decrease in the future, if, to the extent that man is a rational animal, he is prepared individually and collectively to learn the lessons of the past and not to let the notion of his own and his fellow man's health and welfare be blurred by obtuseness, greed and sloth.

10. It is too early to determine the circumstances and to assess the consequences of the nuclear accident that took place at the end of April in the Ukrainian SSR, but it already can be asserted that the catastrophe has rendered evident the need for:

(a) Rapid international exchange of information on the intensity and geographical distribution of environmental contamination when releases of radioactive material may or do spread to countries other than those from which the material originates;

(b) An international system to warn about radio-active leaks above an agreed magnitude, and about any malfunction in a nuclear facility that may lead to such a leak;

(c) Uniform, internationally agreed, standards of safety in the operation of nuclear plants;

(d) Provision on request of international assistance in taking preventive measures to avoid or reduce exposure, or curative ones to treat the people already exposed to radiation;

(e) A frank discussion of liability and compensation, particularly in cases of leaks with transboundary impacts.

11. Even allowing for the toll claimed by major industrial accidents, the foregoing clearly shows the preponderant weight of human sufferings from environmentally linked communicable diseases to which the developing world is subjected, compared to that currently afflicting the world as a whole because of pollution from chemical or physical agents. One is therefore entitled to ask why, though the problems of the developing world are far from neglected, so much attention is given at international level to non-biological pollution problems. There are a number of arguments justifying this.

12. Pollution affects the world as a whole. Some of the major pollutants know no frontier, whether they are transported through the environment or conveyed by commodities traded internationally. No one is protected from pollutants, whatever their effects on health may be. Developing countries are no exception. By contrast, communicable diseases resulting from strictly environmental circumstances tend to remain confined to the sometimes large but always limited areas where those circumstances prevail, and they can be corrected locally.

13. Oversimplifying, we may say that if area A were to be rid of malaria, and the eradication were to be followed up adequately by appropriate environmental and health measures, the disease would not recur, except for imported cases as now happens in Southern Europe where, until soon after the Second World War, whole areas were infested by malaria. If city B were to be provided with adequate water supply and sanitation services, a major reduction in diarrhoeal diseases would be expected, even if the same measures were not taken in a neighbouring town. By contrast, if area C decided on a drastic reduction of sulphur emissions, its population could still be exposed to high levels of sulphur oxides, as long as similar action had not been taken in neighbouring countries and even in far away areas.

14. An additional reason for the interest in environmental pollution is that its effects are not confined to human health but may affect resources — these being in many cases the primary reason for concern. In summary, there are enough reasons for international efforts to be devoted to the monitoring, assessment and control of environmental pollutants affecting human health, even if at present, in terms of sheer numbers of victims, their importance does not compare with that of environmentally linked communicable diseases or natural disasters.

Chapter V

RECOMMENDATIONS FOR ACTION

General

1. The following recommendations for action are based on the foregoing discussion and take into consideration the results of the WHO technical discussions on health and environment held during its thirty-ninth World Assembly (7-9 May 1986).

2. Decisions on environmental action for whatever purpose involve strong interactions with a number of other authorities or sectors. In addition to industry, agriculture, public works and settlements, even actions in fields of conservation of genetic resources, preservation of the landscape, protection of the cultural heritage have sometimes adverse health consequences that will require difficult trade-offs between competing demands. By way of example, the conservation of wetlands and their resources may, in certain areas, conflict with the control of malaria, or the preservation of historical human settlements may impede the improvement of their sanitary conditions.

3. These interactions cannot be improvized. Hence a strong machinery, formal and flexible, must be established at government level to sustain systematically a continued dialogue among all concerned. The same applies at the international level, where the advisory and funding activities of agencies and institutions, including national aid institutions, must be conducted with the knowledge and counsel of those who have experience with the wide ramifications that modifying the environment may have, and must be conducted in close consultations with the local machinery referred to above.

4. It is recommended that major efforts be devoted to encouraging the systematic collection (if necessary on a rational sampling basis) of morbidity and mortality statistics by age, sex, cause and geographical location in countries where such information is not yet available. This will require the strengthening and sometimes the establishment of close working links between departments of demographic and health statistics (often belonging to different ministries), and the continued advice of environment authorities. All these bodies — and the planning authorities with them — must then establish joint machinery for analysing the data so as to extract from them the message they contain in a form meaningful to decision makers, and so make possible the allocation of resources and trained manpower that the situation demands.

5. Until such systematic data become available, decisions will have to be based solely on partial but well-planned and frequently costly and time-consuming surveys tailored to the decisions to be made on the siting and servicing of urban and rural settlements, the adoption of agricultural practices and the development of new industries. Experience shows that in too many cases, while surveys are made before taking decisions, they are ill-planned, incomplete, hurried and provide little more than frequently misleading hunches leading to less than successful, and sometimes catastrophic, consequences. This, incidentally, is not the privilege of developing countries alone.

6. Projects and policies for development and management of natural resources should be subjected to systematic appraisal. These initiatives should be organized to create a

sustained 'watch' on the environment-health linkage both to appraise new initiatives to improve health and environment and to monitor health and environment impacts of programmes and projects with potentially high health and environmental risks. Methodologies and mechanisms for the integrated assessment, prediction and monitoring of the impact of economic development activities on health and the environment should be developed and used as important levers to minimize damaging effects, as well as to assist in raising health, environment and social well-being in the order of priorities for allocation of government budgets.

7. UNEP, WHO, Habitat and other relevant United Nations organizations should co-operate to develop simple, easy-to-apply cost benefit and cost effectiveness methodologies to evaluate the positive role of health and environmental protection in strategies, policies and programmes to promote growth in productivity and production and to test them in a limited number of countries that are prepared and willing.

8. Emphasis should be given to identifying the needs of the most disadvantaged groups and to formulating strategies aimed at eliminating or reducing their most important health and environmental risks. Voluntary non-governmental organizations should be involved in meeting these needs because of their skills and experience in working at the interface between government and communities and their areas of involvement which often transcend many sectors.

9. Priority should be given to integrated rural development programmes which can combine employment creation, increased economic growth, establishment of infrastructure and improved living conditions as successful approaches to intersectoral action for the betterment of environmental and health conditions.

10. Appropriate — implementable — legislation should be established or consolidated to ensure that it may be used as effectively as possible as an important tool for improving health and human environment.

11. Priority should be given to training of national technical staff in ways that will help them to better understand the intersectoral nature of health and the environment.

12. Communicable diseases must be basically fought by national authorities, and where necessary, in co-operation with neighbouring countries. International advice on the ways to do so, and funding to make this possible, are a must. Internationally concerted action, with regard to a number of tropical diseases, is essential in the fields of research and training as is being done currently by the UNDP/IBRD/WHO Special Programme for Research and Training in Tropical Diseases. With regard to most pollutants, international programmes must be continued in order to be able to assess, in a uniform way, sources, pathways, levels and effects and to arrive at a common understanding that can lead to joint action. Such action has, indeed, already gone so far as to develop international global and regional conventions for the protection of the environment against various forms of pollution.

Specific

13. The more detailed recommendations that follow are limited in number and also based directly or indirectly on the earlier review. They have been selected because of their urgency, their relative importance or their past neglect.

Food production

14. *At the national level:*

(a) Experience has shown that, with the newly acquired means to protect cattle from diseases that regularly culled the stock in the past, the number of cattle allowed to graze on fragile grassland should not be planned on the potential of the land in years of good rainfall but maintained within limits that can be sustained during dry years. In many areas, this will create strong cultural resistance, to be overcome by the adoption of new assessment and decision procedures, if the traditional ones prove to be ineffective;

(b) The management of water resources to improve soil productivity requires authorities down to the community level to be fully aware of the consequences that water distribution may have on the health of the people that may not even benefit themselves directly from the increased yields. While such considerations, if not always followed, are now commonplace in the construction of major schemes, they are usually ignored at community level, where clear guidelines, education and firm guidance, so far virtually absent, would, once systematically introduced, reduce substantially the prevalence of some major scourges;

(c) Guidelines on the safe use of pesticides as part of integrated past management, are already available. The newly approved FAO Code of Conduct will further assist in the appropriate and safe use of pesticides. What is lacking is education and training at community level and awareness, particularly among field workers, of the risks that could be avoided. Efforts should be made to ensure that, if, in hot climates, the wearing of personal protective equipment is an intolerable burden on the worker, the use of pesticides that require such equipment be avoided, or suitable shifts be systematically introduced in order to reduce the time of exposure of the individuals;

(d) Again, guidelines on the safe storage of grain in humid conditions have been developed. But too many villages are still not familiar with them. They should be educated to avoid the development of aflatoxins in their produce, thus reducing the incidence of acute poisoning and of liver cancer.

(e) Information on the levels of pesticide residues in foods and human milk in developing countries is extremely scanty. Efforts must therefore be devoted to widening the coverage by appropriate training of technicians so as to provide the data that might make it possible to better control the exposure of man, and especially sucklings, to those substances.

15. *At the international level:*

International organizations and financial and aid agencies should support government efforts in the above areas.

Energy production

16. *At the national level:*

(a) The goal of cheap energy available at community level and of its efficient use should be pursued both to reduce the claim on vegetation with its long-term effects on land productivity and eventually on food availability, and to redirect the energies of the fuel gatherers, usually women, to more productive activities and the care of the family;

(b) Through internationally co-ordinated studies, measurement levels of indoor pollution in both hot and cool countries should be made, in order to assess the exposure of people to fumes and gases and their noxious effects, with the ultimate aim of producing the now lacking guidelines for the control of their sources and levels;

(c) Outdoor levels of some pollutants are known in a number of cities. In too many of them levels are still too high and in most they have never been measured. Efforts should be made to assess those levels and so enable those cities to be provided with a firm factual basis for any corrective action that they may require by controlling industry (including power plants), household or vehicular emissions.

17. *At the international level:*

(a) Through internationally co-ordinated studies, measurement levels of indoor pollution in both hot and cool countries should be made, in order to assess the exposure of people to fumes and gases and their noxious effects, with the ultimate aim of producing the now lacking guidelines for the control of their sources and levels;

(b) International organizations and financial and aid agencies should support government efforts in the above areas.

Production of chemicals

18. *At national and international levels:*

(a) Chemicals are produced and used in increasing numbers and amounts. While many are toxic, relatively few of those released to the environment have yet given rise to major health problems. The assessment of their health effects, and the control of their production, formulation, distribution and use, however, must be strengthened through international agreements and understandings to ensure that their inherent hazards are fully known;

(b) Limits to the exposure of workers, usually developed in temperate countries, and the regulations adopted to observe them, must be reviewed to ensure their applicability in hot countries, well before industries have expanded there, only to discover that costly or prohibitive changes in procedures and equipment are required to protect workers operating in a different environment;

(c) The management of hazardous wastes, not only those from the chemical industry, should aim at reducing their amount, bulk and harmfulness. For such wastes as remain undisposed on-site, increased control through national and international legislation should be achieved concerning their transport, particularly across borders, and ultimate disposal, especially at sea;

(d) The chemical industry has been the cause of rare but sometimes catastrophic accidents. Guidelines on their prevention, as well as the prevention of other industrial accidents, have been fragmentary. There is an urgent need for consolidation of these guidelines into a single set that could provide a framework for the safe design and operation of hazardous industrial installations, with special emphasis on the problems of developing countries;

(e) Non-polluting, non- and low-waste technologies, safe and non-hazardous methods and materials, should be developed and used as an essential means of sustainable use of natural resources.

Provision of shelter, housing and home services

19. *At the national level:*

(a) One of the essential keys to the improvement of the urban environment, and therefore of the urban populations' health, is the provision of safe drinking water and of sanitation facilities. Access to these should be regarded as a basic human right and, in that light, lead to a re-examination by governments of the resources nationally allocated to such a provision. Three elements should be given special attention:

(i) The socio-cultural factors related to the use and maintenance of water and sanitation services;

(ii) The provision of services to groups most vulnerable to health risks among the rural and urban poor;

(iii) The development and application of appropriate cost-effective technologies and systems to manage these services which maximize local control and local resource use and promote equitable access to these services.

(b) Re-allocation of resources will not solve the problem of adequate safe water supply and sanitation in those countries that are inherently short of water, where traditional methods of water adduction to households and of excreta disposal developed in water-rich countries are not applicable. Innovative techniques, including the safe storage of water in households, will need to be devised, or systematically applied when they are already available, in order to satisfy people's need for safe water and sanitation;

(c) Problems of agricultural and urban land availability often lead to the expansion of human habitation into areas subject to flood, sand or mud slides, tropical cyclones and other extreme events, including industrial accidents. Increased attention needs therefore to be paid to the interactions between settlements and hazardous areas. This might involve the development of guidelines for hazard zone assessment, their effective introduction into the planning process, and a continued surveillance of those areas identified as hazardous, to ensure that clandestine settlements are not developing there without the knowledge of the local authorities, and the provision of suitable alternative sites;

(d) Existing codes and regulations of the built environment should be reviewed in order to see how their emphasis can be changed for the purpose of giving advice, support and technical assistance to lower income groups managing the construction of their own houses, and to ensure that basic health and safety standards are met. Resources, such as land, building materials and cheap and easily available credit, should be secured for such housing.

20. *At the international level:*

International organizations and financial aid agencies should support government efforts in the above areas.

Table 1: Established Occupational Causes of Cancer

Agent	Site of cancer	Occupation
Aromatic amines (4-aminodiphenyl, benzidine, 2-naphthylamine)	Bladder	Dye manufacturers, rubber workers, coal gas manufacturers
Arsenic	Skin, lung	Copper and cobalt smelters, arsenical pesticide manufacturers, some gold miners
Asbestos	Lung, pleura, peritoneum (also probably stomach, large bowel, esophagus)	Asbestos miners, asbestos textile manufacturers, asbestos insulation
Benzene	Marrow, especially erythroleukemia	Workers with glues and varnishes
Bischloromethyl ether	Lung	Makers of ion-exchange resins
Cadmium	Prostate	Cadmium workers
Chromium ore,	Lung	Manufacturers of chromates from chrome pigment manufacturers
Ionizing radiations	Lung	Uranium and some other miners
	Bone	Luminzers
	Marrow, all sites	Radiologists, radiographers
Isopropyl oil	Nasal sinuses	Isopropyl alcohol manufacturers
Mustard gas	Larynx, lung	Poison gas manufacturers
Nickel	Nasal sinuses, lung	Nickel refiners
Polycyclic hydrocarbons in soot, tar, oil	Skin, scrotum, lung	Coal gas manufacturers, roofers, asphalters, aluminium refiners, many groups selectively exposed to certain tars and oils
UV light	Skin	Farmers, seamen
Vinyl chloride	Liver (angiosarcoma)	PVC manufacturers
Unknown	Nasal sinuses	Hardwood furniture manufacturers
Unknown	Nasal sinuses	Leather workers

Source: Simplified from R. Doll and R. Peto, "The causes of cancer: Quantitative estimates of avoidable risks of cancer in the United States today", *Journal of the National Cancer Institute*, 66: 1193-1308, 1981.

Table 2: Admission diagnoses and causes of death in a typical month (1984) at the hospital of a relief camp

	Admission diagnoses	Deaths
Diarrhoea	115	72
Relapsing fever	98	—
Malnutrition	61	56
Respiratory infections	41	19
Neurological infections	11	1
Fevers (P.U.O)	13	12
Hepatitis	4	3
Others	6	4
Total	349	167

Source: WHO. "Health conditions in the Ethiopian Drought emergency; report of the WHO technical team, (WHO/ERO/ETH/85.1), Geneva, 1985.

Table 3: Examples of increased prevalence of schistosomiasis resulting from water resource development projects

Country	Project (Year completed)	Preproject prevalence (%)	Postproject prevalence (%)	Schistosome species
Egypt	Aswan Dam (first) (1906)	6	60 (3 yrs later)	*S. haematobium*, *S. mansoni*
Sudan	Gezira scheme (1925)	0	30-60 (15 yrs later)	*S. haematobium*, *S. mansoni*
Tanzania	Arusha Chini (1937)	Low	53-86 (30 yrs later)	*S. mansoni*
Zambia and Rhodesia	Lake Kariba (1958)	0	16-adults, and 69-children (10 yrs later)	*S. haematobium*, *S. mansoni*
Ghana	Volta Lake (1966)	Low	90 (2 yrs later)	*S. haematobium*
Nigeria	Lake Kainji (1969)	Low	31 (1 yr later) 45 (2 yrs later)	*S. haematobium*
Iran	Dez pilot irrigation project (1965)	15	27 (2 yrs later)	*S. haematobium*

Source: Simplified from P.A. Rosenfield, "The management of schistosomiasis", Research paper R-16, Resources for the future, Washington DC, 1979.

Table 4: Air quality within eight African huts in Kenya at different altitudes

Altitude (metres)	Total organic matter[a]	Benzo-a-pyrene[b]	Benzo-a-anthracene[b]
3000	2.754	291	268
3000	6.763	166	515
3000	3.898	140	225
2000	2.575	85	79
2000	1.005	37	33
Sea level	0.808	24	29
Sea level	0.440	12	15
Sea level	0.304	None found	16

a milligrams per cubic metre.

b milligrams per 1000 cubic metres.

Source: Simplified from WHO, "Biomass fuel consumption and health" (EFP/84.64), Geneva, 1984.

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