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Urban environments, wealth and health:
shifting burdens and possible responses in low and middle-income nations

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SUMMARY

This paper examines urban health in low- and middle-income countries, in relation to two sets of environmental issues:

1. persistent local environmental health burdens, and most notably the **water, sanitation and housing** deficiencies prevalent in the poor neighbourhoods of so many urban settlements;
2. emerging global environmental burdens that will be experienced in urban areas, and most notably those associated with **climate change**.

The paper situates these issues within a policy-relevant framework that can help to elucidate the sorts of strategies best able to address them. No attempt is made to provide a general overview of urban health issues. Indeed, many important urban health issues (including, for example, mental health, substance abuse, and violence) are ignored, simply because they are beyond the scope of this paper. However, in order to provide some coherence, the analysis goes beyond the topics of cities and climate change, and urban water, sanitation and housing, narrowly defined.

The first section of the paper considers how a health perspective can provide an alternative or complement to the dominant economic perspective on urban well-being. This is relevant to both local and global environmental issues, and to urban planning more generally. Despite its limitations, even a narrow conception of health can provide more egalitarian indicators of well-being than most income/consumption-based indicators. Thus, for example, a disease burden is weighted equally whoever experiences it, and regardless of what they may be able and willing to pay to avoid or treat it. Moreover, a divergence between health and economic indicators can reveal flaws in economic indicators, as when economic growth is accompanied by falling or stable health. Health trends and differentials can also reveal the limitations of an overly curative approach to health improvement, as these trends are typically dominated by factors other than health care. This has implications not only for understanding of urban health, but also for action taken in the name of creating healthier and more equitable urban settlements.

The second section turns to some of the transitions commonly associated with "development", including not only the economic and urban transitions, but also the demographic, health and environmental transitions. These transitions are presented as politically and socially contingent, and not as laws of development. They are at least as relevant to explaining inequalities that have emerged with historic development as they are to predicting future developments. The urban environmental transition provides a particularly useful framework for considering together the local environmental health risks associated with inadequate urban housing, water and sanitation, and the global risks emerging from climate change. Given the cumulative global environmental pressures already created by the affluent minority, this transition cannot provide a universal model for all to follow. On the other hand, most would agree that existing environmental health inequalities are unacceptable. Addressing these inequalities without adding to global environmental burdens is one of the challenges of the 21st century.

The third section examines in more detail the environmental health risks associated with deficient water, sanitation and housing (features UN-Habitat (2003a) uses to

identify slums). Sanitary reform was central to improvements in municipal governance and public health improvement in the industrializing cities of the late 19th and early 20th centuries. At the start of the 21st century, however, the challenge of providing basic water, sanitation and housing to deprived urban settlements is still neglected and poorly understood. Part of this contemporary neglect reflects the fact that the epidemics and pandemics that once drove reform, by threatening everyone from the poorest to the wealthiest residents, are now less common. Most of the health burden is now endemic, and largely restricted to low-income settlements. This has changed the politics of sanitary reform, making effective organization within, and engagement with, the deprived communities especially important to achieving improvement. Unfortunately, such local organization and engagement is often inhibited by planning and regulatory systems that result in many of these deprived settlements being considered illegal or at least in contravention of planning regulations. Under such conditions it is particularly important for the different ways in which water, sanitation and hygiene affect health to be more widely understood, not only by experts but also by the residents themselves.

The final section turns directly to climate change, ignoring the wide range of intermediate-scale burdens such as ambient air pollution, peri-urban expansion, increasing urban water abstraction and the like. The science of climate change and its impacts is very uncertain, though this does not distinguish it from the science of water and sanitation. A more obvious distinction is that whereas progress on water and sanitation is often inhibited by a tendency to turn to outdated models of improvement, progress on adaptation to climate change is inhibited by the lack of models to turn to. Warming itself can have a direct impact on health, and the net impact is likely to be negative. Sea-level rise and storm surges are likely to have a major impact on health, particularly in unprepared urban areas. Declining water resources may also have a direct impact on health, unless ways are found to secure the basic requirements of deprived urban dwellers in the face of competition from other users. There are also many more indirect ways in which climate change could affect urban health adversely, ranging from changes in the transmission and evolution of infectious diseases, to declining food supplies, to global economic crises.

While the challenges of urban housing, water and sanitation are clearly very different from those of cities and climate change, there are also important similarities, particularly when it comes to health vulnerabilities and the need for action. The urban groups most vulnerable to the health impacts of climate change are likely to be within the deprived urban populations that currently suffer from environmental health risks due to inadequate housing, water and sanitation. This reflects a broader generality: the urban populations most vulnerable to global environmental pressures are those already facing the greatest health risks as the result of local environmental burdens. Alternatively, even in low- and middle-income countries, settlements that have managed to address their local environmental challenges efficiently and equitably are likely to be in a better position to adapt to the challenges of global environmental change. Thus, urban settlements that have already addressed the water and sanitation challenges of their most vulnerable populations are likely to be in the best position to cope with increasing water scarcity efficiently and equitably. Similarly, urban settlements that have already addressed the land and housing challenges of their most vulnerable populations are likely to be in the best position to cope with increasing flood risks efficiently and equitably.

1. Health as an alternative or complement to the economic lens for examining urban well-being

Human well-being is often viewed through a rather narrow economic lens. The market values of goods produced and consumed are routinely used to rank people, countries, and indeed the world as a whole as it changes over time. These economic valuations were not designed to measure well-being, but they are often used for that purpose, particularly in the media. Income figures are readily available and have a certain popular and bureaucratic appeal, as they are expressed in the same units that measure personal and government budgets – money. As indicators of human well-being, however, they also have widely acknowledged flaws, including their failure to take account of important assets and transactions that have no market value, and their failure to account for distributional issues. In relation to distribution, for example, few people would seriously claim that the fourth Rolex watch in a high flyer's bedroom drawer is really contributing as much to human well-being as five years' food supply for a struggling farmer, even if the market values are the same. Some might defend the high flyer's right to buy the watch, should it take her fancy, but not on the basis of the watch's contribution to human well-being.

Health indicators are harder to come by, and have their own problems. However often health is defined as complete physical, mental and social well-being (as in the World Health Organization (WHO) constitution), health indicators tend to focus on disease, infirmity and death. The most comprehensive health measure available globally, the burden of disease estimates, brings together estimates of mortality and morbidity in a single measure, which covers infectious diseases, maternal, perinatal and nutritional conditions, non-communicable diseases and injuries. But well-being is not just the absence of disease. Moreover, most health indicators do not consider the future, and as such ignore long-term environmental impacts. Health indicators do have their strengths, however, particularly when it comes to issues of equity.

Why health indicators are more egalitarian than conventional economic indicators

There is considerable evidence that the relative poverty created by an unequal distribution of income is itself unhealthy (Wilkinson and Pickett, 2006). Even without this effect, a more egalitarian distribution of income is likely to be healthier, since the health benefits a poor household can achieve from additional income is likely to be more than the health benefits an affluent household can achieve with that same additional income.[1] Moreover, prices themselves are determined by the unequal demands inherent in the income distribution, and are likely to deviate appreciably from the prices that would result if income were distributed equally.

For similar reasons, a public policy designed to maximize health is likely to be more egalitarian than one designed to maximize income. The same investment can typically yield far greater health improvements if it is targeted at poor countries and individuals than at the rich. Measures to reduce urban vulnerability are more likely to favour the

[1] Redistributing income may itself incur a cost, but historical evidence suggests that countries can select efficient redistributive procedures, resulting in no significant impact on economic growth (Lindert, 2004).

poor if their selection is based on reducing risks to health rather than to economic assets.

The contradiction between economic and health-based valuation is perhaps most evident when people try to put a value on a life. After much vocal criticism of the economic tendency to value the lives of the wealthy more than those of the poor, many economic assessments place the same value on all lives. It should be kept in mind, however, that this is inconsistent with conventional economic calculation, and that market prices themselves reflect a valuation process that does not put equal weight on the lives of rich and poor. To go back to the example used above, valuing a little-used Rolex watch as equal to five years of food supplies for an impoverished family cannot be reconciled with valuing everyone's lives equally; yet such calculations are implicit in the routine use of market prices to assign values.

The more egalitarian tendencies of health indicators also extend to international comparisons. If national income per capita is plotted against life expectancy, for example, the health improvement associated with an increase of say $100 a year at the bottom end of the scale is far greater that the health improvement associated with an increase of $100 at the top end. Similar differentials, though perhaps less extreme, are likely to be evident with other health indicators. This conforms to what most people, including economists, intuitively feel about the utility of income – that the same additional income is more valuable at lower levels of income.

While the goal of promoting health has more egalitarian tendencies than the goal of promoting economic output, health equity is also a concern, even for some economists (Sen, 2004). For both health and economic output, it is possible to argue that a more egalitarian distribution is desirable in itself. Health equity can be seen as a broader concern, however, which considers not only health outcomes, but also how they are created, and how they ought be addressed.

The challenge of moving beyond curative health care

To the extent that health indicators do reflect important aspects of well-being, they are not always best addressed through curative, or even preventive, health care, conventionally defined. Indeed, there is a permanent tension in the health sector. On the one hand, the institutional and bureaucratic base for most health ministries and departments lies in health care, with the front line being the doctors, nurses and pharmacists, and the services and cures they dispense. On the other hand, many of the most important determinants of urban health lie within the sectors of water and sanitation, housing and transport – and in the countries' economic production and distribution. In these other sectors, the health sector may have an advisory or regulatory position, but is unlikely to have much authority. Moreover, rather than being asked to advise on how policies and practices could be changed to improve health or health equity, they are more typically asked to advise on very specific topics, often related to standards and regulations.

The tension within the health sector between a broad mandate to improve health and a narrow focus on health care extends to health care workers themselves. Nancy Scheper-Hughes, in her account of the "violence of everyday life" for poverty-stricken families in a Brazilian favela, describes a number of these tensions. Perhaps the most disturbing involves a doctor treating a starving child with appetite

stimulants, unwilling to face the inconvenient truth that the child lost its appetite in the first place because it was not being fed (Scheper-Hughes, 1993). While this perversity may seem shocking, it is only a somewhat extreme manifestation of a structural contradiction inherent in attempting to address health inequities generated by the socioeconomic circumstances, while staying within the health sector.

When health differences are more revealing than economic differences

Generally, health differences, between groups of people and over time, can be very revealing, but should not be interpreted in isolation. Considering health variation alongside economic variation is of interest in part because of what their contrasting patterns reveal. For example, as Deaton illustrates, if one looks carefully at the health improvements that have accompanied economic growth in China and India in recent decades, what is of particular interest is that the major health improvements preceded the most rapid periods of economic growth (Deaton, 2006). Moreover, looking across countries, the close correlate of economic growth is not the absolute rate of decline in infant and child mortality but the level of infant mortality, which Deaton takes to suggest that both good health and economic growth are outcomes of the same conditions (e.g. education and institutional quality).

Even economists recognize that health can provide a useful corrective to economic indicators, although non-economists are more likely to reject income-based indicators as the result. Nobel-prize-winning economist Robert Fogel observes that while the US economic statistics for 1820 to 1860 show real wages increasing, heights and life expectancy were falling. He conjectures that the same internal migration and urbanization responsible for about half of the income growth was also a principal factor in the spread of the major killer diseases of the time, including faecal–oral diseases such as cholera, typhoid and dysentery. Fogel's response is to advocate adjusting the real-wage changes to reflect the health burden. Indeed, he argues that the health statistics of the time, which show the health of wealthier and poorer groups diverging, provide a better indication of changes in economic equality than do the conventional economic measures (Fogel, 2004b, pages 34–35 and note 26).

When Simon Szreter, a health historian, encounters similar discrepancies, his inclination is to treat the concept of income as distinct from well-being, and as inherently less revealing of well-being. Thus, for a similar period in England, where urban mortality rates increased as the economy grew, Szreter argues that industrialization and economic growth brought disruption, deprivation, disease and death, and that for the urban poor conditions improved only when political conflicts were resolved in favour of the interests of the working-class majorities (Szreter, 2004). While there are fundamental differences in their interpretations of this sort of history, both Fogel and Szreter clearly reject conventional income estimates as the basis for monitoring changes in human well-being, and use health to provide a more sophisticated interpretation of historical transitions. Moreover, both economists and non-economists are moving towards more multi-dimensional interpretations of both well-being and poverty (Duclos, Sahn and Younger, 2006; Wratten, 1995).

Can better health make a large contribution to economic growth?

While health is clearly an important indicator of well-being, and health inequalities can yield profound insights, it is less clear that health improvements make an important contribution to economic growth, conventionally measured. A WHO report

on macroeconomics and health argues that the economic benefits of health improvements are typically underestimated, and that well-targeted investments in health improvement would yield high economic returns in the form of increased incomes in low-income countries (World Health Organization, 2001). This claim has been contested, however, in part because the economic benefits of health improvement depend on how people respond to declining infant mortality.

There is no doubt that better health can help to prevent households from falling into poverty, and that lower infant mortality rates can be an enormous boon to mothers and families. Detailed work in the slums of Dhaka, for example, illustrates how important health is, not only to people's well-being, but also to their struggle to avoid succumbing to a spiral of ill-health and poverty (Pryer, 1993, 2003). The economics of this type of relationship has been explored in depth by Partha Dasgupta (1993) in his book on the economics of destitution. However, this is unlikely to have a major effect on economic growth rates, since it requires only a small change in income to shift from poverty to destitution, and economic measures do not even take into account the loss of non-income-generating assets or the enormous suffering that accompanies this decline.

The implications for conventional economic growth of lower infant mortality, which typically accounts for a large share of health improvement in low-income countries, depend on how the economy responds to an increasing population. A recent statistical analysis of the relationship between life expectancy and economic growth, focusing on the 1940–1980 period, actually found that increasing life expectancy led to greater increases in population than in income, and as a result had a negative effect on per capita income (Acemoglu and Johnson, 2006). Eventually, one would expect fertility rates to decline as the lower infant mortality rate works its way into people's expectations and cultures. The WHO report relied on this decline in fertility to conclude that the economic returns to investments in health improvement are very high. Again, however, the macroeconomic effects of better health on the economy are not automatic, but depend on how people respond to health improvement.

Historically, the most important effects of health on economic growth may well have been by way of the institutional impacts resulting from people's response to health problems. For example, the heavy disease burden that faced European colonialists in Africa had a major influence on the development of colonial institutions in that continent, while the even heavier disease burden the colonial encounter imposed on native American populations had very different institutional implications (Acemoglu, Robinson and Johnson, 2003). From a narrow economic-growth perspective, large parts of America actually benefited from this health disaster over the long term, because it facilitated settler colonies that in parts of the continent were institutionally well suited to economic growth. This not only illustrates the importance of institutional considerations, but also illustrates yet again the dangers of relying on narrowly conceived economic indicators to monitor human well-being.

2. Health, urban transitions and urban penalties

Not only do health indicators provide a different perspective from economic indicators, they also relate differently to countries' development trajectories. Industrializing and urbanizing countries are often described as going through a set of interrelated transitions. There is the economic transition from agricultural to industrial and commercial production, and the urban transition from predominantly rural to urban living. A related transition posits a shift from traditional to modern environmental health risks (Smith, 1990). This is linked in turn to epidemiologic transition from a situation where health problems are dominated by infectious diseases such as diarrhoea, malaria and acute respiratory infections, to one where non-infectious and chronic diseases such as cancer and heart disease are, in relative terms, far more important. This is accompanied by falling mortality, particularly among infants and children. This is then linked to the demographic transition from a situation of high fertility and mortality to one of low fertility and mortality, with mortality dropping first and leading to population growth until fertility declines commensurately.

The relations underlying these transitions are delayed and contingent, and not only vary over time and space, but depend on how people respond to the different challenges, many of which threaten public health and well-being. Central to this is how urban development is managed. Most of the productivity growth to drive economic growth is in urban locations, and long-term economic growth depends on making effective use of the agglomeration economies that urban concentrations can provide, and the trade that urban centres enable. The environmental risk and health transitions depend on urban public health measures that require political as well as economic reforms.[2] Just as the declining mortality of the demographic transitions depends on successful urban public health reforms, so the later decline in fertility has a strong urban component, and can be facilitated by family planning measures that put control of fertility into the hands of prospective mothers. Moreover, whether, when and how such transitions take place in any given country depend not only on what is done within the country, but on the regional and international context.

For the epidemiologic transition, it is also important to recognize that the shift from infectious to non-communicable diseases is relative. People in poor countries get non-communicable and chronic diseases, typically at higher rates for their age group than in more affluent countries. However, not only do they get more infectious diseases, but mortality from infectious diseases tends to be at an early age, shifting both the mortality statistics and the disability-adjusted life-years away from the non-communicable diseases. Moreover, the chronic conditions and diseases suffered by the urban poor are often neglected, as the formal health system records only the complications or outcomes that require their intervention. Thus, hypertension is often not recorded, but an eventual stroke or heart failure is; mental illness is often not

[2] There has been a great deal of debate about what drove the mortality declines in Europe and America. McKeown (1978) and more recently Fogel (2004a; 2004b) are associated with the case for better nutrition and indirectly productivity growth being the driving force, while Szreter (2005) and Deaton (2006) have argued for the centrality of government action. Both sets of researchers acknowledge the central role of improvements in water, sanitation and hygiene, however.

recorded, but suicide, homicide or other violent events are; diabetes is not recorded, but kidney failure is; early-stage tuberculosis is not recorded, but late-stage is. (For a more complete listing, see Table 1, page 5 in Riley et al., 2007).

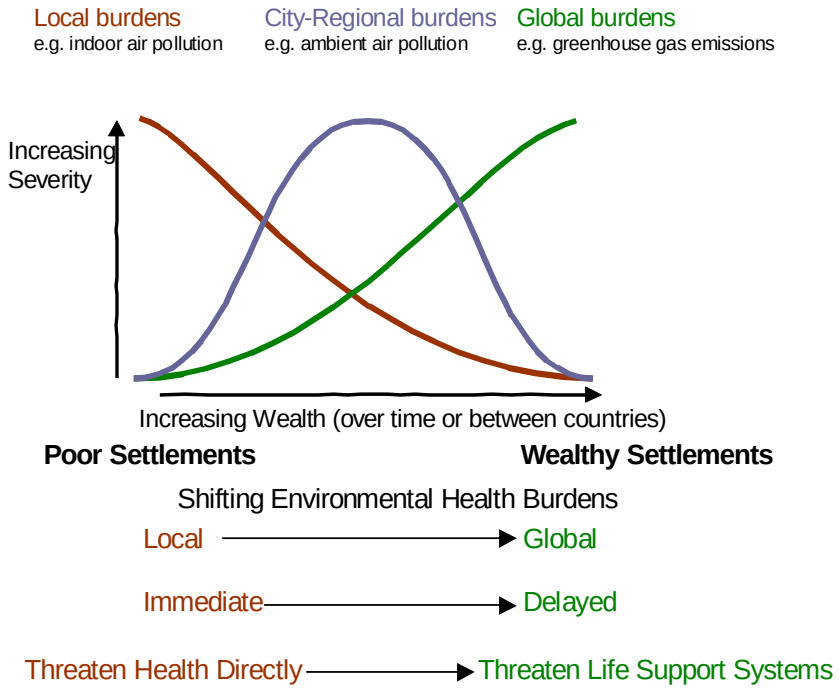
The urban environmental transition

Of more immediate relevance to the themes of urban housing, water and sanitation on the one hand, and cities and climate change on the other, is what has been termed the urban environmental transition (McGranahan, 2007; McGranahan et al., 2005; McGranahan, Songsore and Kjellén, 1996). This involves a shift from local environmental health burdens that impact health directly towards global environmental burdens that impact health through their effects on life-support systems. It is summarized in somewhat stylized terms in Figure 1.

The empirical basis for the diagram lies primarily in the results of multi-country comparisons relating different (mostly urban) environmental burdens to per-capita national income. The main household-level burdens, including urban access to water and sanitation, and indoor air pollution, all fall monotonically with income, as in the "local" curve in Figure 1. The main global burdens, including greenhouse-gas emissions as well as composite measures such as ecological footprints, tend to rise with income, as in the "global" curve. Many of the city-regional burdens, on the other hand, including most notably urban air pollution, have been found to display the inverted U-shape. (A large share of the variation in environmental burdens is unrelated to per capita income, of course.)

The diagram can also be viewed as representing change over time. For countries that industrialized in the 19th century, the declining "local" curve can be taken to represent the sanitary revolution of the late 19th and early 20th centuries; the declining part of the city-regional curve can be taken to represent the pollution revolution of the mid-/late-20th century. A hope that the "global" curve will turn is implicit in the contemporary aspirations for a sustainability revolution. Not only do these curves obscure considerable international diversity in these relations, but regional comparisons indicate that the positioning and overlap of the curves varies, and that the transition in rapidly developing countries involves what, in comparison with the historic development of Europe and North America, can be characterized as "time-space telescoping" (Marcotullio, 2007; Marcotullio, Williams and Marshall, 2005).

Figure 1: Stylized curves representing the urban environment and health transition



Source: Gordon McGranahan, Pedro Jacobi, Jacob Songsore, Charles Surjadi and Marianne Kjellén (2001), *The Citizens at Risk: From Urban Sanitation to Sustainable Cities*, Earthscan, London, page 17.

Historically, this transition has often involved the physical displacement of environmental burdens (McGranahan et al., 2001). Sewers are used to collect faecal material and release them beyond the urban boundaries. Higher stacks are used to displace air pollution burdens. Water and other resources are brought longer distances to urban centres as local sources run out. More generally, the spatial shifting reflects how increasing consumption puts increasing pressure on the environment, but also gives people the capacity to avoid the negative environmental consequences of increasing consumption, at least locally. Again, the relations underlying these transitions not only vary over time and from place to place, but also depend on how people respond to the changing challenges.

In Figure 1, the curves have been given no common units to measure severity of different environmental burdens. Even for the same environmental medium (e.g. air) it is very difficult to compare the severity of a local burden (e.g. indoor air pollution) to that of an intermediate burden (e.g. ambient urban air pollution), or to that of a global burden (e.g. greenhouse-gas emissions) (see Smith and Akbar, 2003 for a review of the different scales of air pollution and their interrelations). Health scholars have tended to focus on the "local" curves, as local burdens are most likely to affect health directly, and most of the better-known environmental health burdens decline with affluence. Environmentalists, on the other hand, focus on the "global" curve, and indicators like ecological footprints, constructed to measure global burdens, tend to

rise with income. The "city-regional" curve might seem the least orthodox, but has been the subject of hundreds of peer-reviewed articles in the field of environmental economics, and goes by the name of the Environmental Kuznets Curve (Yandle, Bhattarai and Vijayaraghavan, 2004).[3]

Disability-adjusted life-years and the urban environmental transition

Despite the different perspectives and metrics typically associated with the differently scaled curves, a recent attempt was made to interpret international differences in the burden of disease, measured in terms of disability-adjusted life-years (DALYs), in terms of this transition (Smith and Ezzati, 2005). The health risks estimated and attributed disease burdens were:

- **household environmental risks** – poor water, sanitation and hygiene; indoor air pollution from solid-fuel use; exposure to malarial mosquitoes;
- **community environmental risks** – urban outdoor air pollution; lead pollution; occupational risks; road-traffic accidents;
- **global environmental risks** – climate change.

The authors found that "the simplistic conclusions commonly drawn about the epidemiologic transition, in particular the increase in chronic diseases with development, are not supported by current data; in contrast, the conceptual framework of the environmental risk transition is broadly supported in a cross-sectional analysis" (Smith and Ezzati, 2005, page 291).

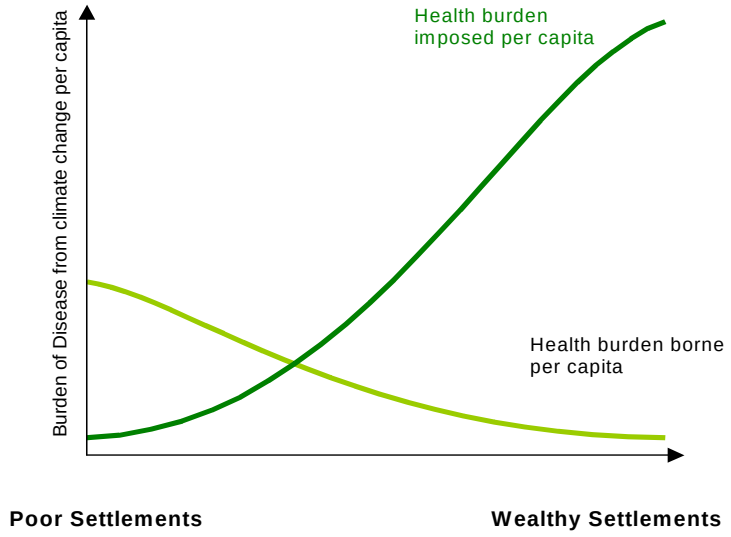
The spatial dimension rather complicates this transition, and makes explicit the interdependence of development trajectories. Thus, while the greenhouse-gas emissions per capita clearly rise with income per capita, the impacts of climate change on health are likely to display a different pattern. Existing estimates suggest that the health burden of climate change is highest in low-income countries and lowest in the affluent countries responsible for the burden. Indeed, Smith and Ezzati (2005, page 323) found that the ratio of imposed and experienced climate-change risks varied by a factor of more than 7,000 across different WHO-defined development regions, from 0.08 in part of Africa to 560 in North America.

The implied relationship between per capita income and imposed versus incurred health burdens from climate change is illustrated, again only stylistically, in Figure 2. The actual shape and level of empirically estimated curves, such as those presented by Smith and Ezzati (2005), will not only depend on the available data, but also on several critical assumptions. If the health burden for both curves is for the current year, then the area under the two curves should be the same, and the curve representing the burden imposed should reflect historic contributions (as in Smith and Ezzati's 2005 article). Alternatively, Figure 2 is intended to represent the burden borne in the current year, and the health burden imposed by the activities of the current year on all years. In this case the areas under the curve have no reason to be equal. The area under the imposed curve has been portrayed as larger than that under

[3] Despite all of this research, there is no consensus on the relevance of the EKC (Environmental Kuznets Curve). This may be in part because most research has been done without any reference to the scale or timing of the burdens. Reviews indicate that meaningful EKCs do not arise when the burdens are of international scale or have delayed impacts (Cole, Rayner and Bates, 1997; Lieb, 2004). Even where empirical EKCs are evident, this should not be taken to imply that income necessarily causes an eventual reduction in the environmental burden in question: since these burdens involve externalities, even market economics implies that there is a need for collective response.

the incurred/borne curve on the assumption that the burden in the current year is smaller than the cumulative impact of the current years emissions on health in future years. The relative positioning of the two curves is far more conjectural than that the burdens incurred curve has a positive slope and the burdens borne curve has a negative slope. In addition to temporal assumptions, spatial assumptions will make an important difference. Thus, for example, the burden imposed curve will be steeper if contributions to climate change are measured in terms of the global emissions supporting consumption in the localities, rather than in terms of local emission.

Figure 2: Stylized curves representing health burdens related to climate change



While both Figure 1 and Figure 2 highlight economically linked differences between urban areas, there are also important economically linked differences within urban areas (Utzinger and Keiser, 2006). For most household-level indicators, the same health-related differences arise: risks resulting from bad water, sanitation, and indoor air pollution are all likely to be worse in very poor neighbourhoods (McGranahan et al., 2001). Indeed, “slums” are often especially exposed to city-regional burdens. For example, they are more likely to be downwind of ambient air polluters, and downstream of water polluters. Climate-change risks are also more likely to fall on “slums”, and for similar reasons. In relation to sea-level rise and flooding, it is often poor groups who settle urban floodplains (McGranahan, Balk and Anderson, 2007). If there are extended droughts affecting urban water supplies, it is poor groups who are most likely to suffer, just as they do already from seasonal droughts (Castro, 2006).

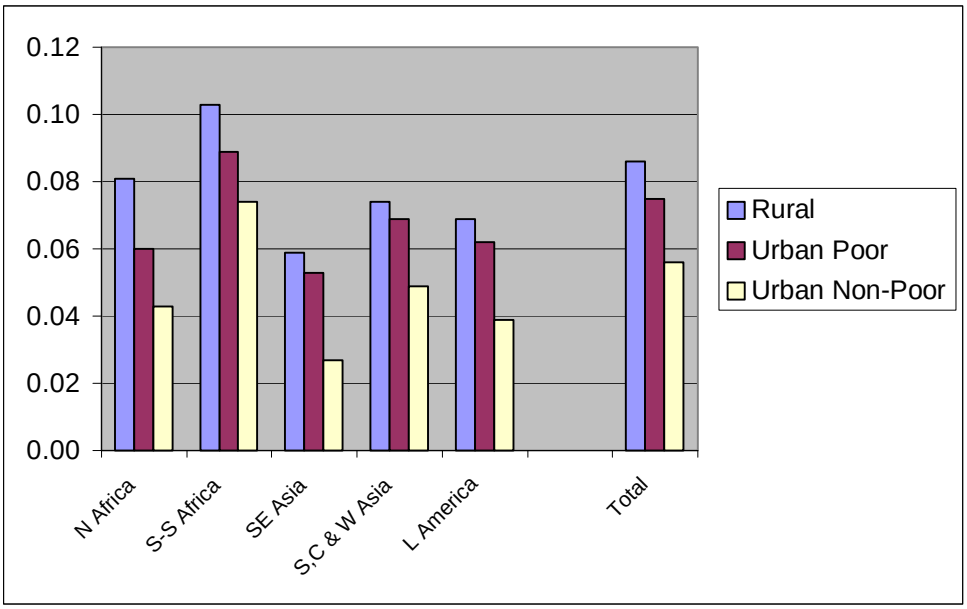
As such, poor urban groups often face multiple burdens, which from the perspective of the urban environmental transition can be described as overlapping, not merely in the temporal but in a spatial sense (Smith and Ezzati, 2005). Moreover, people living in conditions of urban poverty often suffer from a wide range of other health problems, many of which have little to do with the physical environment, even if they are closely linked to poverty. This should not be taken to imply, however, that they are necessarily less healthy than their rural counterparts.

Urban health penalties and advantages

Most cities of medieval and early modern Europe were far less healthy than their rural surrounds, and large cities were particularly unhealthy (Woods, 2003). While this urban health penalty was not universal, an appreciable but narrowing urban health penalty was also observed for the Indian subcontinent leading up to the 1940s, with cities like Madras, Calcutta, Rangoon and Bombay all reporting far higher infant mortality rates than the surrounding provinces (Dyson, 1997). The environment and health transitions described above were particularly evident in urban areas, leaving urban areas healthier than rural ones in most affluent countries. Even in the cities of low- and middle-income countries today, however, the mortality rates are typically far lower than those prevailing in the early industrial cities. Indeed, they tend to be considerably lower than in their country's rural areas. There is thus a sense in which the urban health penalty of the 19th and early 20th centuries became an urban health advantage. This urban advantage depends on public health measures, however. Moreover, with large and growing urban inequalities, it can be misleading to compare average health statistics of rural areas with urban areas. A large part of the difference reflects the fact that the affluent cluster in cities, not that the urban poor are healthier than their rural counterparts. Indeed, as noted at the end of the previous section, poor urban dwellers often face a wide range of health risks.

In most of Africa, Asia and Latin America, the results of Demographic and Health Survey (DHS) data indicate that infant and child mortality rates are lower in urban than in rural areas (Montgomery et al., 2003, page 127; Satterthwaite, 2007, Table 4.2, pages 84–84). Moreover, there is a tendency for infant and child mortality rates to be lower in larger urban settlements (Montgomery et al., 2003, page 280). The picture looks rather different if one differentiates between the better- and worse-off urban residents. Among the urban poor, infant mortality rates are quite close to the rural average, and in a number of countries they are higher (Montgomery et al., 2003, page 281). However, as illustrated in Figure 3, for every region the rural infant mortality rates are somewhat higher than those in what have been defined as urban poor areas. Similarly, an analysis of under-five mortality among wealthy and poor strata in rural and urban areas of African countries (based on 47 Demographic and Health Surveys (DHSs) and World Fertility Surveys (WFSs)) found that on average the urban poor were better off than the rural poor, but considerably worse off than the wealthy strata in both urban and rural areas (Garenne, 2006). Overall, affluence is clearly the dominant factor, particularly when one considers that sample surveys often undercount the very poorest urban dwellers, who can be difficult to locate let alone include in sampling procedures.

Figure 3: Estimates of infant mortality for rural, urban poor and urban non-poor populations, by region



Source: Analysis of demographic and health surveys in Montgomery, Mark R., Richard Stren, Barney Cohen et al. (editors) (2003), *Cities Transformed: Demographic Change and its Implication for the Developing World*, National Academy Press, Washington, D.C.

Within Sub-Saharan Africa, there are regional differences in the rural-to-urban under-five mortality differentials, though without any obvious geographical explanation. In his review of DHS and WFS statistics, Garenne (2006) found particularly large differentials in the southeastern part of the continent, and in Sahelian West Africa, and negligible differentials in a few countries (e.g. Liberia, Namibia, Chad, Botswana and Lesotho). In a number of countries in Sub-Saharan Africa, urban and rural child mortality rates were converging up into the 1990s, due to declining rural mortality rates (or in a few cases increasing urban mortality rates). Wars, economic crises, and other such events can lead to sudden changes in these trends however, and HIV/AIDS has more recently altered a wide range of health statistics in the region, with a particularly adverse effect on urban areas.

Somewhat similar results have been found in relation to child malnutrition. A global review of DHS survey results on children's height-for-age found that the children of the urban poor are consistently taller than rural children (Montgomery et al., 2003). On the other hand, using DHS surveys for 15 sub-Saharan African countries, a recent article found that, controlling for socioeconomic status, rural–urban differences were not statistically significant except in Malawi (Fotso, 2007). Moreover, this latter study found that over time the differences in rural and urban malnutrition have narrowed in most countries due to an increase in urban malnutrition (and have widened in a few countries where urban malnutrition has declined sharply).

3. Housing, water, sanitation and health – the persistent environmental health challenge of urban poverty?

As indicated above, the environmental contribution to the current global burden of diseases is closely linked to conditions in and around people's homes and workplaces. When the World Health Organization focused its *World Health Report* on risks to health, the only two environmental risks that figured in their top ten risks were unsafe water, sanitation and hygiene and indoor air pollution (WHO, 2002). It is estimated that in the year 2000, unsafe water, sanitation and hygiene accounted for about 1.7 million deaths (3.1 per cent of all deaths), and the loss of 54 million disability-adjusted life-years (3.7 per cent of DALYs) (Ezzati et al., 2002; WHO, 2002). In the same year, indoor air pollution accounted for an estimated 1.6 million deaths and the loss of 39 million DALYs (Ezzati et al., 2002; WHO, 2002).

Most of this mortality and disease is linked to diarrhoea in the case of unsafe water, sanitation and hygiene (Cairncross and Valdmanis, 2006), and lower respiratory infection in the case of indoor air pollution (Smith and Mehta, 2003).[4] In 2001, diarrhoeal diseases accounted for an estimated 2 million deaths and 62 thousand DALYs lost, while lower respiratory infections accounted for 3.9 million deaths and 91 thousand DALYs lost (WHO, 2002). These have long been among the principal diseases at the starting point of the epidemiological transition. The burden of these diseases falls predominantly on (infants and) children living in low-income settings in what are termed developing countries. Thus, it is estimated that 99.8 per cent of the deaths associated with unsafe water, sanitation and hygiene are in developing countries, and 90 per cent of the deaths are of children (WHO, 2002). The relative importance of these risks in the urban centres of low-income countries is difficult to estimate, but is likely to follow similar patterns to those for infant and child mortality discussed in the previous section.

Water, sanitation and the health impacts of faecal–oral diseases

In the policy-oriented literature, there is a tendency to focus on well-defined risks and (ostensibly) easy-to-monitor improvements, such as providing clean drinking water. In the Millennium Declaration of the United Nations General Assembly, from which the Millennium Development Goals are derived, the original water target was "to halve, by the year 2015, the proportion of the world's people who are unable to reach or to afford safe **drinking** water". The tendency to focus on clean drinking water has been reinforced by the term "water-borne diseases", which is part of the Bradley–Feachem classification of water-related diseases (Cairncross and Feachem, 1993), and refers to all diseases that can be borne by water. What is misleading is that these water-borne diseases can spread via a number of different routes. As Bradley noted, virtually any water-borne disease can also be spread from person to person, and indeed given unsanitary conditions they can spread through a variety of other routes. Other water-related diseases also have complex links to water provision, but not to drinking water quality *per se*. Malaria is spread by Anopheles mosquitoes that breed in fresh unpolluted water, and accounts for most of the remaining burden of water-related diseases; peri-urban settlements are more at risk, and the link to household

[4] Smith and Mehta (2003) estimate that for indoor air pollution, 64 per cent of deaths and 81 per cent of DALYs lost are from acute respiratory infections.

water supplies is tenuous. Dengue is spread by mosquitoes that can breed in small household water containers, and such containers are more common where water supplies are intermittent or distant. Schistosomiasis is spread by worms is often contracted by people fetching water from open water sources.

Faecal–oral disease transmission in deprived urban settlements

In affluent urban settlements a number of barriers have been created, making it difficult for the infectious organisms that cause diarrhoea (be they viruses, bacteria, protozoa, or helminths) to find their way from the faeces of one individual to the mouth of another. Faeces drop directly into water, in private toilet facilities within the home, and are flushed away. Clean water is piped into the settlement, both to the flush toilets, and to indoor taps where it can be poured directly into drinking vessels, sinks or other washing facilities. Sinks are strategically located to facilitate handwashing after defecation and prior to food preparation. Wastewater is immediately piped out of the homes, and into the sewers. The faecal material of infants and small children is collected in paper and plastic diapers/nappies, which are disposed of in plastic bags, and picked up from the residence on a regular basis. Waste material that would attract pests is also bagged and collected regularly. Barriers, including screens if necessary, are used to prevent insects from accessing either faecal material or food. Most fresh food is kept in a sealed refrigerator that not only secures it from pests but also slows bacterial reproduction. The list goes on, and extends well beyond the immediate residence. For someone living in these conditions, avoiding exposure to diarrhoeal disease is comparatively easy, and does not require a profound understanding of how these diseases spread – adopting a few simple routines will usually do the trick, and most of these can be justified in terms of cleanliness.

The situation in most crowded, unserviced urban settlements is quite different. Barriers are less present and more permeable.

- Water is often collected from local wells, contaminated by local pit latrines.
- If the toilets are distant or have long queues, some people will defecate in the open or dispose of faeces by wrapping them in paper or in plastic bags – known variously as the “wrap-and-throw” method or, more facetiously, as “flying toilets” as the bags are sometimes literally thrown away.
- Children are especially unlikely to use distant, crowded or costly toilets, and their faeces are especially hazardous.
- Household solid waste remains unbagged and uncollected, providing a breeding ground for flies and other pests.
- Children without safe places to play are likely to encounter faecal material in the neighbourhood environment. Children with diarrhoeal infections (or respiratory infections) represent a particular hazard, to their play- and work-mates and to their families.
- Food preparation is often done outside, or in unscreened kitchens where flies are present.
- Handwashing is often inconvenient. It has been estimated that to wash hands after defecating or handling children’s faeces and before handling food, as recommended, entails an average of 32 handwashes a day and consumes 20 litres of water (Keusch, Fontaine and Bhargava et al., 2006, page 377). For those who fetch water from long distances, or pay vendors to do the same, it is unrealistic to expect such standards.

- Shared toilets, and particularly public toilets, are especially difficult to keep clean, and especially hazardous when they are unclean.

An important aspect of this high risk of exposure in deprived urban communities is its public character. McKeown was perhaps only overstating things when he claimed in conditions such as those prevailing in early 19th-century Europe, “the washing of hands is about as effective as the wringing of hands” (McKeown, 1978, page 540). Indeed, while children might be told otherwise, handwashing itself protects those who come in contact with the washer as much if not more than it protects the washer him- or herself. More generally, collaboration within the community and government assistance from outside is clearly needed to address these threats. In economic terms, removing the basis for exposure is a spatially delimited public good, with various complications.

As noted in the previous section, poverty is also associated with poor nutrition, which increases susceptibility to diarrhoeal diseases, which in turn lead to further under-nutrition. Other infectious diseases can enter into this synergistic cycle, which is mediated by the immune system (Keusch, 2003). A parallel cycle can also emerge linking ill health and malnutrition with economic poverty, leading to destitution or death (Dasgupta, 1993).

Not everyone in a deprived neighbourhood is equally vulnerable, or has similar responsibilities for the home and neighbourhood environments. The young are especially likely to contract diarrhoeal diseases, and also often have different hygiene behaviours and responsibilities. Women often have the primary responsibility for securing water and maintaining sanitary standards, but often have comparatively little influence over the underlying infrastructure, facilities and service delivery. Thus, age and gender politics can have an important influence on water, sanitation and health (Songsore and McGranahan, 1998). However, without state support, or at least cooperation, it is very difficult to organize effective measures to prevent faecal–oral disease transmission.

Measures to interrupt faecal–oral disease transmission

Given the enormous diversity of faecal–oral routes (person-to-person, water-borne, food, flies, etc.), of local conditions (with their different levels of poverty, climates, crowding, service deficiencies and hygiene behaviours) and faecal–oral pathogens (with their different infective doses, latencies and abilities to persist and reproduce in the environment) it would be surprising to find simple rules to guide the choice of measures to improve health conditions. Instead, one would expect a measure like increased handwashing, improved sanitation facilities, or better access to water to range from being completely ineffectual in some circumstances to being critically important in others, even given the same initial level of handwashing, sanitation or water access.

Experts have long expressed concern that, judged in terms of their health benefits, water provision receives undue priority over sanitation and hygiene behaviour, and that water quality receives undue priority over the quantity of water households have

available for washing (Cairncross, 1990; Esrey, Potash and Roberts et al., 1991).[5] This would not be surprising, since water is far more saleable than sanitation or hygiene behaviour, and partly as a result most of the "stakeholders" within the water and sanitation sector are more concerned with water. Moreover, piped water quality is of particular concern to the more affluent households who already have sanitation and a piped water supply (though in many cities in low-income countries piped supplies are intermittent). The official statistics also indicate that urban sanitary improvement lags behind water-supply improvements (WHO and UNICEF, 2004).

Unfortunately, even within the narrow range of interventions typically identified with the water and sanitation sector (sanitation, water availability, water quality and hygiene behaviour) the number of rigorous epidemiological studies are too few to create diagnostic procedures allowing the most effective improvements to be derived from local environment and health conditions. A recent review and meta-analysis of water, sanitation and hygiene interventions to reduce diarrhoea screened over 2,000 studies, but ended up identifying only 46 studies deemed relevant (Fewtrell, Kaufmann and Kay et al., 2005). The resulting meta-analysis found that most types of interventions had a similar degree of impact, reducing diarrhoea by between 25 and 37 per cent. One would expect some degree of publication bias – studies that find little or no reduction in diarrhoea prevalence are likely to be harder to publish. Also, the interventions are likely to have been in locations where the interveners expected appreciable improvements. In and of themselves, these studies imply little about which interventions have a greater potential for reducing diarrhoea generally.

A more analytical and less statistical attempt to estimate the reduction attributable to different interventions is summarized in Table 1. The sharp difference in this table between the estimated reduction associated with a public water source and that associated with a house connection is based on the observation that the water-supply studies with the largest impact are those that provide water to the home, backed up by the established fact that households tend to use far less water if their water source is not actually in their residence or plot (Cairncross and Feachem, 1993). The comparatively high figure assigned to hygiene promotion reflects growing evidence that behaviour is central to diarrhoeal prevalence (Cairncross and Valdmanis, 2006). On the one hand, specific measures, such as handwashing, have been found to be surprisingly effective. Indeed, a 2003 review of epidemiological studies of the impact of handwashing on diarrhoea found that on current evidence washing hands with soap can reduce the risk of diarrhoeal diseases by 42–47 per cent, and interventions to promote handwashing might save a million lives a year (Curtis and Cairncross, 2003a). On the other hand, measures involving sanitary or water-supply improvements also depend on changes in hygiene behaviour. Thus, for example, new sanitation facilities are far less likely to affect diarrhoea prevalence if children do not use them.

[5] The discussion in this section ignores the role that different improvements may have on the evolution of pathogen virulence. Ewald argues that this should be an important consideration and, for example, that, when it comes to faecal–oral disease, preventing water-borne transmission is more likely to create evolutionary pressures reducing virulence than is preventing person-to-person transition (Ewald, 1994, 1996, 2004). While his views have not been widely endorsed, this would seem to be more because of the difficulty in predicting effects on virulence, rather than because such effects are not plausible.

Table 1: Estimated reductions in diarrhoea attributable to water supply, sanitation and hygiene promotion

Intervention	Reduction in diarrhoea (percentage)
Water supply	
Public source	17
House connection (additional reduction)	63
Excreta disposal	36
Hygiene promotion	48

Source: Cairncross, Sandy and Vivian Valdmanis (2006), Chapter 41: Water supply, sanitation, and hygiene promotion, in Dean T. Jamison et al. (editors), *Disease Control Priorities in Developing Countries*, World Bank and Oxford University Press, Washington DC, pages 771–792.

Cairncross and Valdmanis are also somewhat sceptical of interventions that target only the quality of water (Cairncross and Valdmanis, 2006). They muster five types of evidence to argue that domestic hygiene, including especially food and hand hygiene, is more important than water quality.

1. The appreciable number of studies where water-quality improvements have not been associated with reduced diarrhoea.
2. The studies of food, including weaning food, that have found higher levels of contamination with faecal bacteria in the food than in the water.
3. The seasonality of diarrhoea, which they argue indicates that food is a more likely vehicle than water.
4. The fly-control studies that have shown reductions in diarrhoea of 23 per cent.
5. The handwashing studies that have shown reductions in diarrhoea of 43 per cent.

Several recent studies and reviews do suggest that improving water quality in the home makes an appreciable difference to health (Bostoen, Kolsky and Hunt, 2007, page 107). However, especially in deprived settlements, water quality in the home also depends on hygiene behaviour, and water is often contaminated between the source and the point of consumption (Wright, Gundry and Conroy, 2004). There are some indications that interventions that improve water quality in the home are more effective than interventions at source (Clasen et al., 2007; Clasen and Cairncross, 2004), although water contamination by close family members will be less significant if transmission would otherwise have occurred through personal contact (VanDerslice and Briscoe, 1993). Water quality is clearly important, particularly in preventing epidemics of diarrhoeal diseases, including cholera. When it comes to the endemic diarrhoea that represents a far larger health burden, however, there are strong arguments for measures that prevent faecal material from entering the home environment, and for prioritizing faecal disposal and washing hands after defecation or the handling of children's faeces (Curtis, Cairncross and Yonli, 2000).

The high-density settlement characteristic of urban living would be expected to make the (average) cost of piped water and sewerage systems lower, and the health impacts of not having such systems higher. Density makes bad sanitation a particular problem, and increases the likelihood that groundwater resources will be contaminated. Indeed, in many urban areas, well-water use is forbidden, although it remains an important source of drinking and, even more often, washing water.

While these various improvements have been shown to have an appreciable impact on health, residents are more likely to prioritize improvements on different grounds, linked to convenience, status and cleanliness. Practices that are culturally maintained, and at least superficially would seem to have hygiene-independent cultural origins, may have an important hygiene dimension. In Jakarta, at least before the expansion of bottled-water sales, a survey found that nobody would drink their water without boiling it, and that they drank this water in the form of, often lukewarm, tea (Surjadi, Padhmasutra and Wahyuningsih et al., 1994). Historically, tea drinking in Jakarta was associated with the ethnically Chinese population there, but was also encouraged more widely for its health benefits (Abeyasekere, 1987). While health was probably not the motivation of most people who switched to tea drinking, the health benefits undoubtedly did help it spread. Tea has the added advantage of giving a visual sign of having been boiled. This complex embedding of hygiene improvements in cultural practices is not surprising, particularly given the public benefits that good hygiene practices provide. It is, however, a relatively slow process, and not one that can be relied upon to protect populations subject to large-scale migration or rapidly changing environmental conditions.

If health is not the primary motivation for changes in hygiene behaviour, it has also lost some of its effectiveness as a motivating force for city-wide water and sanitation improvements. Cholera and other sanitation-related epidemics helped to turn sanitary improvement into the basis for a movement that transformed urban governance (Melosi, 2000). Even before the germ theory of disease was accepted, many blamed urban filth for the emergence of epidemics, and this motivated sanitary improvements (Rosen, 1993). The epidemics affected the poor more, but threatened all classes of society, right up to royalty (Wohl, 1983). Providing public water and sanitation was not just, or even primarily, a means of improving conditions for the poor – these were true public services, that gave a new legitimacy to local government. Currently, endemic diarrhoea is more of a burden than epidemic diarrhoea: the risks are more localized, and for a well-off family a diarrhoeal disease is unlikely to lead to death. As such, the political basis for sanitary reform is far more evident within deprived communities and neighbourhoods than at the level of the city, though even at the local level the political and epidemiologic boundaries are unlikely to coincide (Bostoen, Kolsky and Hunt, 2007). Thus, for example, if one community solves its sanitation problem by releasing untreated human waste into a local stream, the affected downstream residents are likely to be part of a very different community.

Implications for action

Preventing excessive transmission of faecal–oral diseases in urban neighbourhoods typically requires coordinated action on the part of government authorities, utilities and the residents themselves. Water, drainage/sewerage and other networks and environmental services need to be extended, and residents need to change their behaviours. In affluent settings, a combination of taxes and tariffs can fund convenient services that encourage people to engage in hygienic behaviour, and overcome any temptation to engage in practices like open defecation, open dumping, drinking from unsafe water sources, or releasing human waste into open waterways. When it comes to low-income settings, and in particular in informal settlements or those whose legality is questioned, governments, utilities and residents all face far greater challenges. Governments are often loath to allow, let alone enforce, the

provision of infrastructure in informal settlements; the settlements may be considered illegal or sub-standard, and there may be fears that providing infrastructure will encourage their expansion. Utilities are often so under-funded that they hope to avoid providing subsidized services to deprived neighbourhoods. Residents are often so poorly organized and ill informed that they can neither address their own environmental health, nor negotiate effectively with governments and utilities.

This section focuses on water and sanitation, starting with a brief discussion of recent attempts to change the way in which the services are delivered, and then turning to some of the challenges more directly linked to hygiene behaviour and community organization. Somewhat similar considerations also apply to other environmental health problems, such as indoor air pollution and the presence of insects that spread diseases. The section ends with a brief review the implications for these other health risks.

Extending water and sanitation networks

Efforts to extend water and sanitation networks to all residents of cities in low- and middle-income countries have had limited success, only partly because of limited funding (UN-Habitat, 2003b, 2006). The UNICEF/WHO estimates of populations without access to "improved" water and sanitation put the urban estimates at about 570 million for sanitation and 150 million for water (WHO and UNICEF, 2004).[6] Public utilities were once held to be the best model for extending affordable water and sanitation to urban populations. In many low- and middle-income countries, however, public utilities ended up in financial difficulties, providing low-cost and low-quality services to limited parts of the population. During the 1990s a great deal of attention was paid to increasing private-sector participation, and in particular encouraging public–private partnerships involving multinational water companies (Finger and Allouche, 2002). These were promoted on the grounds that commercial efficiency would replace public bureaucracy and political clientelism, and that the private partners would bring in or attract private capital.

After a flurry of concession contracts, however, this process of privatization began to falter. The private sector displayed little interest in investing private capital in extending water and sanitation to deprived households (Hall and Lobina, 2006). It proved difficult even to design and regulate contracts that would give the private operators the incentive to provide quality services efficiently and equitably. It became clear that governments that could not manage public utilities were not well placed to manage contracts with private operators. In any case, many of the obstacles to providing water and sanitation in the informal settlements, where most of the urban poor live, could not be overcome simply by changing the operation of utilities (Budds and McGranahan, 2003). While the debate over privatization has been very polarized, the empirical evidence is ambiguous (Clarke, Kosec and Wallsten, 2004; Kirkpatrick, Parker and Zhang, 2006). Given that this privatization was promoted internationally, and received both financial and political support from the more affluent countries, this is in itself a serious indictment.

[6] These figures are far lower than the numbers of urban dwellers without safe or adequate water and sanitation; "improved" is not intended to imply safe or adequate, and using the same definitions in both rural and urban areas neglects the particular problems of unserved urban areas (Satterthwaite and McGranahan, 2006).

Privatization is no longer being so actively pursued by international agencies such as the World Bank (although many of the regulatory changes being advocated are more supportive of commercialization, and eventually to greater private participation). Good governance is increasingly presented as a precondition for extending water and sanitation provision, whether the operator is public or private (McGranahan and Satterthwaite, 2006; UN-Habitat, 2005). Part of this good governance involves creating better relations with the residents of deprived neighbourhoods, and with their organizations.

Organizing to improve sanitary conditions in deprived settlements

Since it remains likely that centrally organized service provision, whether publicly or privately operated, will continue to fail to reach many of the most deprived urban residents, it is also important to consider alternative approaches, not only to service provision but also to improving hygiene behaviour. Hygiene behaviour is particularly critical when good water and sanitation facilities are not available. People do not change their hygiene behaviour for reasons of health alone. One possible conclusion is that governments need to grasp the nettle, decide what key services and hygiene behaviours are most important to promote, and then to promote them, not on grounds of health, but as the private sector promotes other consumer products – on whatever grounds are most appealing (Curtis and Cairncross, 2003b). Programmes such as the public/private partnerships between soap companies, governments and agencies such as the World Bank fit this mould (http://www.globalhandwashing.org/, accessed 23 April 2007). This approach conforms neatly with the advocacy of markets and private-sector participation described above in relation to service provision.

A problem with this conclusion, and the approach it seems to entail, is that market-responsive enterprises expand or contract depending on the profits that they make, and not according to the health benefits they provide. Advertisers face the challenge of getting people to buy products that they do not inherently want, but when they succeed their enterprises automatically expand, because their sales give them the profits that both signal success and can finance the expansion. Health benefits are not so tangible, and do not provide an automatic basis for expansion. Some health promoters may also feel that the manipulation inherent in advertising should not be transferred to the health sector, because it will undermine the trust necessary for evidence-based health education. Perhaps just as important, because of the continuing uncertainty about which faecal–oral routes are most significant, and hence which measures are likely to be most effective in reducing faecal–oral disease, there is the danger that in many locations the wrong measures will be promoted. If these measures draw on local residents' scarce income, the net health effects in such locations could be negative. There may be some measures, such as washing hands after defecation, that are sufficiently critical to justify widespread promotion, but many other locality-specific opportunities will be lost.

This leads into a second possible approach, which is to recognize the importance of local knowledge, and to provide health-related support to urban poor groups and their organizations in their efforts to improve local conditions. This would entail closer relations between health care workers and urban poor groups and those who work with them. From this perspective, it is important to recognize that while health may rarely be the main reason why people want to improve their water supplies or sanitary facilities, or why they change their hygiene behaviour, people do generally want

better health for themselves, their families and indeed for their communities. Moreover, a concern for health may lie behind and reinforce motivations felt and expressed in other terms, particularly if health is considered to be the domain of experts. If, for example, a mother scolds a child for playing in a smelly gutter, the fact that she does not invoke or even consider the diarrhoeal risk should not be taken to imply that the risk is irrelevant, or that knowledge of that risk has not changed her behaviour, at least indirectly.

On the other hand, a World Health Organization report evaluating the costs and benefits of water and sanitation improvements calculated that benefits typically exceeded the costs, but that time savings made a larger contribution to the benefits than did health improvement (Hutton and Haller, 2004). Indeed, given the quantities of water involved (the minimum recommended quantity is about 20 litres of water per capita per day), the savings in time and effort from piped water can be considerable. Alternatively, the cost of paying itinerant vendors to bring water is also very high (UN-Habitat, 2003b). An assessment of a deprived urban settlement in the Philippines found that, largely because of waiting times, it took on average 3–4 hours to complete a water-collection task, despite the presence of public taps within 100 metres (Aiga and Umenai, 2002). This illustrates the danger inherent in making recommendations on the basis of health considerations, narrowly conceived (or even on the basis of the cost-effectiveness of different measures to improve health). Particularly in conditions of poverty, a narrow pursuit of health may lead to recommendations that go against the interests of local residents. Non-health concerns can be important, and not just as a means of convincing people to take action to improve health.

It is inherently difficult, and at times contradictory, to pursue acceptable health standards for the unacceptably poor. Such difficulties and contradictions are amplified when resident-government relations are bad. The colonial government in Accra (Ghana), for example, enforced sanitary regulations so vigorously that in some years thousands of women were prosecuted for having standing water or filth in their compounds, and the routine “he” used to designate the accused in the District Court was reportedly changed to a routine “she” (Robertson, 1984, page 34). In the post-colonial period, few governments have relied so heavily on the courts to enforce sanitary regulations, but unrealistically high standards have taken their toll in a variety of other ways.

One of the most successful efforts to expand sanitation in low-income settings has been that of the Orangi Pilot Project – Research and Training Institute (OPP–RTI) of Karachi. Contrary to what its name might seem to suggest, OPP–RTI is an NGO that has worked with Orangi residents since 1980 to provide sanitation for about 100,000 households, and has also supervised smaller sanitation projects in about 250 other locations (Hasan, 2006). The OPP model is one of local residents taking responsibility for “internal sanitation” (indoor latrines, lane and neighbourhood sewers), and local government taking responsibility for “external sanitation” (trunk sewers and treatment plants). The OPP helps to organize the lanes, provides communities with plans, maps, tools and training, and has developed construction standards that are compatible with what the low-income residents can afford. Except for the small outlays of OPP (amounting to about a twentieth of the cost of the internal sanitation), local residents cover all of the costs.

Two features of the OPP approach are of particular relevance to health promotion.

1. OPP activists are intimately familiar with local conditions and living arrangements, and standards are designed to provide affordable, as well as desirable, safe and effective sanitation.
2. The first step is to hold meetings and to mobilize people, creating the basis for collective action. (A common reason for failures in attempts to replicate the OPP approach has been the lack of strong community organizations or the capacity to create them).

Many of the other successful attempts to engage local residents in improving local water and sanitation provision have similar features, and are often part of broader efforts to improve local conditions.

In reviewing such efforts, a recent paper argued that the three features common to them and to the OPP are that they promote local ownership, encourage incremental improvements and support alternate forms of community organizations within low-income settlements (McGranahan, Mitlin and Satterthwaite, 2007). Some of the most promising initiatives are not situated within either the health sector or the water and sanitation sector, but are part of more broad-based attempts to help the urban poor to improve their living conditions. Thus, for example, a partnership between an NGO (SPARC), a federation of slum dwellers, and a network of women's savings associations (Mahila Milan) has pioneered a successful and innovative approach to sanitation, as part of a broader approach to grassroots-driven development (Patel and Mitlin, 2002; Satterthwaite, McGranahan and Mitlin, 2005).

Addressing other local environmental health hazards

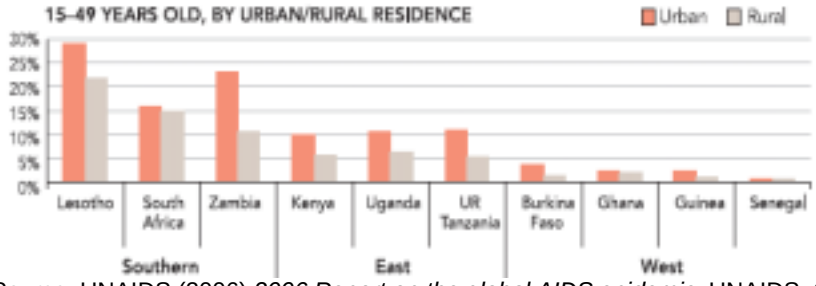
In addition to faecal–oral diseases, there are numerous other health problems linked to the quality of people's homes, workplaces and neighbourhoods that can also be addressed by locally driven initiatives. As indicated above, acute respiratory infection is often linked to indoor air pollution, just as diarrhoeal diseases are often linked to bad water and sanitation. Reducing indoor air pollution, like improving water and sanitation, is often presented as a question of improving service delivery (and providing clean fuels, rather than clean water). Yet, particularly in conditions of extreme poverty, it also raises issues of behaviour, and finding second-best solutions that are affordable. There are also gender and childcare issues, some linked to the fact that it is women and young children who are most exposed to smoke, women who are most often responsible for cooking, and young children who suffer most from acute respiratory infections (Songsore and McGranahan, 1998). Not only can further parallels be made with environmental hazards in people's homes and workplaces, but, as argued in Box 1, there are even parallels with and indeed direct links to the spread of HIV/AIDS.

Especially in very low-income settings, the link between housing, environmental conditions, and livelihood opportunities can be important to health. Moving people from an unserviced downtown slum to an isolated peri-urban settlement can be very disruptive economically, and forced evictions are likely to cause serious health damage (Emmel and Souza, 1999).

Box 1: HIV/AIDS in Africa, urban poverty and environmental health risks

Even in terms of life expectancy, HIV/AIDS in sub-Saharan Africa has reversed a long-term convergence of health outcomes among countries (Goesling and Firebaugh, 2004). It has understandably diverted attention away from other health burdens, particularly in those parts of Africa where prevalence is high and the capacity for treatment low. As illustrated in Figure 4, the prevalence is generally higher in urban areas; on average UNAIDS (2006, page 10) estimates that urban HIV prevalence is 1.7 times greater than rural prevalence. As with faecal–oral pandemics in the past, once the generalized nature of the threat is clear, the HIV pandemic tends to galvanize the public sector, but certain poor groups are often both most at risk and blamed for the disease (in the case of HIV/AIDS more for their sexual practices, or their drug habits, than for their cleanliness). This interferes with efforts to combat both the spread of HIV and the emergence and management of AIDS.

Figure 4: HIV prevalence by urban/rural residence for selected sub-Saharan African countries



Source: UNAIDS (2006) *2006 Report on the global AIDS epidemic*, UNAIDS, Geneva. Accessed 25 April 2007. Available from http://www.unaids.org/en/HIV_data/2006GlobalReport/default.asp.

The spread of HIV is directly linked to sexual practices, but several recent publications argue that an almost exclusive focus on this link in HIV prevention policy has had very detrimental effects (Ambert, Jassey and Thomas, 2006; Mabala, 2006; Van Donk, 2006). Differences in sexual practices do not explain all observed differences in HIV prevalence; if they did, US universities would be in a far worse state than African cities (Stillwaggon, 2006). Economic and gender-related issues can be critically important (Dodoo, Zulu and Ezeh, 2007; Kalipeni, Oppong and Zerai, 2007; Masanjala, 2007; Shelton, Cassell and Adetunji, 2005).

Many of the same conditions described above in relation to faecal–oral diseases also contribute to the spread of HIV and the progression to and impact of AIDS. Malnutrition lowers immunity and increases viral load in HIV-infected persons, making them more contagious (Stillwaggon, 2006). Helminths (worms) associated with bad sanitation make people more susceptible to HIV, speed up progression to AIDS, and greatly increase the transmission of HIV from mothers to babies (Ambert, Jassey and Thomas, 2006). Schistosomes, freshwater worms that women often pick up when getting water or washing at an infected waterhole, can infect the vulva, cervix and vagina, creating lesions that facilitate HIV transmission (Stillwaggon, 2006, page 44). Malaria, which can be indirectly linked to water supply and drainage, makes people more susceptible to HIV. Malaria also increases the viral load, making people with HIV more contagious. Poor access to water also contributes to mother-to-child transmission, as it makes it difficult for mothers to follow the recommendation of exclusive formula feeding after six months (Ambert, Jassey and Thomas, 2006). Depending on the severity of HIV/AIDS-related symptoms, it has been estimated that 20–80 additional litres of water are required daily for an AIDS sufferer (Ngwenya and Kgathi, 2006).

A range of other urban conditions have also been linked to the spread of HIV or the severity of the illness it causes (Ambert, Jassey and Thomas, 2007). These include:

- overcrowding and high densities;
- inequitable spatial access and city form;
- competition over land and access to urban development resources;

- pressure on environmental resources;
- pressure on urban development capacity and resources.

There are a number of important similarities in the challenge of reducing the spread of HIV/AIDS and that of reducing the spread of faecal–oral diseases. In both, intimate behaviour is critical. There are important gender and age dimensions to both; for example, both HIV/AIDS and faecal–oral diseases are likely to spread more easily where women lack power and influence. Economic dynamics are also central to the spread of both. Concerted action based on an understanding of local conditions and behaviours is central to reducing the spread of both. In both, there is a tendency for experts to focus on a central means of transmission (unprotected sex for HIV/AIDS, and contaminated water for faecal–oral diseases), and to neglect contributory factors that vary from place to place. Both have involved pandemics, initially threatening both affluent and poor groups, and more prevalent in urban areas. Perhaps most important, at least in urban areas, both could in principle be addressed together by a locally grounded public-health activism, driven by local concerns, but informed by the latest science. Indeed such public-health activism could also address a variety of other concerns, ranging from indoor air pollution to the locally emerging threats of global climate change.

Two apparent differences are that faecal–oral diseases are now more localized, and primarily a threat to poor groups within the settlements where they are prevalent. The evidence of Demographic and Health Surveys indicates that in a number of sub-Saharan African countries wealthier men and women tend to have higher prevalence of HIV than poorer ones (Mishra, Bignami and Greener et al., 2007). This could be the result of wealthier groups being more urban, more likely to survive for long periods with HIV, and more likely to have the mobility, time and resources to maintain concurrent sexual partnerships (Shelton, Cassell and Adetunji, 2005). Perhaps more important, it may reflect the comparatively recent emergence of HIV/AIDS. When cholera, for example, became a major killer in 19th-century European cities, it was both a pandemic and affected many affluent as well as poor residents. It is quite possible that as the AIDS pandemic evolves, HIV/AIDS will become more localized, and restricted to poor groups, reinforcing a trend already being driven by the dramatic differences between the quality and length of life for those with full anti-retroviral drug therapy and those without. On a more positive note, it is also possible that the public character of the HIV/AIDS pandemic will, like the pandemics of faecal–oral diseases of the past, help drive a new public health movement that extends well beyond the initial diseases of concern. To date, however, there is little evidence of this.

4. Global climate change, urban development and health – a growing environmental challenge of urban affluence?

Economic globalization is widely credited with bringing prosperity, albeit very unevenly. Unfortunately, economic globalization also brings global environmental changes that can pose a wide range of health risks, from new outbreaks of infectious diseases to crop failures and famine. Urban centres are critical to many such risks, because of the environmental burdens they (can) impose and the vulnerable populations they (can) contain. This is nothing new. Most familiar infectious diseases emerged only after people settled and began to live in cities (May, 2006). Urban development and trade helped to spread the plague through Europe, killing off an appreciable share of the population. It also introduced and spread cholera, again killing many millions, before eventually spurring the still incomplete sanitary revolution. The worst hit by the globalization of infectious diseases were those of the "New World"; when infectious diseases from the Old World spread through the Americas, they killed around half the population, and wiped out whole civilizations (McNeill, 1989).

Currently, the most debated global environmental concern is global climate change, caused by the emissions of greenhouse gases. While unique in many of its features, climate change is very much in a class with other global environmental burdens brought on by high levels of human production and consumption. Urban areas concentrate both emitters of greenhouse gases and people at risk from climate change. Wealthy cities and populations are the major emitters, while poor cities and populations are likely to be the most vulnerable. This section is concerned primarily with vulnerability to climate change, and particularly to the health risks that climate change is likely to bring to urban areas.

The potential health impacts of climate change range from quite direct (e.g. ill health from heat exposure) to the extremely indirect (e.g. malnutrition resulting from an economic depression that a wide range of climate changes combine to help create). Attempts to examine the health implications of climate change tend to focus on the more direct effects, as they are if not more predictable at least more clearly linked to climate change. A recent review found that most research on the health effects of climate change has focused on "thermal stress, extreme weather events, and infectious diseases, with some attention to estimates of future regional food yields and hunger prevalence" (McMichael, Woodruff and Hales, 2006). This brief section will of necessity follow this lead. There is no reason to think that the direct impacts will be larger than the less direct impacts, however. As indicated in Figure 1, global environmental burdens are more likely than local burdens to affect health through undermining life-support systems. Moreover, just as climate change is only one of the better understood of many global environmental pressures that could lead to health impacts, so the climate change impacts discussed below are just some of the better understood of many routes by which climate change could affect health.

Not all impacts on health will be negative, but the net effect almost certainly will be, particularly if no adaptive measures are taken. After all, people have adapted their social, human, physical and natural capital to existing climatic conditions and

variability. Other species and ecological systems have also adapted. The problem is not that the changed climate will be inherently worse for humans – though in some ways it will be – but that change itself, and particularly rapid change, is disruptive and damaging to humans and our life-support systems. Even if steps are taken to mitigate the effects of climate change, some global warming and other related changes are already inevitable. Steps must also be taken to adapt to climate change, and cities are among the most important places to start (Huq, Kovats and Reid et al., 2007). This will be difficult, especially in settlements where vulnerability is high, and there are political obstacles to adaptation (De Sherbinin, Schiller and Pulsipher, 2007). The enormous uncertainty about the severity of the impacts adds to the challenge.

Climate modelling is highly uncertain, but the Intergovernmental Panel on Climate Change (IPCC) has attempted to identify the most significant climate changes that can be expected up to 2100, and the ranges within which the changes are likely to fall. It projects temperatures increasing by between 1.1 and 6.4 degrees centigrade, depending on the scenario and where within the uncertainty range the outcome lies (Alley, Berntsen and Bindoff et al., 2007).[7] For the same period, sea level is projected to rise by between 0.18 and 0.59 metres – rapid dynamic changes in ice flow might yield higher sea-level rises, but there is no consensus on their magnitude. Warming is expected to be higher over land than over water, and to be especially high at very Northern latitudes. Heatwaves and periods of exceptionally high precipitation are very likely to become more common. Tropical cyclones (typhoons and hurricanes) are likely to become more intense. Increases in overall precipitation are likely in high latitudes, while decreases are likely in most subtropical land areas. It is also fair to say that we should expect some surprises – these changes are both poorly understood, and known to involve thresholds and sudden shifts.

Table 2 provides a range of examples of how climate change can create direct heath risks. Most of these involve risks that can be countered, at least to some degree. As such, populations that can and do protect themselves from these risks will be far less vulnerable. A selection of these risks is discussed below. In addition to these direct health risks, the economic and social consequences of climate change are also likely to have health impacts. The health of people impoverished by floods or wildfires, for example, is likely to be affected even if they suffer no direct health effects.

“Natural” disasters present extreme health risks, although there are two reasons to question the adjective “natural” in the case of disasters associated with climate change. Firstly, extreme climate events resulting from anthropogenic climate change are not truly “natural”. Secondly, there is nothing “natural” about the lack of preparedness that already allows many extreme events to cause so much damage. Already, incompetent and inappropriate post-disaster responses, as well as pre-disaster neglect, greatly increase the health impacts of storms, floods and the like.

[7] The comparisons refer to 2090–99 relative to 1980–99.

Table 2 Examples of how climate changes can create health risks

		Climatic change	
	Floods, windstorms and storm surges	**Droughts and wildfires**	**Rising temperatures and heatwaves**
Injury	Collapse of shelter and other infrastructure; contact with submerged objects; vehicle incidents	Burning injuries from wildfires in peri-urban zones; violent conflicts over water	Work-related injuries as a consequence of overheating
Temperature stress	Loss of housing leading to exposure to ambient temperature extremes	Lack of water exacerbating effects of thermal stress	Thermal stress, enhanced by urban heat-island effects
Faecal–oral diseases	Exposure to faecally contaminated floodwaters; damaged water and sanitation systems	Declining water resources leading to water-supply interruptions and hygiene problems	Higher temperatures increasing risk of food poisoning (e.g. salmonellosis)
Respiratory diseases	Dampness and mould in the home environment, increasing susceptibility to respiratory diseases	Inhalation of smoke from wildfires, increasing susceptibility to respiratory diseases	Secondary chemical reactions within the urban atmosphere, elevating levels of some pollutants
Vector-borne diseases	Altered breeding conditions for mosquitoes and other vectors, and loss of protective shields (e.g. windows, screens)	Altered breeding conditions for mosquitoes and other vectors; human population movements spreading disease	Altered distribution of mosquitoes and other vectors change, increasing disease transmission.
Malnutrition	Crop damage and lower food supplies; loss of livelihoods and income based access to food	Reduced agricultural productivity and food supplies	Loss of traditional crop production, leading to food shortages
Mental health	Psychosocial responses to danger, disruption, illness, displacement and losses	Psychosocial responses to danger, disruption, illness, displacement and losses	Psychosocial responses to discomfort

Health risk

Sources: Draws heavily on and replicates parts of Table 1 in Few, Roger (2007), Health and climatic hazards: Framing social research on vulnerability, response and adaptation, *Global Environmental Change*, Vol 17, Issue 2, pages 281–295. Also includes examples from McMichael, Anthony J., Rosalie E. Woodruff and Simon Hales (2006), Climate change and human health: present and future risks, *The Lancet*, Vol 367, No 9513, pages 859–869.

Rising temperatures, heatwaves and thermal stress

Thermal stress resulting from higher temperatures is perhaps the most obvious health risk associated with global warming, though it is unlikely to account for more than a small fraction of the health burden of associated climate change. The European heatwave of August 2003, which caused about 15,000 deaths in France alone, clearly showed how severe the impact can be for an unprepared population, even a relatively affluent one (Haines, Kovats and Campbell-Lendrum et al., 2006, Table 1). Elderly people are especially at risk, and the life-years lost depend on the share of deaths that would have occurred in any case in the coming months. A study in Phoenix, Arizona found that low-income people and ethnic minorities were more likely to live in warmer neighbourhoods with greater exposure to heat stress (Harlan, Brazel and Prashad et al., 2006).

One would also expect greater vulnerability to heatwaves among low-income populations, and in low-income countries. A recent IPCC report noted that very little evidence is available on the impacts of thermal stress in low- and middle-income countries (Confalonieri and Menne, 2006). Existing evidence does seem to corroborate this expectation, however. For example, a recent study concluded that the

2003 heatwave in Shanghai caused far fewer deaths than a similar heatwave in 1998 because of a combination of air conditioning, larger living areas, and increased urban green space, along with higher levels of heat awareness and the implementation of a heat-warning system (Tan, Zheng and Song et al., 2007). In this case, affluence and preparedness combined to reduce vulnerability.

As indicated in Table 2, thermal stress is not the only health risk associated with higher temperatures, and some of the other risks, including for example an increased risk of food-contracted illness, are likely to be even more closely associated with higher temperature in conditions of economic poverty. This is evident in a recent comparison of the mortality increases resulting from overly hot days in Delhi, Sao Paulo and London (Hajat, Armstrong and Gouveia et al., 2005). The study found that the increase in all-cause mortality resulting from high temperatures was largest in Delhi and lowest in London, with Sao Paulo intermediate. Moreover, in London the increased mortality was compensated for within a few days by decreased mortality, while in Delhi the increase extended for weeks. The authors concluded that "those most susceptible to heat are likely to remain susceptible if there is not due attention paid to infectious disease, diarrhoeal illness, and other major causes of early mortality in these poor populations" (Hajat, Armstrong and Gouveia et al., 2005).

Floods and storm surges

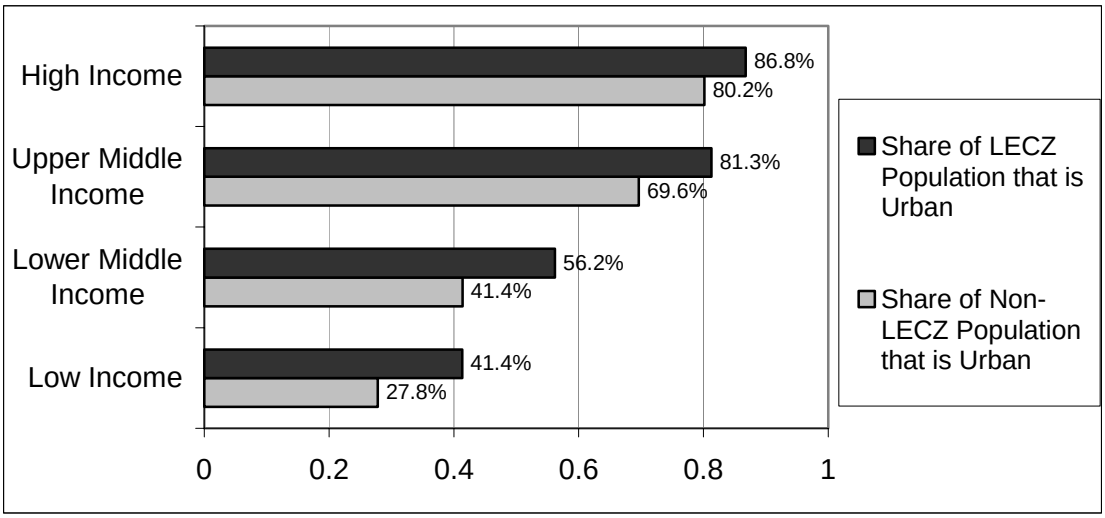
Urban disasters and environmental hotspots are already concentrated in coastal areas (De Sherbinin, Schiller and Pulsipher, 2007). Through both sea-level rise and more severe storms, climate change will increase flood risks in coastal areas. Floods can have a broad range of health impacts, starting with the drowning and bodily injuries resulting directly from people's physical impact with the floodwaters, and extending to the health effects of exposure to sewage, the disruption of clean water supplies, the loss of housing, and associated mental problems (Ahern and Kovats, 2006). Again, far more detailed epidemiological studies are available for affluent countries, but the health risks are almost certainly higher in less affluent countries.

Settlements have long been drawn to the coast. The coastal area that is less than ten metres above sea level covers 2 per cent of the world's land, but contains 10 per cent of the world's population (McGranahan, Balk and Anderson, 2007). While the risk to small island states is (rightly) publicized, most of the countries with large populations in the zone are large low- or middle-income countries with heavily populated delta regions. Indeed, about half the population in the zone is in five Asian countries: China (144 million), India (63 million), Bangladesh (62 million), Vietnam (43 million) and Indonesia (42 million). For Vietnam this represents 55 per cent of the national population, and for Bangladesh 46 per cent, making these countries especially vulnerable.

The low-elevation coastal zone is more urban than other areas. As illustrated in Figure 5, this is especially true in low-income countries, where over 40 per cent of the population in the zone is urban, as compared to less than 30 per cent of the rest of the population. In some countries (most notably China) urbanization is driving a movement in population towards the coast. Even in Africa, where overall only 7 per cent of the population lives in the zone, 12 per cent of the urban population does. Larger urban areas are also more likely to extend into the low-elevation coastal zone,

and almost two-thirds of urban settlements over 5 million in population fall at least partly in the zone.

Figure 5 Urbanization levels within and without the Low Elevation Coastal Zone (LECZ)



Source: McGranahan, Gordon, Deborah Balk and Bridget Anderson (2007), The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones, *Environment and Urbanization*, Vol 19, No 1, pages 17–37.

Already the mortality and morbidity caused by floods are considerable, and the IPCC has estimated that, as a result of sea-level rise and storm surges, many millions more people will be flooded every year by the 2080s. Between 1994 and 2004, it is estimated that there were 1,562 flood disasters, killing 120,000 people and affecting some 2 million people (Few, 2006, Table 1.2, page 13). As one would predict from the estimates given above of populations in low-elevation coastal areas, Asia was particularly hard hit, accounting for about a third of the reported disasters, half of the people killed, and 98 per cent of the people affected. It is not known what shares of this damage were urban.

In low-income urban settings, and especially where responses are slow, the secondary health effects of flood disasters are likely to be particularly significant. Diarrhoeal diseases, which do not appear to be an appreciable risk associated with flooding in affluent countries, emerge as very important but difficult to measure in lower-income countries (Ahern, Kovats and Wilkinson et al., 2005). In their description of the health impacts of the Mozambique floods of 2000, Cairncross and Alvarinho (2006) note that thousands of urban septic tanks overflowed, piped water supplies in eight small towns were damaged, the incidence of diarrhoea increased, and there were outbreaks of cholera. Flooding in Dhaka has also been linked to large increases in diarrhoea incidence, not only in academic studies but also in the press (Alam and Rabbani, 2007). Other infectious disease outbreaks have also been documented in the wake of flood and storm disasters (Ahern, Kovats and Wilkinson et al., 2005; Shultz, Russell and Espinel, 2005).

As with many other risks, floods fall along a continuum, ranging from disasters to everyday hazards (Satterthwaite, Huq and Pelling et al., 2007). The combined health effect of the large number of smaller floods may already be bigger than that of major

disasters, and can also be expected to increase with sea-level rise and more severe storms. These smaller floods are not well documented, and their health impacts are not possible to estimate. Again, however, the vulnerability is almost certainly higher in low-income urban centres. A recently published report from ActionAid portrays the lack of preparedness in six African cities (Douglas, Alam and Maghenda, 2006), but the problems are more general. Drainage systems are often rudimentary, and quickly clogged with waste. Sanitation systems are prone to overflowing, and faecal material can easily find its way into the floodwaters. The effects that impermeable urban surfaces have on water flows are often not taken into account in planning. Even urban dwellers often depend on open wells. Perhaps most important, in coastal urban settlements land in the floodplains is often inexpensive, partly because formal development is not allowed, and attracts low-income residents who cannot afford to live in the formal settlements.

The number of people living in informal settlements vulnerable to coastal flooding is rarely documented locally, let alone internationally. As sea levels rise, however, these people are especially likely to suffer a large health burden. They may already be affected regularly by floods, and indeed many have adapted coping strategies in an attempt to minimize the impact (Few, 2003). Sea-level rise and more severe storms are likely to overcome these strategies, however. Especially where protection is too costly, the obvious solution is to negotiate resettlement. Unfortunately, relations with government authorities are typically poor, particularly in cities where the struggle by low-income residents to obtain land has historically led to conflicts, illegal settlement and evictions. The residents of informal settlements are often not so much planned for as planned against (Hardoy, Mitlin and Satterthwaite, 2001). Efforts to improve conditions are inhibited by a range of factors, including: the lack of economic resources available to the residents; the weakness of local government; the unwillingness of local governments to prioritize (or in some cases even allow) public support for these informal settlements; and unwillingness by international agencies to support assistance to these settlements (Satterthwaite, 2007).

Droughts and water scarcity

A recent IPCC report projects that average river runoff and water availability will decrease by 10–30 per cent in some dry mid- and low-latitude regions (Adger, Aggarwal and Agrawala et al., 2007). The report estimates that in Africa, for example, between 75 and 250 million people will experience greater water stress due to climate change (Adger, Aggarwal and Agrawala et al., 2007). Superficially, this might seem to imply a comparatively direct impact on the health of the urban poor, through household water supplies on the one hand, and food supplies on the other. After all, water-related diseases and malnutrition are two of the principal health burdens among urban poor groups. Hundreds of millions of urban dwellers already lack adequate access to water (Satterthwaite and McGranahan, 2006; UN-Habitat, 2003b). Gaining access to food is also a critical challenge (Ruel and Garrett, 1999), and urban agriculture can be an important coping strategy (Mougeot, 2005).

On closer inspection, however, here too the links between climate-change impacts and health depend very much on intermediate institutions, and how people and governments respond to climate change. While discussions of water stress often imply a clear link to water access, by for example citing the burden of water-borne diseases

directly following an account of the population facing water stress, the empirical evidence for such a link is notable by its absence.

Judging from the official statistics, higher national water stress is associated with a higher share of urban households with access to “improved” water supplies (McGranahan, 2002; UN-Habitat, 2003b). To some degree this probably reflects misleading statistics. Water stress may drive some people to obtain access to improved water supplies, for example, but this does not imply that it actually improves water access for the population at large. To take a local example, since the groundwater in North Jakarta is saline, this area has a higher share of residents using piped water than does South Jakarta, but things are much worse for those without piped water (Surjadi, Padhmasutra and Wahyuningsih et al., 1994). It would be highly misleading to conclude that the salination of groundwater had actually improved water access in North Jakarta. More generally, the lack of any appreciable relation between water stress and water access reflects the fact that water stress is not the principal reason why so many urban dwellers lack adequate access to water.

Urban groups that are economically impoverished, politically weak and socially fragmented face difficulties getting adequate water and sanitation to meet their basic needs, regardless of their region’s water resources (Satterthwaite, 2007; Satterthwaite and McGranahan, 2006). While water scarcity may drive up the price of water, there are often differences of an order of magnitude or more in the price of water in different parts of a city, and in particular between purchases through the piped system and purchases from itinerant vendors who must carry the water door-to-door (McGranahan, Njiru and Albu et al., 2006; UN-Habitat, 2003b). In physical terms, the amount of water required to meet people’s basic needs is only about 7.5 litres per person a day, although access to 20 litres per person per day is often taken to be the minimum acceptable (Howard and Bartram, 2003). Carrying this amount of water any more than a few metres is an onerous task, but in comparison with other major water uses the quantities involved are almost negligible. Thus, for example, increasing the water consumption of a billion urban dwellers by 20 litres a day would require only about 7 cubic kilometres of water annually, while total annual human water consumption is estimated at over 2,000 cubic kilometres (Gleick, 2003).

Drought and increasing water stress may affect the ability of urban residents to meet their water needs, but this impact will depend on the quality of urban governance. Drought and water stress are most likely to have a large and adverse impact on urban faecal–oral diseases if they take place in a setting where basic needs and threats to health are not treated as a priority, and part of the population finds it difficult to translate its water and sanitation needs into entitlements. There is already evidence of scarcity-related conflicts in some cities. Thus, for example, in Mexico City water-related protests rise in the dry season, particularly in the poorer parts of the city where interruptions are more common (Castro, 2006). The struggle for domestic water is more likely to foment conflict where it is already rife. If the economically and politically disadvantaged groups lose out, their access to water and sanitation is likely to be curtailed, resulting in ill health.

The risk that drought and declining agricultural production will increase malnutrition in urban areas involves similar issues. As Sen famously argued, famine is rarely the result of absolute food scarcities (Sen, 1980; 1982). Rather, it is better conceived of as

a crisis in entitlements, which may be set off by declining food production, but can also have other roots. An agricultural crisis can raise food prices, and urban poor groups are particularly vulnerable to high food prices. This is in part a reflection of their general food insecurity (Ruel and Garrett, 1999), which could be made worse by climate change.

The impact of climate change on agriculture could have many other health implications, including for example an increase in faecal–oral diseases. Thus, an agricultural crisis can also have a severe impact on certain groups of the rural population, driving increased rural–urban migration. Urban authorities are likely to react by blaming migrants for the increasing demand on urban services, including for example water and sanitation. This, in turn, can become an excuse for not addressing service deficiencies in the informal settlements of the urban poor, on the grounds that better services will encourage still more migration (McGranahan, Mitlin and Satterthwaite, 2007; Tacoli, McGranahan and Satterthwaite, 2007). While it is difficult to predict how such crises will unfold, it is important to be aware of the multiplicity of routes through which changes in climate may affect urban health.

Implications for adaptation

Climate change is not the only environmental change likely to contribute to the health risks described above. Urbanization and the heat-island effect will contribute to thermal stress. Land subsidence in the delta regions will contribute to increasing flood and storm risks. Population growth and the growth of competing water demands will contribute to water scarcity. More generally, for many countries the evolving risks of climate change must be seen within the context of the transitions described in Section 2, above. As Revi (forthcoming 2008) describes, for example, it is important to view India's climate-change mitigation and adaptation agendas in the context of its rural–urban transformation.

In considering urban adaptation to climate change, Satterthwaite and colleagues (2007) note that it is important to build resilience in a way that:

- also reduces the risks from other environmental hazards;
- builds on existing experience in dealing with urban disasters;
- builds up a strong local knowledge base; and that
- recognizes the importance of
    - competent and accountable city and sub-city government, interested and able to develop good working relations with all residents, including those living in informal settlements and working in the informal economy
    - well-organized civil society groups, including especially representative organizations of the urban poor, interested and able to develop good working relations with supportive government agencies (and able to criticize unsupportive agencies)
    - national governments and international agencies, willing to support local governments, and fostering better relations between local government and urban poor groups
    - constructive engagement with the private sector, which also has a collective interest in adapting to climate change.

The urban settlements of high-income countries are likely to find it easier to adapt to climate change, but this makes it all the more important that those in low- and middle-income countries also start to take measures for adaptation. Measures to reduce the urban heat-island effect, to avoid or protect settlements in flood-prone areas, or to reduce vulnerability to increasing water scarcity will be less expensive if they are taken early, before more investments are made in inappropriate infrastructures, institutions and locations.

This need not mean ignoring the current needs of vulnerable groups. The cities in a good position to adapt to climate change, as its effects emerge, are likely to be those that can already address the contemporary challenges of enabling their urban poor to acquire land, housing, water and sanitation. Settlements that have managed to find equitable and efficient means of distributing their existing water resources will be in the best position to adapt as these resources become scarcer. Settlements that have managed to find the means to resolve land disputes equitably and efficiently will be in the best position to change their land-use patterns in response to sea-level rise.

There are also specific measures that will need to be taken to adapt to the risks of climate change (and, of course, to mitigate against climate change). These will need to be debated and negotiated locally, and supported nationally and internationally. As implied in the above discussion on health and well-being, it will be critical to bring a health perspective to bear on these issues. Furthermore, as implied in the discussion on transitions, adaptation to climate change can be seen in the context of a shifting set of environmental burdens that are in danger of leaving the urban poor exposed to a wide range of environmental health risks over which they have very little control. Since climate change has been created by a process of environmental displacement driven by economic growth, those who have benefited from this economic growth have a responsibility not only to mitigate climate change but also to help vulnerable groups adapt. As implied by the last two sections above, this should be achievable through an approach that considers both the health risks of local environmental burdens and also the emerging risks of global environmental change. While it would be a serious mistake to make support for adaptation conditional on taking measures of mitigation, one would expect localities engaged in adaptation to be more supportive of mitigation measures.

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