

The urban environment and health in a world of increasing globalization: issues for developing countries

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Urban living is the keystone of modern human ecology. Cities have multiplied and expanded rapidly worldwide over the past two centuries. Cities are sources of creativity and technology, and they are the engines for economic growth. However, they are also sources of poverty, inequality, and health hazards from the environment. Urban populations have long been incubators and gateways for infectious diseases. The early industrializing period of unplanned growth and laissez-faire economic activity in cities in industrialized countries has been superseded by the rise of collective management of the urban environment. This occurred in response to environmental blight, increasing literacy, the development of democratic government, and the collective accrual of wealth. In many low-income countries, this process is being slowed by the pressures and priorities of economic globalization. Beyond the traditional risks of diarrhoeal disease and respiratory infections in the urban poor and the adaptation of various vector-borne infections to urbanization, the urban environment poses various physicochemical hazards. These include exposure to lead, air pollution, traffic hazards, and the "urban heat island" amplification of heatwaves. As the number of urban consumers and their material expectations rise and as the use of fossil fuels increases, cities contribute to the large-scale pressures on the biosphere including climate change. We must develop policies that ameliorate the existing, and usually unequally distributed, urban environmental health hazards and larger-scale environmental problems.

Keywords: urban health; urban population; urbanization; environmental health; environmental pollution; international cooperation; socioeconomic factors; poverty.

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Introduction

Homo sapiens is undergoing a radical transformation of its ecology. The proportion of the world's population living in large towns or cities has grown from around 5% to 50% over the past two centuries. Demographers estimate that by 2030 approximately two-thirds of all people will live in large towns or cities. The human population is thus becoming urbanized. In future, urban populations will have a distinctly higher proportion of older people than they do today.

Urban migration reflects many things: the advent of industrialization, insecurity about the availability of food in rural areas, the search for refuge from conflict and environmental damage and the lure of jobs, amenities and stimulation. Africa, where the relation between economic development and urbanization is weaker than in other regions, is currently the least urbanized major region in the world. Nevertheless, it is also the most rapidly urbanizing region. In sub-Saharan Africa much of the rapid growth in the urban population reflects a

combination of flight from rural poverty and high fertility rates in urban areas. In Latin America, in contrast, urban growth has been driven more by the pull of industrialization and economic opportunity. Hence, urban growth has slowed in Mexico City, São Paulo and Buenos Aires during the past decade of economic recession (1).

Historical perspective

Cities have historically been associated with the evolution of ideas of public health and practice. The modern public health revolution began in European cities in the 19th century where, under the pressures of industrialization, poverty, crowding and the breakdown of traditional ways of living, the conditions of daily life had deteriorated for most people.

The economic historian Szreter argues that in England, which led the industrial revolution, rapid economic growth in the first half of the 19th century disrupted traditional structures of authority, social relationships and ideologies. This caused urban environmental blight, the flight to the outer suburbs by the economically better off, further worsening of deprivation in inner urban areas, and increases in disease and death (2). In mid-19th century England those in the suburbs largely ignored the plight of the

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urban poor. The resultant policy stasis and the growing crisis of urban poverty, disease and overflowing workhouses precipitated Chadwick's report on the conditions of workers (3).

Chadwick argued that averting additional environmental degradation would remedy the social crisis more effectively than would further workhouse "relief" under the provisions of the Poor Law of 1834, the law that required the unemployed poor to work for their daily subsistence. Even so, within the prevailing laissez-faire ethos, the struggling middle-class representatives of inner urban electorates were too preoccupied with the immediacies of their own commercial survival to embrace grander urban improvement schemes. Hence, Chadwick's centrally controlled programme to develop a network of local boards of health, established under the 1848 Public Health Act, met with widespread resistance from unsympathetic local politicians. The composite problem of economic deprivation, urban squalor and severe health inequalities was eventually remedied by devolving sanitary powers to local municipalities through the Sanitation Act of 1866 (2, 4). Over the next three decades urban authorities in England, using new sanitary technologies and public borrowing, transformed sewage and water services from private enterprises to public services.

There is a contemporary relevance to this historical account: the failure of many large cities in low-income countries to implement similar changes has left them with problems of environmental blight, inadequate housing, poverty and disease. The process has been further slowed in many countries by the pressures, distortions and priorities of economic globalization.

Until the second quarter of the 20th century, the dominant cause of mortality among industrialized urban populations was infectious diseases. However, mortality from infections had begun to decline during the 19th century. McKeown attributes most of the decline in mortality after the 1850s to improvements in social and environmental factors (5). He emphasizes that improvements in food supplies and nutrition boosted biological defences against infectious diseases. He notes that better housing, safer water supplies, increasing literacy and the idea of domestic hygiene gave further protection to infants and children. Various commentators have broadly concurred with McKeown. However, others have emphasized the important role of deliberate public health interventions including sanitary engineering, refuse disposal and vaccination (6). In France, for example, substantial gains in life expectancy emerged first in Lyon in the 1850s, then in Paris during the 1860s and 1870s (albeit more slowly), and then in Marseille around 1890; each gain was directly associated with the deliberate improvement in the supply of public water and sanitation in each of these cities (7).

As industrialization intensified the general absence of air quality controls allowed pollution levels to increase in industrialized cities. Spectacular

episodes of air pollution occurred during the mid-20th century in Europe and North America, including the great London smog during the winter of 1952. These experiences ushered in new legislation, which has since led generally to a decrease in air pollution in developed countries. The various major categories of air pollutant have followed a multi-phasic trajectory (7). Smoke emissions from William Blake's "dark satanic mills" of industrialized Europe began to decline in the early 20th century, and sulfur dioxide emissions declined from the middle of the century. However, emissions of carbon dioxide and very fine particulates are still rising.

The rise and fall, or "inverted U", trajectory displayed by measurements of smoke and sulfur dioxide is sometimes referred to as the "environmental Kuznets curve"; this refers to the graph described by the economist Kuznets in the 1950s of the increase and then decrease in income disparities within a country that occurred as industrialized countries grew wealthier. Not all urban environmental pollutants, however, have followed this trajectory (8). For example, household sanitation problems in western countries have been on a downwards trajectory (decreasing) since the early stages of industrialization, but carbon dioxide emissions and consumer wastes are continuing on an upward trajectory (increasing). The current trend for these latter pollutants will, presumably, turn out to be the up slope of the longer span of the inverted U.

This sequence of rise and fall in environmental contaminants is not a law of nature. In the megacities of the developing world, such as Mexico City, São Paulo and Delhi, residents often face the worst of both the traditional and modern worlds. They encounter a wide spectrum of pollution ranging from a lack of sanitation (with exposure to human excrement and unsafe drinking-water) to exposure to hazardous synthetic organic chemicals in their air, food and water. In Delhi, India, for example, the coliform count in the city's main river, the Yamuna, increases 3000-fold from the time it enters the city to the time it leaves (9). That stretch of the river also receives about 20 million litres of industrial effluent. Meanwhile, Delhi's air quality, especially in the colder months, is among the worst in the world (10).

Chaplin argues that there are three reasons why a successful urban sanitation programme has not arisen in India (4). Firstly, local government in urban areas lacks the resources and commitment to counteract problems in inner urban areas that are associated with poverty, overcrowding and haphazard urban growth. The influential middle classes and upper classes have relocated to new, leafier, suburbs. In the atmosphere of indifference both corruption and incompetence flourish. Secondly, there is no manifest political threat from the illiterate, fragmented, relatively powerless, urban poor. Thirdly, the availability of vaccinations, antibiotics and effective domestic plumbing have rendered the middle class oblivious to the environmental health hazards faced by the poor. Modern medicine and sanitary technol-

ogy insulate the middle class from the threats of infectious diseases.

The three main pathways through which the urban environment impinges on human health are through the social changes that accompany urbanism and the way in which these changes alter behaviour-based risks to health; the way that the physical urban environment poses various microbiological risks and risks of toxicity; and the way that the larger-scale environmental impact of modern urban populations creates wider-spread and longer-term risks to health through their disruption of the life-support systems of the biosphere.

Urbanism: changes in social relationships and individual behaviour

Urbanism potentiates many changes in human behaviour that affect disease risks. For example, cities are characterized by high levels of tobacco smoking, traffic injuries, fatalities and adult obesity (11). The increase in the incidence of obesity illustrates several aspects of urban living. Among city dwellers, it reflects the combination of easier access to energy-dense processed foods and a decline in physical activity at work, at home, and recreationally. Typical urban living thus entails an imbalance in the energy budget that leads to obesity, and this greatly increases the risk of high blood pressure and type II (adult onset) diabetes (11, 12).

The urban facilitation of microbial traffic, via the increased intensity and diversity of human mobility, contact and sexual behaviours, may have been critical in launching the otherwise poorly transmissible human immunodeficiency virus (HIV) in the 1980s (13). Urbanism, increased mobility and the relaxation of traditional cultural norms yield new patterns of human behaviour, including changes in sexual activities and the use of illicit drugs (14). The extensive transmission of the human immunodeficiency virus in the 1980s and 1990s owed much to the combination of new sexual freedoms, movement between urban and rural areas, and long distance travel. Similarly, reported rates of food poisoning have increased in industrialized countries during the past two decades and have almost doubled in the United Kingdom between the mid-1980s and mid-1990s (15). This probably reflects a mix of factors including increasingly long "supply lines" between production and consumption in complex urban social environments, changes in consumer behaviour and, perhaps, consistently warmer summers since the 1970s.

However, urban life also confers many health benefits. Within cities, there is readier access than in rural settings to health services, education, and financial and social services. Community life can be rich and fulfilling. The urban environment is diverse, stimulating and full of new opportunities. Individual and family mobility make it easier than in a conservative rural community to escape from oppres-

sive social relationships. On the other hand, cities are often impersonal, alienating and sometimes menacing.

Microbiological, physical and chemical hazards

Large cities in the least developed countries typically combine the traditional environmental health problems of poverty, particularly respiratory and enteric infections, with those of poor quality housing and unregulated industrialization. Residents therefore are often at risk from diseases and injuries associated with poor sanitation, unsafe drinking-water, dangerous roads, polluted air, indoor air pollution and toxic wastes. The United Nations Centre for Human Settlements has written that "the deterioration in the built environment is sharply in evidence throughout most of urban Africa... This trend seems to have been accentuated by the effects of structural adjustment in many countries, according to which urban workers lost more than rural smallholders" (16).

In developing countries infant mortality is typically four or more times higher in poorer segments of urban populations than in richer segments. There are also large differences between richer and poorer populations in the incidence of environmentally related infectious diseases such as tuberculosis, typhoid and cholera, and in exposure to local air pollution and indoor air pollution (1). Psychosocial health problems are also related to income including depression, alcohol and drug abuse, suicide, violence and murder. In large cities everywhere, poor people are the main victims of property crime, assault, rape and murder. In response, the richer people raise higher barricades and employ more security guards. The vulnerability of poor people then increases further because the adaptive behaviours of crime and violence are inevitable with high levels of unemployment and poverty.

Poverty, then, is more than income deprivation. Urban poverty is the most important predictor of environmental health risks when its definition includes other forms of deprivation such as physical assets, political influence, access to basic services and access to social capital (17). Satterthwaite concluded that: "Although considerable progress has been made since 1990 in improving housing conditions for low-income groups in certain cities and more effective approaches are now being more widely applied, the number of people suffering serious environmental health burdens in urban areas probably increased significantly during the 1990s — in part because urban populations continue to grow rapidly in most of Africa, Asia and Latin America, in part because of weak and ineffective urban governance, in part because of continued increases in urban poverty in many nations" (18). He argues that what is often forgotten is the contribution towards reducing poverty that is made through the health benefits gained by improving housing and providing clean water, sanitation and waste removal.

Microbiological hazards

As it reshapes modern human ecology, rapid urbanization is expanding the traditional role of cities as gateways for infections. Crowding and unsanitary conditions are important amplifiers of the transmission of infectious diseases: many infectious diseases thrive where there is a lack of water, and inadequate drainage, sanitation and solid waste removal. Population movement from rural areas into cities and greater mobility within cities are bringing new opportunities for otherwise marginal and obscure microbes (19). Research in Kwa-Zulu Natal, South Africa, has shown that the vector-borne disease schistosomiasis is spreading to urban areas through the migration of the rural population to informal settlements around the cities (20). For similar reasons, including poor sanitary facilities, filariasis, another vector-borne infection, (also known as elephantiasis and spread by a culicine mosquito that breeds in contaminated pools of water) has been spreading in towns in Recife, in north-eastern Brazil (21). Yellow fever, plague (especially in Madagascar), Lyme disease and cutaneous leishmaniasis have all become more urban in their distribution, reflecting ongoing changes in human demography and behaviour and in the environment as urbanization proceeds (22).

A new concern is that as global temperatures continue to rise, which they have done over the past quarter of a century, mosquito-borne infections, such as malaria, will become more prevalent in highland cities in low-latitude countries (such as Nairobi and Harare). Recent movements of such vector organisms and their diseases to higher altitudes may be an early response to climate change (23), although causal attribution remains difficult because of the limited evidence. Associated with this is the belief held by some climatologists that rainfall patterns will intensify as a result of global warming and more local flooding will occur, facilitating the breeding of mosquitoes and causing microbiological contamination of urban sources of drinking-water.

The advance of dengue fever in tropical and subtropical zones has been aided by the expansion in urban areas of breeding sites for the *Aedes aegypti* mosquito. This disease is now the most frequently occurring vector-borne infectious disease in urban areas. The more recent spread (particularly via the international trade in used car tyres that contain mosquito eggs) of the second mosquito vector of dengue fever, *Aedes albopictus*, has increased the risk of infection in urban settings in several subtropical and warmer temperate zones.

Physical and chemical hazards

The modern urban environment combines industrialization, crowding, waste generation, and dense transport systems. This combination, compounded by the periurban poverty that surrounds many cities in developing countries and the poverty of inner urban areas in cities in the developed world, introduces many environmental health hazards

(1, 24). These may be overt, as in the cases of road trauma or the increase in asthma attacks that occurs during episodes of high air pollution, or more insidious, as with exposure to environmental lead.

Environmental lead exposure. In 1997, the World Bank made the phasing out of lead in petrol the top priority of its 10 main objectives for improving health and the environment (25). Exposure to lead has developed in the urban environment over many decades; the lead comes from industrial emissions, house paints and the use of leaded motor fuel (24, 26). Many high-income countries, including the United States and Australia, have recently set new, lower standards for environmental exposure to lead to protect young children. However, childhood lead poisoning — a particular hazard in the neurocognitive development of children — is an increasing problem in many low-income countries, especially in urban environments. High concentrations of lead in blood have been observed in cities such as Bangkok, Jakarta, Taipei, Santiago and Mexico City (7, 26). In Dhaka, Bangladesh, the airborne lead concentration is one of the highest in the world, and the mean concentration of lead in blood in 93 randomly chosen rickshaw pullers was 53 µg/dl, five times higher than the acceptable limit in high-income countries. The lead content of petrol sold in Africa is the highest in the world and is associated with high concentrations of lead in the atmosphere, dust and soil. Many other exposures in Africa come from industrial sources, cottage industries and domestic sources. In recent surveys, more than 90% of the children in the Cape Province, South Africa, had lead concentrations in blood over 10 µg/dl (27).

The best available estimate of the neurotoxicity of lead at low doses in childhood comes from cohort studies conducted in industrialized urban populations. These studies indicate that preschool-aged children whose blood concentrations of lead are in the top and bottom quintiles, and which thus differ by around 10 µg/dl, have a persistent 2–3% difference in measures of intelligence (28). Lead-induced deficits in children's intelligence are therefore probably widespread in cities of developing countries that have persistently high levels of environmental exposure to lead.

Urban transport and air pollution. One consequence of the global influence of transnational corporations is that private car ownership is increasing spectacularly. In 2000 there are more than 750 million cars in the world. This rapid growth in car ownership reflects the influence of advertising, the power of the roads lobby, the wealth of consumers and their desire for status, comfort and mobility. In cities where there is no public transport, private cars are especially desirable. Car congestion is now endemic in cities everywhere (29). In addition to the fragmentation of neighbourhoods, intrusive noise, and restrictions on physical exercise, there are three broad categories of public health hazard from urban car traffic. Firstly, over 750 000 people die from car crashes annually, including car occu-

pants, pedestrians and cyclists, most of them in developing countries (30).

Secondly, emissions from vehicles cause local air pollution, particularly photochemical smog during summer. Urban air pollution has, in recent decades, become a worldwide public health problem, particularly in many large cities in the developing world. An estimated 130 000 premature deaths and 50–70 million incidents of respiratory illness occur each year due to episodes of urban air pollution in developing countries, half of them in East Asia (31).

In Mexico City, for example, three-quarters of the air pollution is caused by motor vehicle exhaust, and nearly half of the toxins within that pollution come from the same source (32). In São Paulo, which currently has a population of around 17 million, rapid development has created a culture of car dependency, with little investment in the subway and rail systems. The proportion of trips in a motorized vehicle taken by car in São Paulo has doubled over the past quarter of a century, from around 25% to 50%; the number of vehicles in the city is estimated at five million, two-thirds of which circulate within the city each day (33). Studies elsewhere have shown that increases in airborne nitrogen oxides and fine particulates are followed by an increase in the incidence of, and mortality from, respiratory diseases in children and the elderly over the ensuing several days. The local topography and climate exacerbates air pollution in winter, when strong thermal inversions trap the pollutants close to the ground (33).

Thirdly, exhaust emissions contribute to acid rain and to the global accumulation of carbon dioxide. Each of these have wide ranging consequences for human health. In developed countries, traffic exhaust accounts for approximately one-quarter of all carbon dioxide emissions.

Heatwaves, urban vulnerability and mortality.

Heatwaves adversely affect health. The frequency and intensity of heatwaves will likely increase over the coming century as world temperatures rise (34). The impact of heatwaves on mortality is typically greatest in the centre of large cities, where not only do temperatures tend to be higher than in the suburbs and surrounding countryside but night-time cooling is lessened. This “heat island” effect is caused by the large heat-retaining structures and treeless asphalt expanses of inner cities and the physical obstruction of cooling breezes.

Studies of heatwaves have shown that those who are most vulnerable to heat-related illness and death are elderly people, those who are sick and poor people living in urban areas. In the United States in July 1995 more than 460 extra deaths occurred as a result of a heatwave in Chicago during which temperatures reached 40 °C. The rate of heat-related death was much greater among African Americans than the rest of the population and among people who were confined to their beds or poorly ventilated inner-city apartment blocks (35). In the severe heatwave in England and Wales in 1995, a 10% excess of deaths occurred, particularly in the adult age

ranges, from respiratory and cerebrovascular disease (36). In the greater London area, where daytime temperatures were higher (and where, as in all large cities, there is less cooling at night), mortality increased by around 15%. The excess mortality risks were generally greater among socioeconomically deprived groups (37).

There is a need for studies on the impact of extremes of heat and cold on urban populations living in the developing countries. Most research has been done in the United States and Europe.

Agriculture in urban areas. Agriculture in urban areas is increasingly prevalent in many developing countries. Typically, between one-quarter and three-quarters of families carry out some type of small-scale gardening for food, usually despite both official disapproval and regulatory prohibition. This activity reflects both cultural and economic forces: the maintenance of rural traditions and knowledge and as a form of insurance (mostly by women) against monetary poverty.

Urban agriculture has nutritional, economic and social benefits. It also has health hazards including the potentiation of vector-borne infectious diseases (for example, the development of mosquito breeding sites in irrigation channels), exposure to pesticides and various types of contamination of locally grown food caused by the presence of lead and other heavy metals in the soil, and microbiological contamination from the use of human excrement as fertilizer.

The larger dimensions of urban impact on environmental health

There is a larger framework within which to consider health in an urban environment. The impact of burgeoning urban populations on the wider environment is escalating and is bound up with the composite process of globalization. This process entails an increase in various types of interconnectedness that transcend national boundaries and other traditional demarcations (38). The process of globalization, which has been evolving over several centuries, has been greatly amplified over the past two decades by the transnational economic reshaping of world trade and investment, as free market economics has achieved ideological and political ascendancy. The concurrent revolutions in human mobility and electronic communications have contributed to this interconnectedness. The centrepiece of economic globalization is the new freedom of capital to cross national boundaries and the accompanying market in international currency, now freed from exchange controls.

Economic globalization has resulted in an international division of labour. In particular, the manufacturing of “low-end” products — such as footwear, garments, and toys — and the introduction of low-end processes — such as electronic assembly — has been increasingly outsourced by high-income industrialized countries to poorer countries where labour is cheap and workplace standards are

comparatively unregulated. Less developed countries, which have small internal markets, strive to generate wealth by exporting goods from light manufacturing to the developed world, where the low price of these products helps maintain low inflation in the developed countries. These practices have two main consequences for the less developed countries. Firstly, socioeconomic stratification is widened by supranational economic forces. People working in favoured sectors (for example, tourism) prosper; those working in export-led manufacturing earn subsistence wages; and those remaining in sectors not keyed in to the global economy (for example, many rural workers) suffer. Many rural communities thus become marginalized both globally and nationally. This results in an inevitable downward spiral of environmental degradation, increased poverty, food insecurity, the stunting of children's growth and increasing health risks from infectious diseases. Secondly, the fall of commodity prices and the low prices paid for low-end manufactured goods in a competitive global marketplace where trading loyalties no longer count, may consign exporting countries to continued poverty. The growth of slums and shanty towns in and around cities in the developing world is an expression of the persistent and widening economic inequalities in the world.

Worldwide, poorer residents of large cities bear the brunt of the adverse health consequences of environmental degradation. Industrial activities are often concentrated near impoverished communities living on the fringes of urban areas where the enforcement of environmental standards is weakest. In South Africa, for example, the industrial pollution affecting townships such as Soweto and Mafefe is well documented (39). Two-fifths of the population of Soweto lives in houses with asbestos roofs.

Urban "ecological footprints": endangering global sustainability

Urban populations play a dominant role in the mounting pressures on the world's ecosystems. Girardet says that cities "are also vast processors of food, fuels, and the many raw materials that feed a civilization. With their complex metabolisms they are huge organisms without precedent in nature: their connections stretch across the globe" (40). Cities thus have increasingly large "ecological footprints" (41). The ecological benefits of urbanization include economies of scale, the shared use of resources and opportunities for reuse and recycling. However, there are great externalities, that is environmental and social costs not reflected in the market price. Urban populations depend on supplies of imported food, raw materials (timber, metals, fibre, etc.), external energy sources (especially fossil fuels) and on being able to dispose of their voluminous wastes elsewhere.

Urban populations depend on access to environmental goods and services from an area

vastly larger than a city itself. Feeding the residents of imperial Rome two thousand years ago was dependent on importing more than 1000 tonnes of grain daily from North Africa. Today, the highly urbanized Netherlands consumes resources from a total surface area equivalent to 15 times larger than itself. The consumption of food, wood, paper and fibres by 29 Baltic cities requires a total area 200 times larger than the combined area of the 29 cities; this total area comprises 17 units of forest, 50 units of arable land and 133 units of marine ecosystems (42). Similarly, Rees estimates that the almost 500 000 residents of Vancouver, Canada, who occupy just 11 400 hectares, actually use the ecological output and services of 2.3 million hectares (41). This ratio of 207:1 for the urban population is substantially greater than the ratio of 12:1 for the regional population of the Lower Fraser Basin overall, which includes Vancouver as a whole.

There is nothing intrinsically undesirable about such ratios, so long as urban populations in aggregate can achieve an ecologically sustainable way of life. The scale of the externalities of urban populations is growing (40, 43). The externalities now include massive urban contributions to the world's problems of greenhouse gas accumulation, stratospheric ozone depletion, land degradation, and destruction of coastal zones. Indeed, cities play a central part in much of the large-scale pressure that people impose on the biosphere's life-support systems. These systems provide environmental stabilization, biological productivity, the cleansing of water and air, and the recycling of nutrients. Whereas our predecessors could take these environmental "services" for granted in a less populated world on which they had less impact, today humankind is introducing unprecedented change to the global environment. These large-scale changes pose long-term risks to the health of human populations (44).

The most prominent of these changes is climate change, occurring in response to the human-induced accumulation of heat-trapping greenhouse gases in the lower atmosphere (34). The urbanized developed world, which accounts for one-fifth of the world's population, contributes about three-quarters of all human-made emissions of greenhouse gases (34). The contributions from urban populations in developing countries are rapidly increasing, although they are starting mostly from a lower base level.

A brief consideration of climate change and health illustrates the nature of these health hazards (45) and the fact that that, generally, poor populations in urban areas will be particularly vulnerable to the adverse health impacts of climate change (37). An increase in the incidence of heatwaves would cause an increase in heat-related mortality and illness during the summer. By contrast, less severe cold weather would reduce the documented seasonal excess of deaths in winter. Hot weather would also amplify the production of photochemical smog (for example, ozone) in urban areas, thereby increasing health risks. Other impacts of climate change on health would

arise from disturbance of the world's biophysical systems, thereby affecting the various foundations of public health, such as the sufficiency of local food production, the provision of safe and adequate drinking-water, the provision of secure community settlements and family shelter, and the ability to control various infectious diseases. Early changes may well be the result of alterations in the geographical range (latitude and altitude) and seasonality of certain vector-borne infectious diseases, such as malaria, dengue fever, schistosomiasis, leishmaniasis, Lyme disease, and various tick-borne viral encephalitides (23, 46). Health would also be jeopardized by rising seas and by the displacement of populations caused by physical hazards, land loss, a decline in water supplies, economic disruption and civil strife. These effects, and those caused by altered patterns of agricultural yields, would probably not become evident for several decades.

Estimates of the regional impact of climate change have been more difficult to generate because of the peculiarities of the behaviour of climate systems within local environments. However, regional modelling is becoming more robust. For example, climatologists estimate that by 2050 the Sahara and the semi-arid parts of southern Africa may increase in temperature by 1.6 °C. Equatorial countries such as Cameroon, Uganda and Kenya could experience temperatures that are 1.4 °C higher (34). Trends in mean rainfall for 1901–95 show that some regions in Africa have experienced an increase while others have had a decrease. Projections are that rainfall will increase in East Africa and decrease in West and North Africa (47). These projections are hampered by problems in the down-scaling to regional level of global predictive models.

There is a flip side to this calculus of health risks. If the world were to comply with targets to reduce greenhouse gas emissions then a great deal less fossil fuel would be burnt in urban environments and much of the disease and mortality in urban areas caused by toxic air pollutants would be averted (48). Estimates for China indicate that if China were to comply with the 1997 Kyoto Protocol (agreed under the UN Framework Convention on Climate Change) by reducing CO₂ emissions, then by 2020 the annual number of premature deaths from ambient (external) air pollution that could be avoided would range from 2000 to 16 000; the number of deaths that could be avoided by simultaneously reducing indoor exposures (where coal is currently the main domestic fuel and exposures are often extreme) would range from 50 000 to 500 000. The width of these ranges reflects both the existence of alternative technological approaches to emission reductions and the uncertainties of the dose-specific risks to health (49).

Conclusion

City living is the keystone of human ecology. Humans are social animals, craving comfort, security, variety

and opportunity. Cities are sources of ideas, energy, creativity and technology. They can foster enlightened, congenial multicultural living. However, cities also continue to be sources for poverty, inequality and environmental health hazards. Populations in the cities of less developed countries typically experience the double environmental health jeopardy of the traditional risks from infectious diseases and the physical and chemical hazards that accompany poorly regulated industrialization, substandard housing, traffic hazards, and social violence.

Urban populations around the world are increasing the pressure on the natural environment. As fossil fuel combustion increases, as land is cleared, as the number of consumers and their expectations rise, so cities are contributing to the degradation of the world's natural systems. These large-scale environmental problems should be remedied with win-win strategies that also ameliorate the existing, and usually unequally distributed, urban environmental health hazards. Poverty is at the heart of this challenge, but better management of the environment is an important part of the solution (39).

Solutions require radical social and technological transformations. These solutions include expanding the provision of education and training; the international transfer of appropriate technology; an enhanced role for the state as a modern, efficient and transparent institution; a more equal redistribution of income, especially within developing countries; international alleviation of debt; and a true international commitment to sharing the world's common property resources (such as the atmosphere and the ocean fisheries). This last objective could be achieved via a targeted convergence granting equal access per person, internationally, to the biosphere's sources and waste-absorbing sinks. (Both the 1987 Montreal Protocol and the 1997 Kyoto Protocol, for constraining the emission of ozone-destroying gases and greenhouse gases, respectively, point in the direction of eventual intercountry convergence in per-person atmospheric emissions.)

In the 21st century we will undoubtedly modify the design and use of our cities. City planners will probably develop approaches to allow us to live in high-density "urban villages" separated by parklands, recreation facilities and garden plots, and connected by light-rail transport. Urban greenery, gardens and horticulture will thus be reinstated. Urban community structures and facilities will be recreated on a human scale. Environmentally benign technologies for transport and generating energy will be taken up. Most importantly, both social equity and ecologically sustainable ways of living will be sought.

Cities have become the great contemporary focal points of human ecology. They are a fulcrum that allows great leverage in reshaping how humankind lives. Ecologically sustainable cities, based on low-impact technologies, social enlightenment and sharing, are an essential part of our future survival. ■

Résumé

La santé en milieu urbain : conséquences de la mondialisation pour les pays en développement

Le mode de vie urbain est la clef de voûte de l'écologie humaine moderne. Au cours des deux derniers siècles, les villes se sont multipliées et développées rapidement dans le monde entier. Berceau de la créativité et de la technologie et moteur de la croissance économique, elles engendrent aussi la pauvreté, des inégalités et des risques pour la santé liés à l'environnement. Depuis longtemps, les populations urbaines servent à la fois d'incubateur et de porte d'accès aux maladies infectieuses. Les citoyens des pays en développement sont donc doublement exposés : aux risques classiques de maladie diarrhéique et d'infection respiratoire ; aux risques physiques et chimiques des temps modernes, liés à une industrialisation mal contrôlée, à de mauvaises conditions de logement, à la circulation routière et à la violence sociale.

La croissance non planifiée et la politique économique de laisser-faire des débuts de l'ère industrielle ont fait place à une gestion collective du milieu urbain, en réaction à la dégradation de l'environnement et du fait de l'alphabétisation, de l'avènement de la démocratie et de l'accumulation de richesses. Dans de nombreux pays à faible revenu, ce progrès est freiné par les impératifs et les tendances anti-corporatistes de la mondialisation de l'économie.

On peut répartir les effets du milieu urbain sur la santé en trois grandes catégories. La première concerne les changements sociaux dont s'accompagne l'urbanisation et la façon dont ils modifient les risques pour la santé liés au comportement. Le régime alimentaire, l'activité physique, les comportements toxicomaniaques, la sexualité et la nature de l'engagement social changent. Le risque de maladie cardio-vasculaire, de diabète sucré, de certains cancers, d'infection sexuellement transmissible et de problèmes mentaux évolue lui aussi.

La deuxième catégorie concerne les risques microbiologiques et les risques de toxicité présents dans le milieu urbain. A la menace que constituent habituellement les maladies infectieuses pour les citoyens pauvres s'ajoutent des dangers de nature physico-chimique tels que l'exposition au plomb (dans l'air, le sol et l'eau), la pollution atmosphérique, les accidents de la circulation et l'amplification des vagues de chaleur dans les zones urbaines.

Troisième point : l'influence des populations urbaines modernes sur l'environnement atteint une telle ampleur qu'elle entraîne, par la destruction des milieux vitaux de la biosphère, des risques pour la santé à long

terme. A ce phénomène s'ajoute celui de la mondialisation observé sur la plus grande surface du globe dans les domaines social, politique et économique et qui, à son tour, crée de nouvelles dépendances dans les pays pauvres qui s'efforcent de faire face à la concurrence sur le marché mondial. Il s'ensuit que les normes environnementales sur le lieu de travail et la protection de l'environnement sont insuffisantes et que les écarts de revenu se creusent, autant de facteurs qui influent sur la santé des populations.

Les consommateurs devenant de plus en plus nombreux et exigeants, les villes contribuent dans une très large mesure aux agressions que subit la biosphère et notamment aux changements climatiques. Les villes des pays développés, qui abritent un cinquième de la population mondiale, émettent les trois quarts environ des gaz à effet de serre générés par l'activité humaine. Bien que généralement plus faibles au départ, les émissions imputables aux populations urbaines des pays en développement augmentent rapidement.

L'évolution du climat de la planète aura toutes sortes de répercussions sur la santé humaine, pour la plupart néfastes. D'une manière générale, les plus vulnérables seront les populations pauvres des zones urbaines.

Pour résoudre ces problèmes écologiques de grande ampleur, il faut des stratégies avantageuses pour tous qui visent aussi à réduire les inégalités et les risques pour la santé auxquels sont exposés nombre de citoyens au niveau local. La solution passe par des changements sociaux et technologiques radicaux, notamment une ferme volonté, au niveau international, de mettre en commun les ressources de la planète, telles que l'atmosphère et les pêcheries en mer.

Il y a tout à parier que notre conception et l'usage que nous faisons de la ville changeront au XXI^e siècle. Les urbanistes imagineront probablement des solutions nous permettant de vivre dans des « villages urbains » à forte densité de population, séparés par des espaces boisés, des aires de loisir et des jardins, et reliés entre eux par un réseau de transports ferroviaires légers. On réintroduira ainsi les espaces verts, les jardins et l'horticulture ; les infrastructures collectives seront de taille humaine ; les modes de transport et les sources d'énergie seront sans danger pour l'environnement. Mais surtout, on tendra vers l'équité sociale et un mode de vie écologiquement viable.

Resumen

La salud y el entorno urbano en un mundo cada vez más globalizado: problemas para los países en desarrollo

El modo de vida urbano es la piedra angular de la ecología humana moderna. En todo el mundo, las ciudades se han multiplicado y extendido rápidamente a lo largo de los dos últimos siglos. Las ciudades son fuente

de creatividad y tecnología y motores del crecimiento económico. Sin embargo, también son fuente de pobreza, desigualdades y peligros medioambientales para la salud. Durante mucho tiempo, las poblaciones

urbanas han servido de incubadora y vía de entrada para las enfermedades infecciosas. Y en particular las poblaciones urbanas de los países en desarrollo corren en general un doble peligro, pues están expuestas tanto a los riesgos tradicionales, desde las enfermedades diarreicas a las infecciones respiratorias, como a los peligros modernos, físicos y químicos, que traen consigo una industrialización mal regulada, unas viviendas en malas condiciones, el tráfico y la violencia social.

La primera fase de la industrialización, caracterizada por un crecimiento no planificado de las ciudades y por la economía del *laissez-faire*, ha dado paso a la gestión colectiva del entorno urbano. Esto ha sucedido como respuesta al deterioro del entorno, paralelamente al aumento de la alfabetización, el desarrollo de gobiernos democráticos y el crecimiento de la riqueza. En muchos países de ingresos bajos este proceso es más lento debido a las presiones y las prioridades anti-corporativas de la globalización económica.

Existen tres vías principales a través de las cuales el entorno urbano afecta a la salud humana. La primera son los cambios sociales que entraña la urbanización y el modo en que dichos cambios inciden en los riesgos comportamentales para la salud. Estos cambios afectan a los hábitos de alimentación, a la actividad física, los comportamientos adictivos, la conducta sexual y diferentes tipos de compromisos sociales. También varían los riesgos de padecer enfermedades cardiovasculares, diabetes mellitus, algunos cánceres, infecciones de transmisión sexual y problemas de salud mental.

La segunda vía tiene que ver con el entorno físico urbano y sus diversos riesgos microbiológicos y de toxicidad. Además del riesgo tradicional que suponen las enfermedades infecciosas para los pobres de las zonas urbanas, el entorno urbano también esconde diversos peligros fisicoquímicos, como por ejemplo la exposición al plomo (a través del aire, la tierra y el agua), la contaminación del aire, los peligros del tráfico y la amplificación que de las olas de calor provoca la bóveda térmica urbana.

La tercera vía guarda relación con el impacto medioambiental a gran escala de las poblaciones urbanas modernas; la perturbación de los sistemas de la bioesfera necesarios para la vida provoca riesgos para la salud a más largo plazo. Esto coincide con la globalización social, política y económica general

imperante en la mayor parte del mundo, que a su vez crea nuevas dependencias para los países más pobres, los cuales están luchando por competir en el mercado mundial. Las deficiencias resultantes en lo tocante a la calidad del entorno laboral y a la protección medioambiental, así como el recrudecimiento de las disparidades en materia de ingresos, tienen consecuencias para la salud de la población.

Debido al aumento del número de consumidores y de sus expectativas, las ciudades contribuyen enormemente a las presiones a gran escala que sufre la bioesfera, en particular al cambio climático. El mundo desarrollado urbanizado, que cuenta con una quinta parte de la población mundial, produce unas tres cuartas partes de todas las emisiones de gases termoactivos de origen humano. La contribución de las poblaciones urbanas de los países en desarrollo a ese fenómeno está aumentando rápidamente, aunque en la mayoría de los casos el punto de partida es más bajo.

Las alteraciones del clima mundial ocasionarán muchos cambios en la salud humana, la mayoría de ellos adversos. En general, la población pobre que vive en zonas urbanas será particularmente vulnerable.

Debería ponerse remedio a estos problemas medioambientales en gran escala mediante estrategias que beneficien a todas las partes, y que además reduzcan las desigualdades existentes y los peligros locales para la salud a que están expuestos muchos habitantes de las zonas urbanas. Las soluciones exigirán transformaciones sociales y tecnológicas radicales, incluido un verdadero compromiso internacional de compartir los recursos mundiales de propiedad común, tales como la atmósfera y la pesca del océano.

En el siglo XXI modificaremos sin duda el diseño de las ciudades y las usaremos de otro modo. Los urbanistas probablemente desarrollarán criterios que nos permitirán vivir en «aldeas urbanas» de alta densidad separadas por parques, instalaciones recreativas y zonas verdes, y comunicadas mediante formas de transporte ferroviario ligero. Reaparecerán la vegetación urbana, los jardines y la horticultura. Se volverán a crear estructuras y servicios comunitarios urbanos a escala humana. Se adoptarán tecnologías electrógenas y de transporte respetuosas del medioambiente. Y lo que es más importante, se procurará fomentar tanto la equidad social como la adopción de modos de vida ecológicamente sostenibles.

References

1. Brennan EM. Population, urbanization, environment and security: a summary of the issues. *Environmental Change and Security Project Report*, 1999, **5**: 4–14.
2. Szreter S. Economic growth, disruption, deprivation and death: on the importance of the politics of public health for development. *Population and Development Review*, 1997, **23**: 702–703.
3. Chadwick E. *Report on the sanitary condition of the labouring population of Great Britain*. Edinburgh, Edinburgh University Press, 1965 (first published in 1842).
4. Chaplin SE. Cities, sewers and poverty: India's politics of sanitation. *Environment and Urbanization*, 1999, **11**: 145–158.
5. McKeown T. *The modern rise of population*. New York, Academic Press, 1976.
6. Szreter S. The importance of social intervention in Britain's mortality decline c. 1850–1914: a re-interpretation of the role of public health. *Social History of Medicine*, 1988, **1**: 1–37.
7. *World development report 1992. Development and the environment*. Oxford, Oxford University Press for the World Bank, 1992.
8. Rothman DS, De Bruyn SM. Probing into the environmental Kuznets curve hypothesis. *Ecological Economics*, 1998, **25**: 143–145.
9. Hardoy JE, Mitlin D, Satterthwaite DE. *Environmental problems in third world cities*. London, Earthscan, 1992.
10. *World resources report: 1998–99*. Washington, DC, World Resources Institute, 1998.

11. **Obesity: preventing and managing the global epidemic. Report of a WHO Consultation on Obesity.** Geneva, World Health Organization, 1998 (unpublished document WHO/NUT/NCD/98.1).
12. **McKeigue PM.** Cardiovascular disease and diabetes in migrants — interactions between nutritional changes and genetic background. In: Shetty PS, McPherson K, eds. *Diet, nutrition and chronic disease: lessons from contrasting worlds.* Chichester, John Wiley & Sons, 1997: 59–70.
13. **Morse SS.** Factors in the emergence of infectious diseases. *Emerging Infectious Diseases*, 1995, **1**: 7–15.
14. **McMichael AJ.** Urbanisation and urbanism in industrialised nations, 1850–present: implications for human health. In: Schell L, Ulijasek S, eds. *Urbanism, health and human biology in industrialised countries.* Cambridge, Cambridge University Press, 1999, pp. 21–45.
15. *Health and environment in sustainable development: five years after the Earth Summit.* Geneva, World Health Organization, 1997.
16. **United Nations Center for Human Settlements (HABITAT).** *An urbanizing world: global report on human settlements, 1996.* Oxford, Oxford University Press, 1996: 559.
17. *The world health report 1995. Bridging the gaps.* Geneva, World Health Organization, 1995.
18. **Satterthwaite DE.** Environmental health and urban poverty and overcrowding. In: Munn T, ed. *Encyclopedia of global environmental change.* Chichester, John Wiley & Sons, 2000, in press.
19. **Wilson ME.** Infectious diseases: an ecological perspective. *British Medical Journal*, 1995, **311**: 1681–1684.
20. **Johnson CL, Appleton CC.** Urban schistosomiasis and rural-urban migration. Abstract presented at the Annual Conference of the Epidemiological Society of Southern Africa, East London, United Kingdom, February 23–25, 2000 (unpublished abstract).
21. **Maciel A et al.** Epidemiological study of bancroftian filariasis in Recife, northeastern Brazil. *Memórias do Instituto Oswaldo Cruz*, 1996, **91**: 449–455.
22. **Githeko A et al.** Climate change and vector-borne diseases: a regional analysis. *Bulletin of the World Health Organization*, 2000, **9**: 1136–1147.
23. **Epstein PR et al.** Biological and physical signs of climate change: focus on mosquito-borne diseases. *Bulletin of the American Meteorological Society*, 1998, **78**: 409–417.
24. **Schell LM.** Effects of pollutants on human prenatal and postnatal growth: noise, lead, polychlorobiphenyl compounds and toxic wastes. *Yearbook of Physical Anthropology*, 1991, **34**: 157–188.
25. **Listorti J.** Is environmental health really a part of economic development — or only an afterthought? *Environment and Urbanization*, 1999, **11**: 89–100.
26. **Tong S, Prapamontol T, von Schirnding Y.** Environmental lead exposure: a public health problem of global dimensions *Bulletin of the World Health Organization*, 2000, **9**: 1068–1077.
27. **Nriagu JO, Blankson ML, Ocran K.** Childhood lead poisoning in Africa: a growing public health problem. *The Science of the Total Environment*, 1996, **181** (2): 93–100.
28. **Tong S et al.** Declining blood lead levels and cognitive function during childhood — the Port Pirie cohort study. *Journal of the American Medical Association*, 1998, **280**: 1915–1919.
29. **Newman P, Kenworthy G.** *Cities and sustainability: reducing auto dependency.* Washington, DC, Island Press, 1999.
30. **McMichael AJ.** Transport and health: assessing the risks. In: Fletcher T, McMichael AJ, eds. *Health at the crossroads: transport policy and urban health.* Chichester, John Wiley & Sons, 1996: 9–26.
31. **Maddison D.** *A meta-analysis of air pollution epidemiological studies.* London, Centre for Social and Economic Research on the Global Environment, University College London, 1997.
32. **Connolly P.** Mexico City: our common future? *Environment and Urbanization*, 1999, **11**: 53–78.
33. **Jacobi P, Segura DB, Kjellen M.** Governmental responses to air pollution: summary of a study of the implementation of *rodizio* in São Paulo. *Environment and Urbanization*, 1999, **11**: 79–88.
34. **Intergovernmental Panel on Climate Change.** *Second assessment report. climate change 1995.* Vol 1–3. New York, Cambridge University Press, 1996.
35. **Semenza JC et al.** Heat-related deaths during the July 1995 heat wave in Chicago. *New England Journal of Medicine*, 1996, **335**: 84–90.
36. **Rooney C et al.** Excess mortality in England and Wales, and in Greater London, during the 1995 heatwave. *Journal of Epidemiology and Community Health*, 1998, **52**: 482–486.
37. **Megens T, Kovats RS, McMichael AJ.** Mortality impact of heatwaves in the UK, 1976 and 1995. *The Globe*, 1998, **42**: 4–5.
38. **Lee K.** Globalisation and the need for a strong public health response. *European Journal of Public Health*, 1999, **9** (4): 249–250.
39. **McGranahan G et al.** Urbanisation and healthy living environments. In: *Environmental change and human health in countries of Africa, the Caribbean and the Pacific.* Stockholm, Stockholm Environment Institute, 1999: 166.
40. **Girardet H.** *The Gaia atlas of cities. New directions for sustainable urban living.* London, Gaia Books, 1992.
41. **Rees WE.** Revisiting carrying capacity: area-based indicators of sustainability. *Population and Environment*, 1996, **17**: 195–215.
42. **Folke C, Larsson J, Sweitzer J.** Renewable resource appropriation. In: Costanza R, Segura O, eds. *Getting down to earth.* Washington, DC, Island Press, 1996.
43. **Guidotti T.** Perspective on the health of urban ecosystems. *Ecosystem Health*, 1995, **1**: 141–149.
44. **McMichael AJ.** *Planetary overload: global environmental change and the health of the human species.* Cambridge, Cambridge University Press, 1993.
45. **McMichael AJ, Haines A.** Global climate change: the potential effects on health. *British Medical Journal*, 1997, **315**: 805–809.
46. **Patz JA et al.** Global climate change and emerging infectious diseases. *Journal of the American Medical Association*, 1996, **275**: 217–223.
47. **Hulme M, ed.** *Climate change and southern Africa: an exploration of some potential impacts and implications in the SADC region.* Norwich, Climate Research Unit, University of East Anglia, 1996.
48. **Working Group on Public Health and Fossil-Fuel Combustion.** Short term improvements in public health and global-climate policies on fossil-fuel combustion: an interim report. *Lancet*, 1997, **350**: 1341–1349.
49. **Wang X, Smith KR.** Near-term benefits of greenhouse gas reductions: health impacts in China. *Environmental Science and Technology*, 2000, **33** (18): 3056–3061 (available on the Internet via <http://pubs.acs.org/journals/esthag/index.html>).