TOPIC GUIDE:
Urban poverty, urban pollution and environmental management

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- Are illustrated with examples and case studies;
- Stimulate thinking and questioning;
- Provide links to current best 'reads' in an annotated reading list;
- Provide signposts to detailed evidence and further information;
- Provide a glossary of terms for a topic.

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- Send an email to the Evidence on Demand Editor at enquiries@evidenceondemand.org with your recommendations for other Topic Guides.

Acronyms

APHRC	The African Population and Health Research Centre
CODI	Community Organisation Development Institute
GDP	Gross domestic product – the monetary value of all the finished goods and services produced within a country's borders in a specific time period
GHG	Greenhouse gas
IFRC	International Federation of Red Cross and Red Crescent Societies
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
LPG	Liquefied petroleum gas
MDG	Millennium Development Goal
PCB	Polychlorinated biphenyls
PM	Particulate matter
SDG	Sustainable Development Goal
UCLG	United Cities and Local Governments
UNICEF	United Nations Children's Fund
WHO	The World Health Organisation

Summary and key lessons

Defining urban pollution: This Topic Guide covers chemical pollutants and disease-causing agents in the home, workplace and wider city. It also includes consideration of GHG emissions in urban areas; most are not pollutants in the sense of having a direct impact on human health or ecological resources but they are the main drivers of climate change.

Most urban inhabitants in low- and middle-income nations suffer very large (and mostly preventable) health burdens from urban pollution. The main cause of this is a lack of capacity and competence within urban governments to meet their responsibilities for ensuring environmental health, waste management and pollution control. This is often exacerbated by a lack of local government accountability to those living in their jurisdiction. Urban economies and populations have grown far faster than the needed (mostly local) government capacity.

Well-governed cities with adequate infrastructure are among the world's healthiest places to live and work. Cities concentrate people and businesses – and all their solid, liquid and gaseous wastes. For well-governed cities, this is not a problem as the needed infrastructure and services are in place. Also, the regulatory and public investment capacities are there to ensure these are managed well. Cities provide many agglomeration economies for this – as it is cheaper per person to provide high quality provision for water, sanitation, solid waste collection and management and to implement environmental regulations. The result is that well-governed cities do not have all of the health problems associated with pollution. In addition, hundreds of city governments have committed to reducing GHG emissions and have demonstrated ways of delinking a high quality of life from high emissions per person.

Poorly governed cities that lack infrastructure are among the world's most dangerous places to live and work. Most urban governments show governance failures. This can be seen in the high proportion of the urban population that lacks water piped to their premises, provision for good quality sanitation and household waste collection. In many cities, the proportion lacking such provision has increased since 1990. Most cities in sub-Saharan Africa and a high proportion in Asia have no sewers or other provision to collect toilet wastes and no covered storm drains. If they do, these only serve a small proportion of the population.

New governance frameworks at the city and regional level will help to meet the increased demand for resources and reduce the impact of pollution at both local and global levels. Generally, the larger and wealthier the city, the greater its draw on resources from the surrounding area (especially for freshwater and usually for food) and on waste sinks (for polluted water and solid wastes). Most wealthy cities also have high levels of GHG emissions within their boundaries or peripheries. The very urgent global need to avoid dangerous climate change adds two new tasks to city governance: seeking wherever possible to keep down GHG emissions and building a greater resilience to climate/climate change impacts.

Both indoor and outdoor pollution create challenges for pollution control. Ambient air pollution levels are usually high in industrial cities with inadequate control and in cities where solid fuels are widely used for cooking and heating in homes and small-scale industries. Air pollution is also a serious problem in many large cities with high concentrations of motor vehicles (especially where local conditions inhibit the dispersal of air pollutants). The

problems of indoor air pollution (for those using dirty fuels in the home) and occupational exposure (both in formal and informal businesses) also need to be addressed.

Safeguarding water resources and preventing water pollution is essential. All cities depend on reliable supplies of freshwater but few urban authorities in low- or lower-middle-income nations have paid sufficient attention to managing their water resources.

Innovation is key to pollution control. This Topic Guide has many case studies illustrating this. From Surat's response to a plague epidemic and flood to Manizales disaster risk reduction programme, innovation has provided a basis for developing responses to climate change.

Most of the environmental health burdens from pollution are concentrated in informal settlements in urban areas. Around a billion people live in such settlements. Many informal settlements have developed on land at increased risk from the impacts of climate change, e.g. flooding. A lack of infrastructure, such as storm drains, exacerbates this risk.

Initiatives to improve conditions in informal settlements including provision for water and sanitation are an important (if unconventional) form of pollution control. Household's wastes – including wastewater, garbage and toilet wastes – are not usually considered as 'pollution'. But with poor quality sanitation and no solid waste collection service, these become among the most serious environmental health problems, particularly in informal settlements.

Bottom-up partnerships between informal settlement residents and local governments are effective in improving conditions. Federations of slum/shack dweller organisations have developed in over 30 nations. They are currently engaged in partnerships with local governments in over 100 cities to improve provision for water, sanitation and drainage and support housing improvements.

Changing frameworks is the key to cleaner industry. Many industries have shifted from a conventional 'pollution control' agenda to one that supports cleaner production and addresses the larger sustainable development issues, including climate change mitigation.

Local governance gaps must be addressed. Much of the responsibility for addressing the pollution/environmental health problems noted above falls to local governments. But most local governments in low- and middle-income nations lack the capital and the technical and institutional capacity to act. One of the deficiencies of the MDGs and potentially the SDGs is the failure to recognise how much their goals (and associated targets) depend on local governments for their fulfilment.

To be effective, pollution control policies must be integrated across all levels of governance. Effective local governments need support from higher levels of government – to address city-regional issues (especially freshwater management and disaster risk reduction) and for the much-needed framework of regulatory controls for water and wastes (especially hazardous wastes).

Environmental management and governance has great relevance for four agendas:

- poverty reduction and universal provision of services (with its strong focus on environmental health)
- disaster risk reduction (much of which is identifying and acting on risks from extreme weather)
- climate change adaptation (to incorporate new risks or increased risk levels into

disase risk reduction and service provision)
- climate change mitigation (attention to where GHG emissions within the city and its surrounds can be kept down or reduced).

Three challenges

1. **To recognise the many economic, social and environmental determinants of health in urban areas** and in doing so, to identify the many local measures that can contribute to environmental health/pollution control.
2. **To understand and address the environmental health/pollution control needs and priorities of those most at risk and most vulnerable to pollutants**. This has to include a strong focus on upgrading informal settlements. Also consideration of how risks and vulnerabilities vary by age and gender. Women and girls from low-income households often face higher exposure to toilet wastes and indoor air pollution and higher risks accessing toilets.
3. **To find ways to support urban governments to meet their pollution control/environmental health responsibilities** – and get what are usually competing urban agendas to work together.

The chart below is a guide that enables quick navigation through the document. Click on the section or subsection title to skip to your area of interest

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Terms in italics refer to boxes outlining case studies and examples.

SECTION 1

Introduction

Urban areas can be among the world's most healthy places to live and work – but also among the least healthy.

This Topic Guide is a summary of what is known about the environmental impacts of urban areas with a particular focus on urban pollution and on good practice in reducing it. Urban pollution encompasses the exposure of urban populations to pathogens (disease-causing agents) and chemical pollutants in the home, workplace, neighbourhood and wider city.

This guide also:

- **considers links between poverty and pollution in urban areas,** i.e. where and how do low-income women, men and children get higher levels of exposure, and the impacts on health, incomes, assets and livelihoods;
- **focuses on urban pollution within the informal settlements** and cheap boarding houses that are home to around one billion urban dwellers in low- and middle-income nations;[1]
- **covers the exposure of populations and ecosystems outside urban boundaries to urban pollution** and how a consideration of climate change needs to be integrated into this.

Box 1 Common confusions

1. **Discussions of urban environmental problems often conflate or confuse environmental health issues (e.g. the impact of air pollution on health) with ecological impact issues** (including the impact of wastes generated within cities on their surrounds and GHG emissions generated within cities – or arising from the consumption of urban dwellers). Environmental health issues such as contaminated water or food, indoor air pollution and disease vectors (for instance those that spread malaria and dengue fever) often get too little attention, perhaps because they are not seen as environmental problems. Maybe the most telling evidence on the relative impact of different pathogens and pollutants is their contribution to premature death. In general, what might be termed environmental diseases (diseases transmitted through water, food, air or contact with disease vectors) make a much larger contribution to premature death in low- and lower-middle-income nations compared to upper-middle- and high-income nations. Generally, it is also low-income urban dwellers that have the highest levels of premature death from these within urban populations (Mitlin and Satterthwaite 2013, Sverdlik 2011, APHRC 2014).

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[1] This Guide draws on Hardoy et al. (2001) which is the most comprehensive volume on environmental problems in urban areas of the Global South; the origin of this book was a request from DFID in 1989 for a detailed brief on this topic in preparation for the 1992 Earth Summit. This brief was then developed into a book in 1992 and Hardoy et al. (2001) is a revised and much expanded version of this book.

2. **Human-induced GHG emissions are not really pollutants in the sense of having a direct impact on human health or ecological resources** but they contribute to global climate change that is bringing or will bring very serious direct and indirect impacts, especially if global agreement is not reached and acted on for the needed global emissions reduction.

The impacts of pollutants and pathogens in the urban environment are evident in their impacts on premature death, illness or injury and loss of income, livelihoods or assets. They have central roles in these issues in urban areas where local governments are unable or unwilling to address these, along with a third category of environmental hazards – physical hazards in the home (for instance, burns, cuts or scalds, accidental fires) and the wider city (including road traffic accidents). Their most serious impacts are usually concentrated in the informal settlements and cheap boarding houses where much of the low-income urban population is concentrated. In more prosperous and well-governed urban centres, these impacts are much reduced. The impacts of environmental hazards and capacity to reduce risk or cope with the impacts differ within exposed populations (for instance, infants and young children are especially at risk from many pollutants and pathogens). These are often termed vulnerable populations with vulnerability being understood to include higher exposure to hazards, higher risks when exposed and lower capacity to avoid these or cope with their impacts.

Urban areas often have damaging impacts on the areas around them that affect both the health of the inhabitants and resources, including freshwater resources and protective and productive ecosystem services.

This Topic Guide also covers:

- **global environmental issues** (especially climate change) and
- **the implications of urban pollution and the consequences for development.**

SECTION 2

An urbanising world and the multi-dimensional aspects of urban poverty

2.1   Key knowledge and research

2.1.1   Current trends in urbanisation

Today, urban areas in the Global South (what the UN terms less developed regions) are home to around three-quarters of the world's urban population, about 2.7 billion people. The Global South also has most of the world's large cities and mega-cities.

The United Nations anticipates that almost all growth in the world's population over the next 30–35 years will be in urban areas in the Global South, as populations in high-income nations hardly grow at all and the world's rural population declines (see Figure 1).

Figure 1 Projected growth in the world's population 2015–2050
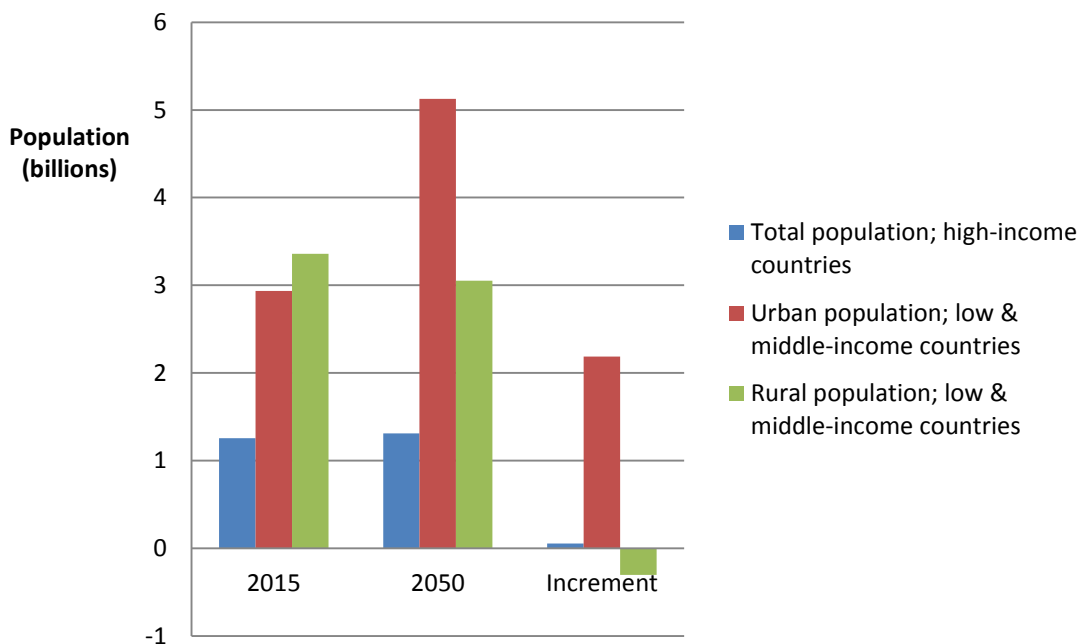
Source: United Nations 2014

2.1.2   Reasons for the trends

There is an economic logic underpinning urbanisation (the increase in the proportion of a population living in urban areas) and the growth of most large cities (Satterthwaite, 2007; World Bank, 2008). Most new capital investments and employment opportunities are

concentrated in particular urban areas (to which there are also generally the largest new migration flows). The largest cities are heavily concentrated in the world's largest economies – even if not all of these are among the economies with the highest per capita incomes. (For instance, China and India, among the world's largest national economies, have a high concentration of the world's largest cities.) The world's wealthiest nations are predominantly urban.[2] In addition, virtually all of the low- and middle-income nations that have shown large increases in the level of urbanisation over the last few decades have had long periods of rapid economic growth and large shifts in the structure of their economy and employment from agriculture, forestry and fishing to industry and services. Most nations (and all relatively urbanised nations) generate most of their GDP through industry and services and a high proportion of their workforce is employed in these sectors. Some nations have experienced rapid migration flows to urban areas (or particular cities) that are not in response to economic growth – including some related to civil strife or civil wars or to rural impoverishment or disasters – but this does not alter the fact that most urbanisation is linked to economic growth.[3]

2.1.3 Urbanisation and statistics

Box 2 Urbanisation: statistics can lie

Almost all commentaries on urban change globally include a comment that the level of urbanisation in sub-Saharan Africa is increasing rapidly. But some care is needed on this issue because of the lack of census data for many nations in this region (see Potts, 2009). The latest UN statistics on urban trends also suggest that the level of urbanisation in sub-Saharan Africa is not urbanising as rapidly as had been previously stated or expected. In fact, the rate of increasing urbanisation was more rapid in Asia for 1990 to 2000 and for 2000 to 2010. Eastern Asia (including China) had particularly high rate of increase in the level of urbanisation between 1990 and 2010 (United Nations, 2014).

There has been a rapid growth in the number of low-income urban dwellers, despite the new investment and employment opportunities in urban areas. Most of the benefits of economic growth go to non-poor groups. The scale of urban poverty today is much larger than it was in the mid-1970s – and the proportion of the world's population with inadequate incomes who live and work in urban areas has increased.

2.2 Urban poverty

2.2.1 Causes of urban poverty

Many factors contribute to urban poverty. Inadequacies in the international measurement of poverty have led to difficulties in quantifying the scale of the problem. Many poverty lines are still based mainly on food costs with some small upward adjustment for non-food needs. The original dollar/day poverty line that is now usually set at $1.25/day (and with current discussions considering a further increase) was based primarily on the cost of food (see Mitlin and Satterthwaite, 2013, for more details on this), but does not consider the multi-

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[2]   In addition, most rural areas have been 'urbanised' in terms of employment structures as most of the rural population do not work in agriculture, forestry or fishing with many commuting to urban jobs or to industry and service enterprises that locate in rural areas or tlecommuting.

[3]   Here it is important to distinguish between growth in urban populations and growth in levels of urbanisation. Nations' urban populations can be growing rapidly from natural increase even as the level of urbanisation increases slowly or not at all.

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dimensional nature of urban poverty. Figure 2 illustrates this by showing eight immediate causes of urban poverty and a much larger number of contributory factors. Of the eight causes listed, three are directly linked to urban pollution (poor quality hazardous housing, inadequate provision of infrastructure and services, inadequate protection of rights through the operation of the law) with most of the others also having an influence (for instance, voicelessness and powerlessness within local governments and low incomes necessitating use of poor quality water and fuels).

Figure 2 Dimensions of poverty
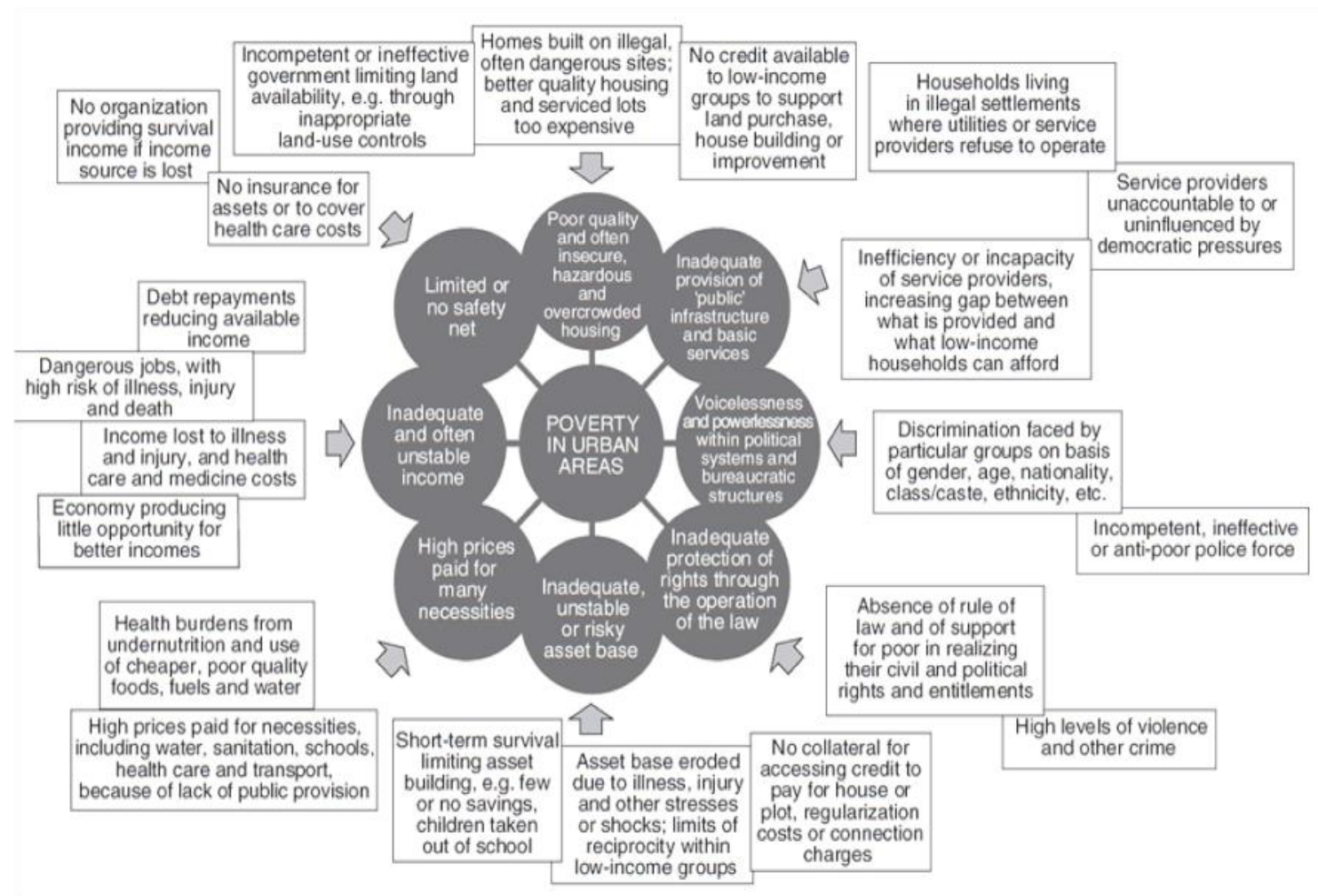
2.2.2 Impacts of urban poverty

Table 1 below gives some estimates for the number of poor urban dwellers based on different aspects of deprivation with a short commentary on the implication for urban pollution policy responses.

Type of poverty	Numbers of urban dwellers affected	Notes
Inadequate income to meet the cost of food and non-food basic needs	800–1,200 million	No accurate figures are available on this and the total varies, depending on the criteria used to set the poverty line (the 'income-level' required for 'basic needs').
Inadequate or no provision for safe, sufficient water and sanitation	In 2000, at least 680 million for water and 850 million for sanitation. UN figures for 2010 suggest over 700 million urban dwellers do not have water piped to their premises and are without 'improved' sanitation	The estimates for 2000 are from a detailed global UN review of individual city/urban studies (UN–Habitat, 2003a) The figures for 2010 are from UNICEF and WHO (2012) but the figures for 'improved sanitation' are known to considerably understate the number of urban dwellers without access to good quality toilets in their home (Mitlin and Satterthwaite, 2013).
Hunger	500 million+?	In many Asian and sub-Saharan African nations, 25–40% of urban children are underweight and/or under height. In many nations, more than half the urban population suffers from food-energy deficiency including India, Pakistan and Bangladesh (Ahmed et al., 2007).
Living in poverty i.e. in housing that is overcrowded, insecure and/or of poor quality and often at risk of forced eviction	1 billion+? Many cities in Asia and Africa have 30-60% of their population in informal settlements	Based on a 2003 global UN review of the number and proportion of people living in 'slums' (UN–Habitat, 2003b) with an allowance for the increase in number since then. UN–Habitat's more recent estimates suggest around 800 million but this is likely to be an underestimate.[4]
Homelessness (i.e. living on the street or sleeping in open or public places)	c. 100 million	UN estimate. There are also large numbers of people living on temporary sites (for instance, construction workers and often their families living on construction sites) that are close to being homeless.
Lack of access to health	Hundreds of millions?	No global estimates, but many case studies of

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[4] There are serious doubts as to the accuracy of the UN–Habitat 'slum' statistics for many nations in UN–Habitat (2012). First, there are the criteria used for defining 'slum' households. A household is defined as a slum household if it lacks one of more of 'improved' water, 'improved' sanitation, durable housing or sufficient living area. But a large proportion of households with 'improved' water or sanitation still lack provision to a standard that meets health needs (or, for water, what is specified in the Millennium Development Goals as sustainable access to safe drinking water). If there were the data available to apply a definition for who has provision for water and sanitation to a standard that reduces health risks and ensures convenient and affordable access, the number of 'slum' dwellers would increase considerably. Second, the UN's 'slum population' statistics show very large drops in the proportion of urban dwellers living in 'slums' in some nations, for which there is little supporting evidence. For instance, the proportion of the urban population living in 'slums' in India is said to have fallen from 54.9% in 1990 to 29.4% in 2009. For Bangladesh, the proportion is said to have fallen from 87.3 to 61.6% in this same period. Where is the supporting evidence for this? It may be that most of the apparent fall in the slum population globally between 2000 and 2010 was simply the result of a change in definitions – as a wider range of (inadequate) sanitation provision was classified as 'improved'.

Type of poverty	Numbers of urban dwellers affected	Notes
care, education and social protection; also to emergency services		informal settlements show the lack of provision for these. Access to these may require a legal address which those living in informal settlements lack.
Absence of the rule of law	Hundreds of millions?	No global estimates, but in a high proportion of informal settlements, there is little or no policing. The absence of the rule of law may show up in high levels of violence and high murder rates.
Lack of voice	Hundreds of millions?	No global estimates – but getting on the voter's register often depends on having a legal address and/or documentation that most urban poor groups do not have. There are also many nations where even if those in informal settlements can vote, this has not provided the 'voice' needed to get their needs and priority concerns addressed.

Table 1 Estimates for the scale of different aspects of urban poverty in low- and middle-income nations

2.2.3 Policy responses

Urban policy responses to pollution and its impacts on the poor must adopt a more holistic understanding of urban deprivation. Such a definition recognises the 'environmental' aspects of urban poverty in terms of the higher environmental health risks faced by much of the low-income population. This includes how different aspects of urban poverty (inadequate incomes, assets, housing, access to infrastructure and services, voice…) relate to exposure to urban pollution and its impacts. Identifying the groups most at risk requires consideration of exposure and susceptibility to pollution (for instance, the risks from diarrhoeal diseases, malnutrition and of premature death being higher for infants and young children), as well as their coping capacity and adaptive capacity (that contributes to lower risks).

SECTION 3

Challenges and opportunities

3.1 Urban pollution challenges

Urban areas concentrate the solid, liquid and gaseous wastes produced by their inhabitants, workforce, businesses and other institutions. These include air pollution and solid and liquid wastes from residents and their homes, industries and other businesses, public bodies, motor vehicles and often thermal power stations. There may also be pollutants that are part of the urban stock – for instance, asbestos used in buildings.
Urban workers are exposed to a range of indoor and outdoor pollutants. Without effective governments able to legislate, regulate and ensure waste collection, management and disposal, urban centres become very dangerous places to live and work.

3.1.1 Informal settlements

One of the greatest challenges is the billion or so urban dwellers that live in informal settlements or in very poor quality, overcrowded accommodation in formal settlements.

There is no accurate data on the scale of this population. In most nations there is no regular, detailed assessment of the number or proportion of the urban population living in such accommodation. UN–Habitat publishes statistics on the proportion of the urban population living in 'slums' for many nations and globally, but much of this is based on estimates or projections from old data and on questionable definitions of 'slums' and 'slum households' (see footnote 4; also Section 5 below discusses the inadequacies in the statistics on water and sanitation that are a key part of the definition of 'slum populations'). UN–Habitat's claim that 227 million people 'moved out of slums' between 2000 and 2010 seems to be attributable to a change in how slum populations are defined (see IFRC, 2010; Mitlin and Satterthwaite, 2013; see also footnote 3).

Several case studies have highlighted the problems associated with informal settlements, but data are patchy and more research is needed. There are many detailed case studies of poor quality housing and living conditions, in particular informal settlements, and some include health data to show the very large burden of disease from pathogens or pollutants (see Sverdlik, 2011 for review of health issues facing residents of informal settlements). There is also the path-breaking study by the African Population and Health Research Centre on infant, child, adult and maternal health in informal settlements in Nairobi that shows the very large health burden facing those living in such settlements (that house more than half of Nairobi's total population) (APHRC 2002; also APHRC 2014). But perhaps unsurprisingly, there is little data on this for most informal settlements in that their informality (or illegality) can also mean they fall outside basic data collection systems. There are also very large deficiencies in most urban areas in data on causes of death – which have proved a valuable data source for understanding and orienting government intervention and action in what are today high-income nations.

3.2   Urban pollution opportunities

Urban concentrations also provide agglomeration economies for addressing these challenges. For instance, in the lower costs per person or per household reached with piped water, sewers, storm and surface drains, solid waste collection and most forms of services (including schools, health care services and emergency services).

3.3   Governance

Where urban governments have the competence and capacity to ensure their provision, cities can become among the world's healthiest places to live and work. For larger cities, governance challenges include establishing the much-needed multi-level governance that involves coordination and cooperation among different adjacent local government units (typically through some key tasks assigned to a metropolitan government). National (or state) government support for city governments is particularly important, especially in providing the legislative base for effective urban government and in supporting more competent and accountable urban governments. Of course, the decentralisation of responsibilities and their financial underpinnings (including supporting stronger local tax bases) are intensely political issues – although in some Latin American nations there is good evidence of municipal government innovation supported by national government reform (Campbell, 2003; Satterthwaite, 2009; Galilea Ocón, 2014).

However, many cities and smaller urban centres across low- and middle-income countries have metropolitan, city or municipal governments without the needed competence and capacity, or the necessary funding to meet their responsibilities (see Figure 3).

Figure 3 Comparisons between cities in local government budgets per person (US$)
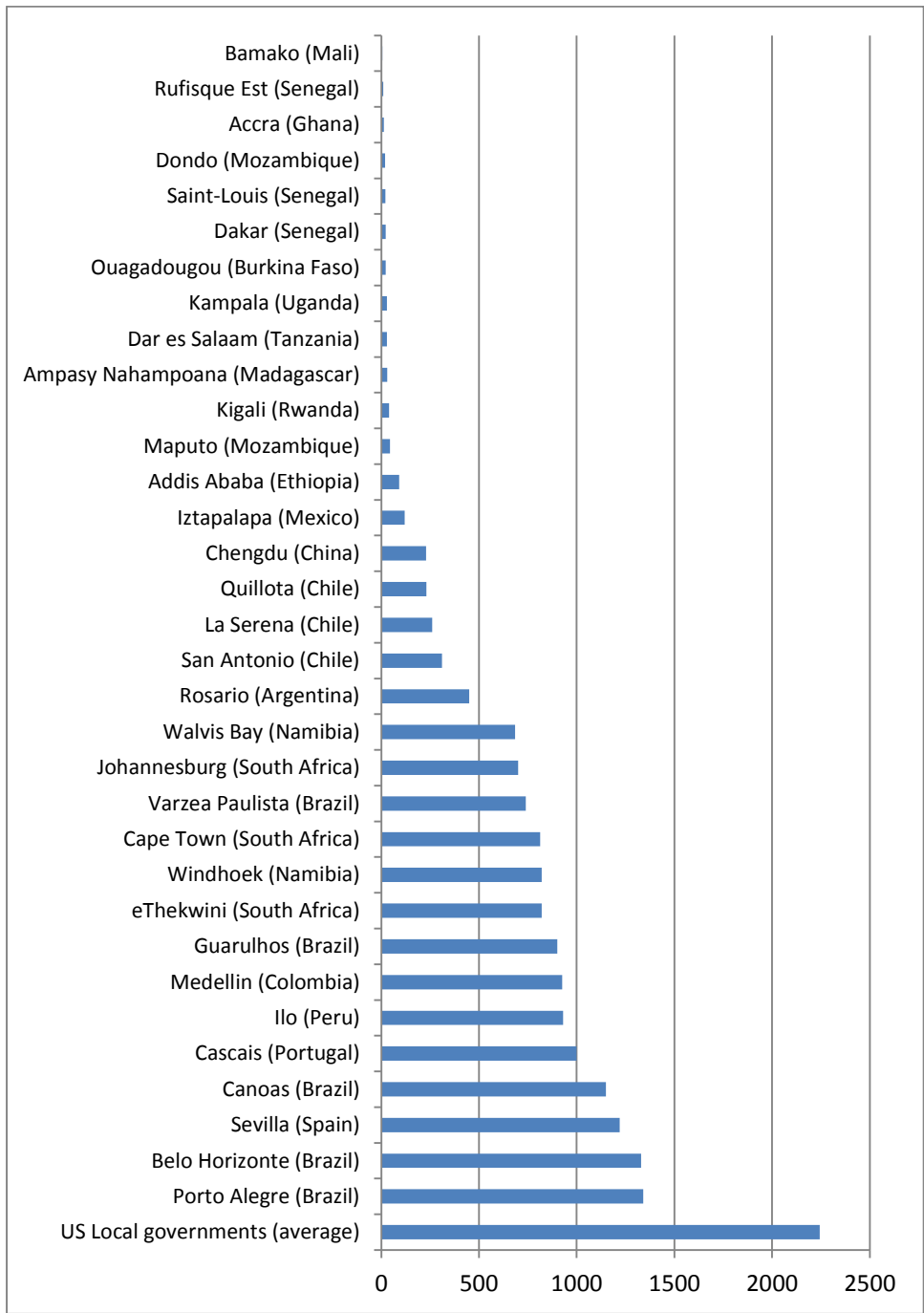
Source: Most statistics drawn from Cabannes (2014) with some additional cities added, drawing on UCLG (2014).

SECTION 4

Urban pollution in the home and neighbourhood

4.1 Types of urban pollution

Urban pollution in the home and its immediate surrounds (the neighbourhood) can include:

- indoor air pollution (linked mostly to use of 'dirty' fuels and overcrowded dwellings lacking ventilation)
- air pollution in the neighbourhood (often a combination of pollutants generated by households from cooking and where needed heating) and ambient air pollution
- pollutants/pathogens in food, water, the home environment and the surrounds (streets, lanes, open spaces)
- disease vectors that breed or feed within the home and neighbourhood
- pathogens or pollutants from income-earning activities undertaken within the home (which may include keeping some livestock).

4.1.1 Indoor air pollution

Inefficient cooking and heating practices produce high levels of household (indoor) air pollution. WHO suggests that around 3 billion people cook and heat their homes using solid fuels (i.e. wood, charcoal, coal, dung, crop wastes) on open fires or traditional stoves; around 700 million of these are urban dwellers. The household air pollution produced by such practices includes a range of health-damaging pollutants such as fine particles and carbon monoxide. "In poorly ventilated dwellings, smoke in and around the home can exceed acceptable levels for fine particles 100-fold. Exposure is particularly high among women and young children, who spend the most time near the domestic hearth".[5]

A broad range of fuels is used by urban poor households in all low- and middle-income nations. At one extreme is the continued reliance on woodfuel, charcoal and waste materials, with no electricity. In the middle of the range there is greater use of solid or liquid fossil fuels (coal and/or kerosene) and a proportion of households with electricity. The least polluted households use cleaner fuels (LPG or connection to gas) and have widespread access to electricity.

Low-income urban households often cook with solid fuels that pose serious health threats to household members. This is a particular problem for those with the longest exposure (typically the women who cook and take care of children and the infants and children that stay with them). Exposure to emissions from the use of coal and biomass is associated with acute lower-respiratory infections in children, while women are at increased risk of lung cancer, chronic bronchitis and pulmonary disease (Torres-Duque *et al.* 2008).

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[5]   http://www.who.int/indoorair/en/

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In general, the higher a nation's GDP per capita, the lower the proportion of the urban population using wood or charcoal for cooking. Data from the Demographic and Health Surveys showed that in 20 out of 43 nations, more than half of the urban population relied on non-fossil fuel cooking fuels – charcoal, woodfuel, straw and dung. Figure 4 highlights that this is more likely to be the case in low-income (in terms of per capita GDP) countries.

Figure 4 The proportion of urban households using wood or charcoal for cooking
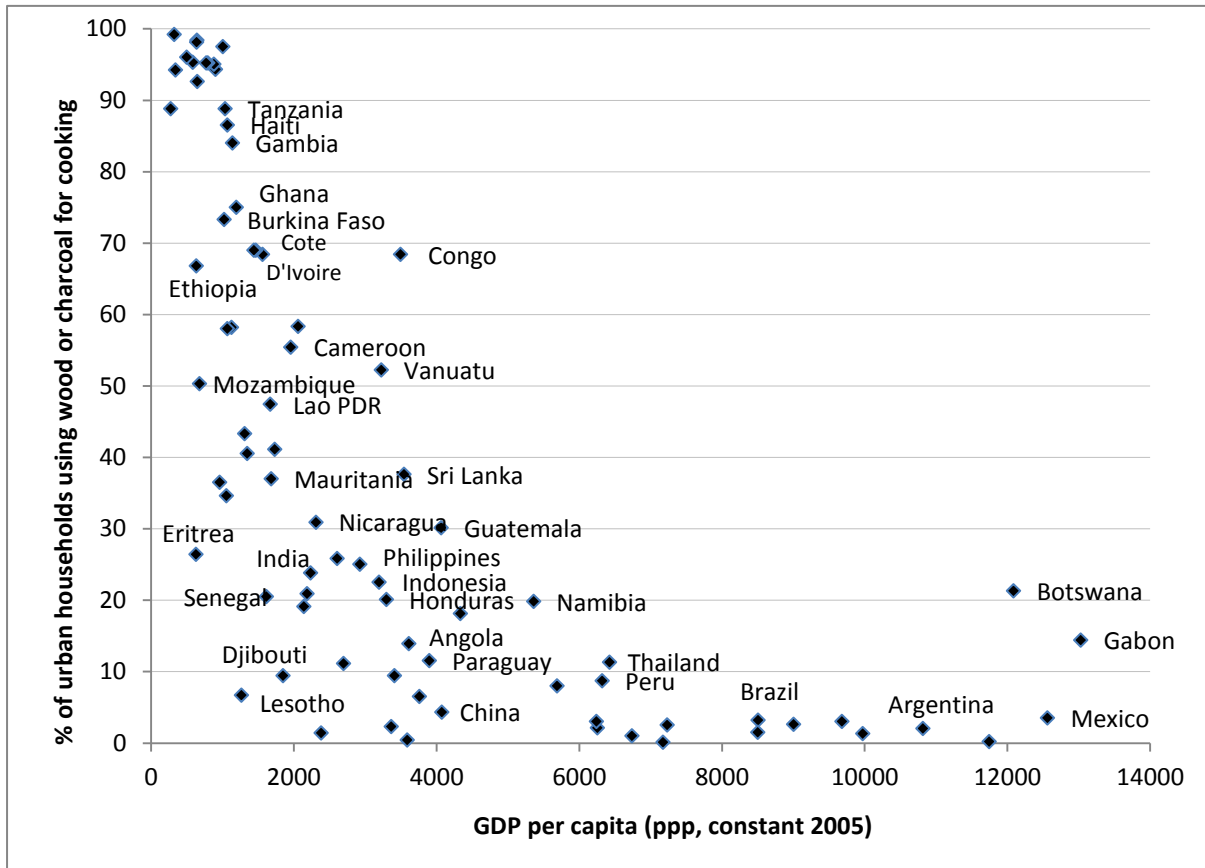
Source: Satterthwaite and Sverdlik 2012

4.1.2 Water pollution

There are no international datasets on the proportion of urban or rural populations that have access to 'safe' water or 'drinking water' or even if they have regular water supplies. The official UN statistics on provision for water and sanitation in urban (and rural) areas produced by the Joint Monitoring Programme (run by WHO and UNICEF) suggest that 95% of the urban population in "developing countries" had improved provision for water by 2012 and 73% had improved provision for sanitation (UNICEF and WHO, 2014). Even in the least developed countries, it is reported that 84% of the urban population had improved provision for water in 2012, with 48% having improved sanitation on this date. Unfortunately, these figures are misleading because the criteria for 'improved provision' is so broad and includes forms of provision that are inappropriate for urban contexts (see Box 3). For water, the definitions for what constitutes 'improved' provision do not guarantee that the water supply is safe or drinkable or regular or necessarily affordable or accessible.

Box 3 Definitions of water and sanitation provision

> Statistics used to monitor the MDGs on provision for water and sanitation do not measure who has adequate provision or safe water or take account of differences in rural and urban contexts. For water, improved provision includes piped water into dwelling, yard or plot, public tap or standpipe, tubewell or borehole, protected dug well, protected spring or rainwater collection. For sanitation, improved provision includes use of flush or pour-flush toilets to piped sewer system septic tank or pit latrine, ventilated improved pit latrine, pit latrine with slab or composting toilet (UNICEF and WHO 2012).

Current data on provision for water and sanitation for most nations is limited.
The only recent data comes from a few questions included on surveys collecting demographic and health data of a nationally representative sample of households. It is not possible to ascertain whether a household has adequate provision for water or sanitation from a few questions, especially when households rely on a range of water sources. Asking a household if it has access to piped supplies close by does not establish if the water is of adequate quality, if the supply is regular or access is easy (there may be a tap close by but it is often shared with hundreds of other people so long queues are common). Asking a household if they have access to an 'improved' toilet is no indication of whether the toilet is adequate or available or used by all household members (for instance, toilets may be on the premises but with some inhabitants – e.g. tenants – having limited or no access). This is why the official UN statistics are so careful to state that their statistics (which draw heavily on these household surveys) do not reveal who does and does not have 'adequate' provision or safe drinking water. The UN agencies reporting on water and sanitation provision for the MDGs use these statistics but often label them as statistics on provision for safe water or clean water. For instance, The "Millennium Development Goals Report 2011" uses the statistics on 'improved provision' yet claims this is "progress to improve access to clean drinking water" (page 54). It also claims that the MDG drinking water target is likely to be surpassed – but the MDG target is for 'safe' water not for 'improved' provision.

Some current data is available for urban households with piped water, which is a better indicator of adequate provision. The WHO/UNICEF Joint Monitoring Programme recently began providing statistics on the proportion of the urban population in each nation with water piped to their premises. For urban populations, this is a better indicator of who has 'adequate' provision because reliance on any public source (standpipe, kiosk, vendor, tanker, protected well) rarely provides adequate supplies for good health and usually involves large time and cost burdens. It is still not a measure of adequate provision because this would also need data on the regularity of supply through the pipes, the quality of the water and the cost. Irregular supplies for piped water are common in many cities – and these present many problems, including a greater likelihood of water contamination and a range of health risks from storing water in the home. This includes water storage containers that can provide breeding sites for the mosquitos that the vectors for dengue fever. But this data on the proportion of the urban population with water piped to their premises helps highlight two key issues:

1. The proportion of the urban population with water piped to their premises is much lower than the proportion said to have 'improved provision' in many nations (see Figure 5) and globally. In 2010, 700 million urban dwellers in the Global South were reported not to have water piped to their premises compared to 130 million that do not have 'improved' provision (UNICEF and WHO, 2012).
2. There are a very large number of nations where half or more of their urban population lacks improved provision.

Figure 5 Provision of 'improved' water and provision of water piped into premises in urban areas
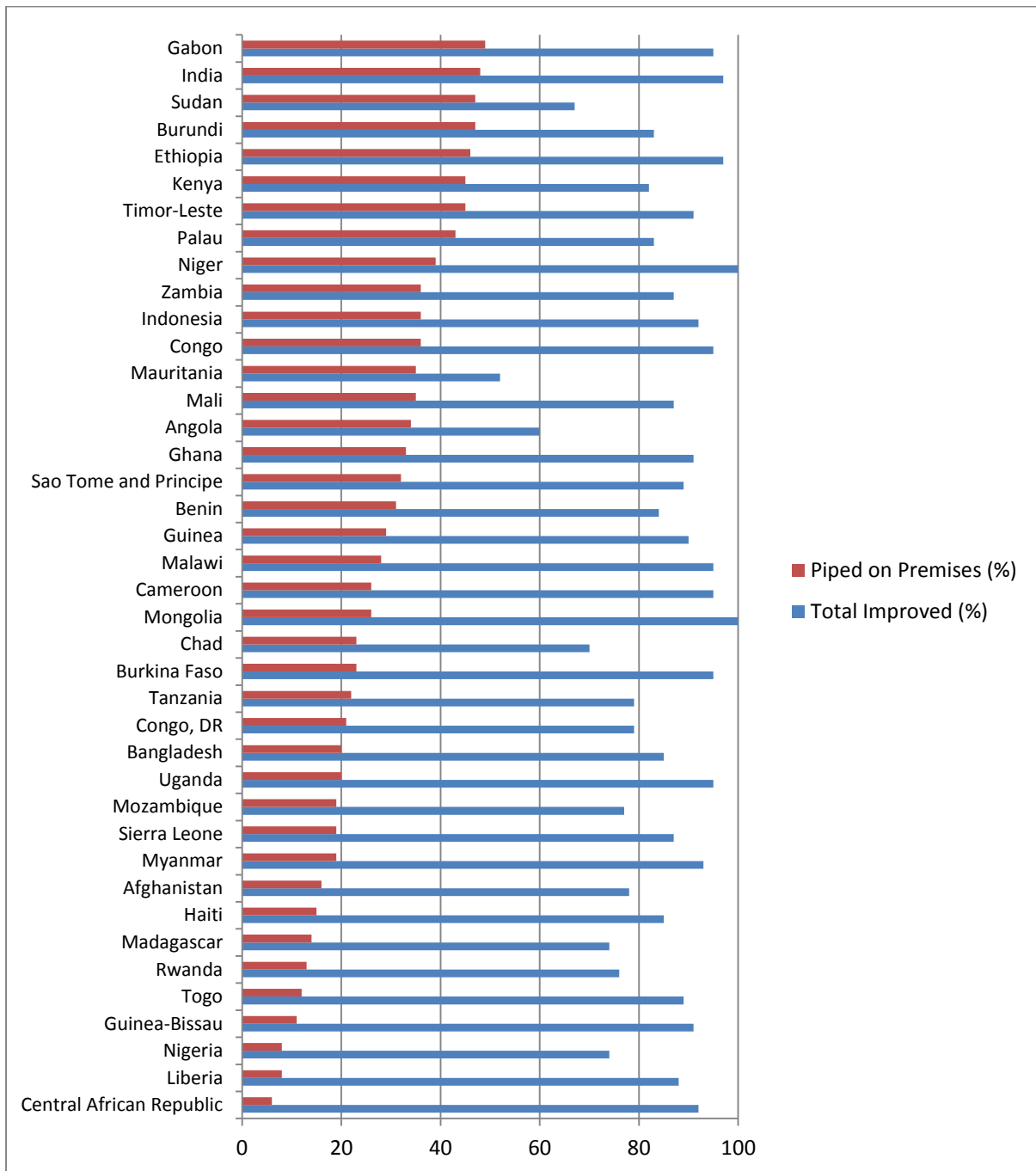
4.1.3 Trends in water provision

Much of the available data shows decreases in adequate water provision. For the 173 nations for which data were available for 2010, 35 had *decreases* in the proportion of their urban population with water piped to the premises between 1990 and 2010. Some nations had dramatic drops. In Congo DR, 51% of the urban population had water piped to the premises in 1990 and 21% in 2010. Coverage for Sudan dropped from 76 to 47% in these two decades. In several other nations coverage dropped by more than 20 percentage points. There are probably more nations that had declines but these are not recorded as no data were available for 1990 (UNICEF and WHO 2012). A study in the late 1990s in Kenya, Uganda and Tanzania also showed that in many cities, provision for water (and sanitation)

was worse than it had been in the early 1970s, with a lower proportion of the population adequately served and with lower-quality provision (Thompson et al., 2000).

There were also many nations with low levels of coverage for water piped to premises that did not increase or hardly increased between 1990 and 2010. These include Sierra Leone (no increase) and Myanmar and Pakistan (2 percentage point increase).

The UN statistics on provision for 'improved' sanitation have been dramatically lowered for sub-Saharan Africa. The 2000 assessment reported that almost all the urban populations of many sub-Saharan African nations had improved sanitation by 2000. However, the 2014 report (UNICEF and WHO, 2014) presents much lower proportions so served (41% in 1990, 2000 and 2012).

4.2   Household waste

There is no global monitoring of who has regular collection of solid wastes, although there are many city case studies that show that half or more of the population lack such services (For the most recent assessment see UCLG, 2014).
It is generally the responsibility of local governments to provide a regular house-to-house collection services and to keep roads and public spaces clean, although many contract out some or all of this to private enterprises. Where there is no capacity to provide house-to-house collection, public authorities may provide communal skips (Hardoy et al., 2001). (For a detailed review of solid waste management including case study cities, see Hoornweg and Bhada-Tata, 2012).

There are many environmental problems associated with lack of provision for household waste collection.
These include wastes dumped in any nearby open site or drainage ditches or nearby water bodies. Problems include the smells, the disease vectors and pests attracted by rubbish, clogged drainage ditches (with plastic bags often contributing to this) and stagnant water bodies. Since provision for sanitation is often poor, solid wastes disposed of in the neighbourhood may include toilet wastes. Uncollected wastes can pose serious health hazards for all inhabitants, for instance for children playing in open spaces.

Indoor exposure to other pathogens relating to disease vectors (including those for malaria and dengue fever) is an increasing problem. Dengue has become a serious issue in many cities (it is endemic in over 100 countries).[6] Malaria was considered primarily a rural problem but it has become a major public health problem in many urban centres.[7]

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[6]   For more details on dengue, see http://www.who.int/mediacentre/factsheets/fs117/en/
[7]   See http://www.who.int/mediacentre/factsheets/fs094/en/

SECTION 5

Urban pollution in the workplace

5.1 Hazards

Environmental hazards arising in the workplace are a major problem. They are evident in workplaces from large factories and commercial institutions down to small 'backstreet' workshops and people working from home. They include:

• dangerous concentrations of toxic chemicals and dust
• inadequate lighting, ventilation and space
• lack of protection for workers from machinery and noise.

Many industries have long been associated with high levels of risk for their workforce from toxic chemicals; for instance, in factories extracting, processing and milling asbestos, chemical industries, cement, glass and ceramics industries, iron and steel industries, factories making rubber and plastics products, metal and non-ferrous metal industries and textile and leather industries (WHO 1992a). The most common environment-related occupational diseases include silicosis, byssinosis, lead and mercury poisoning, pesticide poisoning, noise-induced hearing loss and occupational skin diseases (WHO 1990).

Serious health problems from environmental hazards in small workshops have been documented in several studies – see, for instance, Matte et al 1989 on lead poisoning among household members exposed to lead-acid battery repair shops in Kingston and Dasgupta 1997 on risks from lead-smelting units in Kolkata. Further evidence comes from studies of particular sectors such as those involved in waste management including waste pickers (see Furedy, 1992).[8] Studies of the informal economy or of particular groups of workers (e.g. street vendors, those working at home) often mention such problems but focus is more on livelihoods and incomes than on exposure to pollution (see WIEGO no date on street vendors).

There are environmental problems associated with work in 'the home'. Many poor city dwellers use their homes as a workshop to produce goods for sale or as a store for goods sold on the street, or as a shop, bar or café. Environmental problems here are too diverse to be covered in a short summary, but there are often problems with home workers' use of toxic or flammable chemicals. Many of these chemicals should be used in carefully controlled conditions in factories with special provisions to limit inhalation or skin contact and to guard against fire hazards.

5.2 Scale of the problem

The number of occupational health hazards found in small-scale industries has probably been underestimated.
Many people working in informal enterprises use chemicals that should only be used under carefully controlled conditions with special safety equipment. In several countries, small-scale enterprises are legally exempt from labour regulations including health and safety

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[8] See http://www.waste.nl/ for many detailed and relevant studies

(Barten et al., 1998). Occupational exposure may be particularly serious for child-labourers, as illustrated by a case study on the effects of lead on adolescent children working in battery recycling workshops in Pakistan (Shah et al., 2012).

A 2014 working paper gives estimates for the scale of informal employment (Vanek et al., 2014). Informal employment comprises 82% of non-agricultural employment in South Asia, 66% in sub-Saharan Africa, 65% in East and Southeast Asia, 51% in Latin America and 45% in the Middle East and North Africa. Certain nations have particularly high levels of informal employment; for instance, 82% in Mali and 76% in Tanzania.

Most informal settlements include a range of enterprises and these may have high levels of exposure to pollutants for their workers or for those living and working around them.
However, there is little documentation available on this. One study in Kibera, one of Nairobi's largest informal settlements illustrates this (Karekezi et al., 2008). There were many home-based businesses and electricity consumption was limited by the large upfront connection costs. Over 42% of the enterprises used charcoal, while 19% used fuelwood and 9% kerosene. Access to electricity offers more efficient and cleaner energy for small businesses that rely on fuels that are inefficient, polluting and a major drain on their incomes. Electricity also has particularly large advantages for power and for lighting.

Urban pollution at the municipal, city or metropolitan scale

6.1 The need to act on urban pollution

The need to address urban pollution may not appear to be an urgent priority in the Global South. The environmental problems commonly associated with cities such as high levels of air and water pollution and large volumes of solid wastes (including some highly toxic or otherwise hazardous wastes) might be assumed to be less important in Africa, Asia and Latin America for two reasons:

1. A smaller proportion of the population lives in cities (although this is no longer true for Latin America).
2. These regions are less industrialised. Rural and agricultural environmental problems such as deforestation, soil erosion and floods may seem more urgent even if some of these have important linkages with cities.

However, there are hundreds of cities or city regions with high concentrations of industries. Many low- and middle-income nations generate a third or more of their GDP through industry. Nations such as China, India, Mexico and Brazil figure prominently amongst the world's largest producers of many industrial goods.

6.2. Causes of the problem

Industrial production has often increased very rapidly in the absence of an effective planning and regulation system. The more rapid the growth in industrial production, often the more serious the environmental problems related to industrial pollution since time is required to identify and act on problems, develop the legislative basis for pollution control and develop the institutional and governance structure needed to implement it. In addition, there are usually powerful vested interests that oppose the implementation of pollution control and political circumstances often slow or halt such implementation.

Industry is often concentrated in in one or two cities or 'core regions' within nations. For instance, the metropolitan areas of Bangkok, Dhaka, Lima, Mexico City, Manila and São Paulo include a high proportion of their nation's industrial output. It is also common for informal settlements to develop around factories, which can mean higher levels of exposure to pollutants and higher risk from industrial accidents.

6.3 Ambient air pollution

6.3.1 Scale of the problem

Urban pollution occurs at two levels.
City-wide air pollution problems are most serious in:

- industrial cities with inadequate pollution control
- cities where solid fuels are widely used for cooking and heating in homes and small-scale industries
- large cities with a high concentration of motor vehicles where local conditions inhibit the dispersal of air pollutants.

More *localised* problems with air pollution occur, in and around particular industries or roads or particular hot spots created by particular combinations of emissions and weather conditions. The concentrations of air pollutants may vary greatly during a day – for instance higher concentrations during peak hour traffic flows or during periods with little wind. The concentration of air pollutants from motor vehicles also varies by height from the ground – with higher concentrations close to the ground impacting young children.

The scale of the pollution, and relative importance of different pollutants and sources varies among cities and seasons. For instance, cities on or close to the coast on a flat plain have prevailing winds that help to disperse pollutants. A combination of topography, particular climates and weather conditions can help trap pollutants in or over a city. Many cities suffer from thermal inversions where a mass of warm air well above a city helps to trap pollutants in the cool air underneath it; these often occur in cities surrounded by hills and mountains. Many cities that are prone to high air pollution episodes are in arid or seasonally arid areas where high pressure persists for long periods.

6.3.2 Sources of air pollution

Most outdoor air pollution in urban areas comes from the combustion of fossil fuels.
Coal, oil or oil-derived fuels are used for heating and electricity generation and also in industrial processes. Petrol and diesel are used to fuel motor vehicles. The use of fossil fuels tends to increase with economic growth. So too does air pollution, unless measures are taken to promote efficient fuel use, the use of the least polluting fuels (for instance, natural gas rather than coal with a high sulphur content for domestic and industrial use and unleaded petrol for motor vehicles) and the control of pollution at source (World Bank, 1992).

Motor vehicle use is a significant contributor to air pollution. The often rapidly growing numbers of motor vehicles, congested roads and high proportion of inefficient and poorly maintained motor vehicle engines add greatly to air pollution. Air pollution from motor vehicles might be assumed to be less of a problem than in high-income countries because there are fewer automobiles per person. But this is not the case in many major cities in middle-income nations that have as many automobiles per person as many cities in high-income nations. Even where the ratio is lower, a combination of narrow congested streets and old and poorly maintained vehicles can still result in serious air pollution problems.

A particular problem is the increasing contribution of photochemical ('oxidising') pollutants to air pollution. In many cities, especially within city cores, this is largely the result of growing automobile use (although industry can also be a major source).

The most important of these pollutants are:

- oxides of nitrogen.
- hydrocarbons: mainly from petrol evaporation and possibly leaks in gas pipes and emissions from petroleum industries.
- ozone: secondary reactions in the air between nitrogen dioxide, hydrocarbons and sunlight cause the formation of ozone which is present in photochemical smog along with other hazardous chemicals. Ozone can have serious health impacts when in high concentrations in or close to cities (WHO 1992a).
- carbon monoxide: formed by the incomplete combustion of fossil fuels. The main danger in cities is high concentrations in particular areas, from motor vehicle emissions.
- lead: high concentrations are often evident where lead compounds are still widely used as additives in petrol.
- there may also be small concentrations of certain organic chemicals in the air with worrying health implications, for instance, benzene which is a known carcinogen (WHO 1992a).

Particulate matter in the air can carry toxic pollutants. The concern is therefore not only about the health impact of the particles themselves but also about potentially toxic pollutants present in much smaller concentrations - some of them bound to particles of smoke.

Air-borne lead remains a particular concern, especially for infants and children because relatively low concentrations of lead in the blood can have a damaging effect on their mental development with an effect that persists into adulthood (Needleman et al., 1991; see also WHO fact sheet on lead poisoning and health.[9]

Many cities also have significant natural sources of pollution, for instance, wind-blown dust (often made more serious by poor land management and many unpaved roads).

6.3.3 Health impacts of air pollution

In many cities, the concentrations and mixes of air pollutants are already high enough to seriously impact people's health. This pollution can cause illness in more susceptible individuals and premature death among the elderly, especially those with respiratory problems. Air pollution is likely to be impairing the health of far more people. WHO estimates that ambient air pollution in both urban and rural areas caused 3.7 million premature deaths worldwide in 2012. Some 88% of those premature deaths occurred in low- and middle-income countries. Estimates for 2008 suggest that the number of premature deaths attributable to urban outdoor air pollution was 1.34 million worldwide; of these, 1.09 million deaths could have been avoided if the WHO Air Quality Guideline values were implemented. This report notes that "the number of deaths attributable to air pollution in cities has increased from the previous estimation of 1.15 million deaths in 2004. The increase in the mortality estimated to be attributable to urban air pollution is linked to recent increases in air pollution concentrations and in urban population size, as well as improved data availability and methods employed." [10]

Acute air pollution episodes occur at particular times (for instance when high emissions coincide with particular meteorological conditions). The link between air pollution and health can often be seen in increased mortality among particular susceptible groups, for instance, the elderly (WHO 1992b). Acute air pollution episodes occur regularly in many cities.

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[9]   http://www.who.int/mediacentre/factsheets/fs379/en/).
[10]   See http://www.who.int/mediacentre/news/releases/2011/air_pollution_20110926/en/

It is difficult to establish the precise health impact of the air pollutants introduced by human activities into urban air. For instance, it is difficult to isolate the impact of one particular pollutant from others, and some health impacts are the result of combinations of air pollutants or of synergistic interactions between them. There are also many factors that influence the level of risk which means that there are large differences in the exposure of each person to air pollutants and the extent to which the exposure is likely to impair their health. There are particular groups within the population who are more susceptible to air pollution, including people with asthma, those with existing health and lung diseases, the elderly, infants and pregnant women and their unborn babies (Elsom, 1996). There are particular circumstances that increase exposure, for instance, those who spend longest in or close to busy roads including drivers and passengers in cars, cyclists and pedestrians walking beside the road. Drivers and passengers in cars in congested driving conditions face much higher pollution levels than those outside the car (Elsom, 1996).

It is important to remember that people's exposure to air pollution includes exposure indoors (at home or at work) or within neighbourhoods with particularly high levels of air pollution. In cities where many households use solid fuels in inefficient heaters and cookers, these contribute much to air pollution. This means that the measures of outdoor air pollution are not necessarily reliable indicators of total exposure (Smith and Akbar 1999).

6.3.4 Air quality guidelines

Different air quality standards are set for different pollutants. The standards are based on the period of exposure. For instance, for sulphur dioxide and suspended particulates, standards may be set for the maximum permitted concentration for the annual average and also a less stringent standard than is permitted for fewer than 7 days each year or for 1 day. For air pollutants such as carbon monoxide, ozone and nitrogen dioxide that have much more immediate health impacts, air quality standards with much shorter exposures are set. For carbon monoxide, since the health effects are immediate (the reduction in oxygen carrying capacity of the blood with impacts on the central nervous system and the heart), different air quality guidelines are set for 15-minute, 30-minute, 1-hour and 8-hour exposures. Air quality guidelines for nitrogen dioxide usually have a 1-hour average maximum permitted concentration; for ozone, the guidelines are for an 8-hour average maximum permitted concentration.

6.3.5 Particulate matter guidelines

Regulation is based on the size of the polluting particles. Initially, the concern for controlling particulate matter in the air concentrated on setting and enforcing standards for 'total particulate matter'. Then, in recognition of the larger health impact of small particles, standards were set for particles that were smaller than 10 microns, so called PM_{10}. More recently, standards were introduced for even smaller particles, less than 2.5 microns, so called $PM_{2.5}$.

Mortality and morbidity are inversely correlated to particle size. The associations between concentrations of air-borne particulate matter and rates of mortality and morbidity in city populations generally get stronger, if the measure goes from total suspended particulate matter to PM_{10} to $PM_{2.5}$ (Lippmann, 1999). The smallest particles include several chemically distinctive classes of particles that may have more serious health impacts, including those that are emitted in the exhausts from diesel engines and those formed during photochemical reactions (Lippmann, 1999).

WHO sponsors an urban outdoor air pollution database that includes data on PM_{10} and $PM_{2.5}$ for close to 1,600 cities in 91 nations. Table 2 below lists the 10 cities with the highest recorded $PM_{2.5}$. All the cities with the highest levels are in low- and middle-income

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nations. Some have annual mean PM_{10} and $PM_{2.5}$ that are more than 10 times the WHO guidelines (10 µg/m³ annual mean for $PM_{2.5,}$ 20 µg/m³ for PM_{10}). What is also notable is how many cities in India are among the most polluted by these measures – and far more so than Chinese cities.[11]

Country	City/station	PM10 Annual mean, ug/m³	PM10 Year	PM 2.5 Annual mean, ug/m³	PM2.5 Year
India	Delhi	286	2010	153	2013
India	Patna	164	2011	149	2013
India	Gwalior	329	2012	144	
India	Raipur	305	2012	134	
Pakistan	Karachi	273	2010	117	2010
Pakistan	Peshwar	540	2010	111	2010
Pakistan	Rawalpindi	448	2010	107	2010
Iran	Khoramabad	121	2010	102	2010
India	Ahmedabad	67	2011	100	2013
India	Lucknow	219	2010	96	

Source: http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/

Table 2 The 10 cities with the highest recorded $PM_{2.5}$

6.4   Water pollution

In most cities, there are serious problems with water pollution. This not only damages water bodies (and aquatic life within them including fisheries) but also contaminates fresh water sources and can then cause health problems for those who subsequently use them, including those that draw on these for domestic use and urban and peri-urban farmers.

6.4.1 Sources of water pollution

There are usually four main sources: sewage, industrial effluents, storm and urban run-off and agricultural run-off (Lee 1985). Agricultural run-off is often an 'urban' problem since water sources from which an urban centre draws may be polluted with agricultural run-off and contain dangerous levels of toxic chemicals from fertilisers and biocides.

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[11]   http://www.who.int/phe/health_topics/outdoorair/databases/cities/en

Box 4 The three main types of water pollution

Most water pollution falls into one of three categories: liquid organic wastes; liquid inorganic wastes; and water-borne or water-based pathogens.

Liquid organic wastes: These can be termed 'oxygen demanding' wastes since when disposed of into water, bacteria and other microorganisms combine them with oxygen dissolved in the water to break them down. Liquid organic wastes include sewage, many liquid wastes from industries (especially industries processing agricultural products) and run-off from rains and storms which pick up organic wastes from land, before flowing into streams, rivers, lakes or seas. Too great a volume of organic wastes can overload the capacity of the water's bacteria and other microorganisms to the point where all dissolved oxygen becomes exhausted. As the concentration of dissolved oxygen decreases, so fish and aquatic plant life are harmed or die. The dissolved oxygen in some portions of rivers or lakes that receive large volumes of organic wastes may be used up and thus they lose their ability to break down these kinds of wastes and become black and foul smelling

Liquid inorganic wastes: Most inorganic liquid wastes come from industry. These are not broken down in water in the same way as organic wastes, but for most, their dilution in large water bodies renders them harmless. Many such wastes kill animal and plant life, unless diluted sufficiently. Some inorganic wastes can become concentrated up the food chain to fish or in other fresh- or seawater products (shellfish, seaweed) to the point where they can kill or do severe damage to the health of humans who eat them. Wastes that include certain chemical elements known as heavy metals (including cadmium, chromium, mercury, arsenic and lead) or some of their compounds can be particularly dangerous.

Water-borne or -related pathogens: Many pathogens (disease-causing agents including bacteria, viruses and worms) are spread in water, either through human ingestion of contaminated water or food or through water providing the habitat for intermediate hosts. The most common and widespread problem is pathogens from human excreta, which contaminate water supplies. Typhoid, diarrhoeal diseases and cholera are among the diseases spread by contaminated water. Contaminated water also has a central role in the transmission of many intestinal worms.

6.4.2 Sewage

Sewage is a major source of urban water pollution. Most cities in low- and middle-income nations have much more serious 'non-point' sources of water pollution than cities in high-income nations because large sections of their population are not served by sewers, drains or solid waste collection services.

A sewage and storm drainage system that serves the whole city makes it much easier to control water pollution. The wastes collected by this system can be treated, before being returned to rivers, lakes, estuaries or the sea. The advantage of point sources is that treatment plants can be easily added. However, in most cities, in the absence of adequate treatment, most 'point' sources (liquid wastes coming from sewers and industrial waste pipes) receive minimal or no treatment and are also major sources of water pollution.

A comprehensive solid waste collection system greatly limits the amount of solid waste that is washed into water bodies. In the absence of such systems, much of the liquid wastes from households and businesses (and often industries) and a considerable proportion of the solid wastes end up in the nearest streams, rivers or lakes.

A shortage of water adds greatly to the problem of disposing of wastes, especially liquid wastes from industries and sewage. Large volumes of water dilute wastes and can render them much less dangerous; in addition, as noted above, bacteria and other microorganisms in the water can break down organic wastes, if these wastes' biochemical oxygen demand is not too high relative to the water's dissolved oxygen.

6.4.3 Impact of water pollution

Within each industrial sector, environmental impacts can vary considerably between the best and the worst performers. An industry's performance is driven by many factors, including (obviously) the form of environmental regulation and the extent to which it is enforced but also company size, location, profitability and availability and cost of clean technologies.

Very few urban authorities have paid sufficient attention to safeguarding fresh water sources and preventing water pollution even though no city or smaller urban centre can exist without reliable sources of freshwater. It is common for the catchment areas of municipal water supply reservoirs to be heavily used and to contaminate the water. When combined with a lack of or ineffective water treatment plants, this often means that an increasing number of people are drawing on polluted sources (for instance, using polluted rivers, streams, lakes and groundwater). Section 5 emphasised just how large a proportion of the population in many cities have no access to protected piped water supplies. It also means the depletion of the cheapest and most convenient sources, especially the over-use of (often contaminated) groundwater resources.

6.4.4 Water scarcity

The demand for water in many cities has outgrown the capacity of their locality to supply water. Thus water has to be drawn more distant sources. This is particularly problematic for cities in arid areas and in areas where rainfall has declined (and climate change may also contribute to this). Many cities now draw on distant water resources and these are often more expensive, especially if they need to be pumped. However, water shortages are often caused more by inadequate water management than by a lack of fresh water resources.

6.5 Toxic/hazardous wastes

Cities in low- and middle-income nations have the same range of toxic and hazardous wastes as cities in high-income nations. These include heavy metals (which include lead, mercury, arsenic, cadmium and chromium and their compounds), waste oils, suspended particulates, polychlorinated biphenyls (PCBs), various organic solvents and asbestos. These and certain other industrial and institutional wastes are categorised as 'hazardous' or 'toxic' because of the special care needed when handling, storing, transporting and disposing of them, to ensure they are isolated from contact with humans and the natural environment.

6.5.1 Sources of hazardous wastes

Most hazardous wastes come from chemical industries. Although other industries, such as iron and steel plants, non-ferrous metal plants, oil refineries and industries producing petroleum products, pulp and paper industries, transport and electrical equipment industries, and leather and tanning industries also produce significant quantities of hazardous wastes. So, too, do many mines.

6.5.2 Types of hazardous wastes

There are many different kinds of hazardous wastes. Some are highly inflammable, for example, many solvents used in the chemical industry. Some are highly reactive and can explode or generate toxic gases when they come into contact with water or some other chemical. Some have disease-causing agents; sewage sludge or hospital wastes. Some wastes are lethal poisons for instance cyanide and many heavy metal compounds. Many are carcinogenic (i.e. cancer inducing), including asbestos, arsenic, nickel and benzene. Some cause serious diseases of, for instance, the kidney (e.g. cadmium and mercury), the central nervous system (organic solvents, mercury, manganese), the cardiovascular system (including cobalt and chlorinated solvents), the blood-forming organs (lead, benzene), the reproductive organs (probably lead and some solvents) and the liver (some organic solvents (WHO 1992a).

6.5.3 Impact of hazardous wastes

Many hazardous chemicals have long-lasting effects. Many are extremely persistent. Many also bio-accumulate resulting in much higher concentrations in organisms as the substance moves up the food chain (Budd, 1999). Many are so toxic that even small quantities are enough to cause serious health or environmental damage. Many are associated with birth defects.

There are also *persistent organic pollutants*. These are resistant to environmental degradation and also bio-accumulate as they move through the food chain. They are found in certain pesticides and industrial chemicals and often in wastes. They have many serious adverse health impacts at high levels and there is increasing concern that they may contribute to disease burdens at low levels, with a particular concern for their impact on sperm, embryos, infants and young children. A UN Convention on persistent organic pollutants came into force in 2004 but some of these pollutants are still present in polluted sites and some countries have not taken the measures needed to stop their generation or use (WHO, 2010).

6.5.4 Control and disposal of hazardous wastes

Few nations in low- and middle-income nations have effective government systems to control the disposal of hazardous wastes. In many, there are no regulations dealing specifically with such wastes, let alone the system to implement them. In others, the problem is less the regulatory framework and more the lack of enforcement. The control of hazardous wastes needs a competent, well-staffed regulatory authority with the ability to make regular checks on each industry likely to be using or generating such wastes, and with the power to penalise offenders. This authority needs the backing of central government and the courts. Industries must keep rigorous records of the kinds and quantities of waste and the dates and methods by which these are disposed of. Businesses that specialise in collecting and disposing of these wastes must be very carefully monitored; so too must the specialised facilities that need to be created to handle hazardous wastes.

The safe disposal or incineration of toxic wastes is extremely expensive. Thus, there are very large incentives to cheat any regulatory system. Toxic/hazardous wastes are often dumped on the ground in untreated liquid form and run into sewers or drains or direct into nearby water bodies. They may be placed on land sites with few safeguards to protect those living nearby or prevent nearby water sources from contamination. Alternatively, they may be simply disposed of down wells where they often contaminate ground water. This is a particular problem for the many low-income urban dwellers who rely on shallow wells for their water.

6.6   Pollution management in smaller cities

Some pollution challenges are common to all cities regardless of their size.
Given that in most countries, a significant proportion of urban dwellers live in relatively small urban centres, there is a remarkable lack of documentation on environmental problems in these. All urban centres (whether large or small cities or urban centres too small to be called cities) need:

- water supply systems drawing from protected water sources, ensuring uncontaminated water is easily available to all households;
- provision for the disposal of household and human wastes (including excreta, household's waste waters, storm and surface run-off and solid wastes);
- preventative and curative health services and basic environmental management (for instance to protect water sources, to minimise breeding and feeding grounds for disease vectors);
- local authorities with the competence and capacity to be able to ensure that pollution regulations are enforced and who are accountable to citizens.

Growing urban centres need adequate land-use management.
They need to ensure sufficient land for housing (and other uses) while protecting valuable land and avoiding settlement over hazardous land.

Small urban centres with polluting industries need the implementation of pollution control legislation.
Some small urban centres develop because of some particular resource based there (for instance, coal or copper) or because of economic incentives (for instance, duty-free export processing zones). One example of this is Ilo in Peru, where the local population and local government had to fight to get a reduction in very high levels of air pollution as a result of the nearby copper mine and refinery (López Follegatti, 1999). Just one or two agricultural processing factories or chemical or pulp and paper factories can seriously pollute a river. Just one cement plant or coal-burning power station can create serious air pollution problems.

Cross-boundary issues for urban pollution

7.1   Pollution impacts beyond the city

Cities transform environments and landscapes not only within the built-up area but also for considerable distances around them. This includes environmental impacts in the region around the city, which usually includes large areas defined as (or considered) rural. The inhabitants, environment and natural resource base of this wider region are usually affected by:

- **the expansion of the built-up area and the transformations this brings**: for instance, as land surfaces are reshaped, valleys and swamps filled, large volumes of clay, sand, gravel and crushed rock extracted and moved, water sources tapped and rivers and streams channelled (Douglas, 1983)
- **the demand from city-based enterprises, households and institutions** for the products of forests, rangelands, farmlands, watersheds or aquatic ecosystems that are outside its boundaries
- **the solid, liquid and air-borne wastes generated within the city that are transferred to the region around it** which have environmental impacts, both on water bodies where liquid wastes are disposed of without adequate treatment and on land sites where solid wastes are dumped without measures to limit their environmental impact.

It is important to consider the environmental impact of cities' physical expansion and the demand for resources from the wider region (the 'inputs') and the impact of wastes generated by city-based activities (especially waste disposal) on the wider region (the 'outputs').

7.1.1   The inputs

Cities require a high input of resources including food-crops, fresh water, fuels, land and all the goods and raw materials that their populations and enterprises require. The more populous the city and the richer its inhabitants, the greater the demand for resources becomes and, in general, the larger the area from which these are drawn. The more valuable and lighter natural commodities such as fruit and vegetables, wood and metals may be drawn from areas hundreds of kilometres away or imported from other countries. But the more bulky, low-value materials will usually come from close by. As Ian Douglas notes, 'the physical structure or fabric of the city, the buildings, the roads, railways, airports, docks, pipe and conduit systems require large quantities of materials for their construction' and 'the bulk of the structures are derived from locally available clay, sand, gravel and crushed rock' (Douglas 1983, page 26). This can be seen in the brick works, quarries, claypits, sand and gravel pits in and around most cities, all of which have environmental impacts.

7.1.2 The outputs

Cities are also usually major centres for resource degradation. Water needed for industrial processes, for supplying residential and commercial buildings, for transporting sewage and for other uses is returned to rivers, lakes or the sea at a far lower quality than that originally supplied. Urban and peri-urban agriculture may have no alternative to the use of polluted water sources. Solid wastes collected from city households and businesses are usually disposed of on land sites in the region around the city while much of the uncollected solid waste generally finds its way into water bodies, adding to the pollution. Air pollutants generated by city-based enterprises or consumers are often transferred to the surrounding region through acid rain.

7.2 Global impacts including climate change

There is also concern for a city's 'ecological footprint' at a global level.
This includes the draw of city-based production and consumption on natural resources and their impact on global systems, including GHG emissions.

Cities are often said to contribute 70–80% of global anthropogenic GHG emissions, but this is not supported by available evidence or by the latest IPCC reports.
The IPCC Fifth Assessment notes that there are very few studies that estimate the relative urban and rural shares of global GHG emissions. It highlights two challenges: the difference between nations in how urban boundaries are defined and severe data constraints about GHG emissions (Seto et al., 2014). There is also no agreement on which methods of calculation should be applied (for instance, is the focus on measuring GHG emissions within urban boundaries or on the GHG emissions that come from urban populations' consumption). However, what is recognised are the very high levels of per capita emissions of GHGs in many high-income cities (especially in North America and Australia) (Hoornweg et al., 2011) and the urgent need for 'contraction and convergence' as cities with high emissions contract and as cities with low emissions seek to minimise the growth in emissions.

Figure 6 The large differences in cities' greenhouse gas emissions per person (tonnes of CO_2 eq/capita)
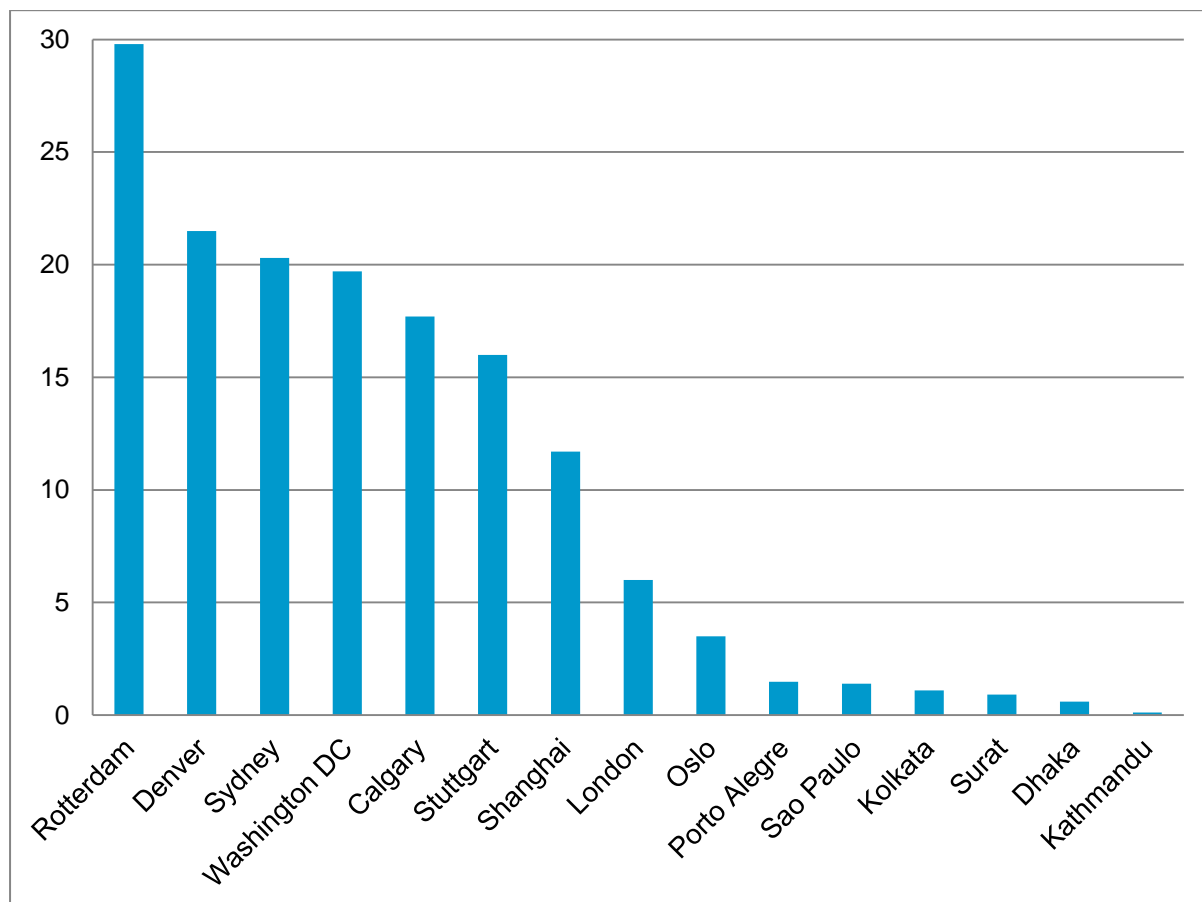
Source: Hoornweg et al. (2011). Some of the differences between cities will relate to different methodologies for calculating GHG emissions. These city estimates also come from different years.

7.2.1 How does a changing climate impact on urban poverty?

Most cities are at increasing risk from the effects of climate change. These include an increase in the number or intensity of heat waves and, for coastal cities, rising sea levels and larger storm surges. In many locations, climate change is also likely to be increasing the intensity of extreme rainfall in the city or 'upstream.' It may also contribute to water stress. Climate change is also constantly increasing most of these risks; the world is still far from reaching agreement on the measures needed to halt global warming.

Within the world's population, low-income urban dwellers in low- and middle-income nations will face among the largest increases in risk and in exposure to climate change impacts. These will be concentrated in particular urban centres and within urban centres in particular districts or settlements. As with most disasters, among low-income urban populations, this will have a disproportionate impact on their most vulnerable groups – vulnerable because they are more exposed, more impacted when exposed, and less able to cope and then adapt to reduce risk in the future. Table 3 gives examples of how climate change will likely impact urban populations, in particular, low-income groups.

Projected changes	Examples of likely impacts	Impacts on low-income groups
Changes in simple extremes		
Higher (and increasing) maximum temperatures: more hot days and heat waves over nearly all land areas	Rise in mortality and illness from heat stress in many urban locations with greatest impacts among groups that cannot afford air conditioning and are particularly vulnerable: infants and young children, the elderly, expectant mothers, those with certain chronic diseases	Concentrations of low-income populations often in heat-islands with very high densities, lack of open space and little ventilation; vulnerable groups within the low-income population less able to take measures to avoid or reduce impacts
Higher (increasing) minimum temperatures: fewer cold days, frost days and cold waves over nearly all land areas	Decreased cold-related human morbidity and mortality. Extended range and activity of some disease vectors, including mosquito and tick borne diseases, with infants and young children often at greatest risk	Many of the settlements with concentrations of low-income groups do not have public health measures to control or remove disease vectors and lack health-care systems that provide needed responses
More intense precipitation events and riverine floods	Increased flood, landslide, avalanche and mudslide damage resulting in injury and loss of life, loss of property and damage to infrastructure. Increased flood run-off often brings contamination to water supplies and outbreaks of water-borne diseases	Low-income groups usually concentrated on sites most at risk of flooding in poor quality housing less able to withstand flooding in settlements lacking risk-reducing infrastructure and whose homes and possessions are not covered by insurance. Road building in inner city areas often diverts flood waters into informal settlements
Wind storms with higher wind speeds	Structural damage to buildings, power and telephone lines, communication masts and other urban infrastructure	Adelekan (2012) shows how a relatively small increase in wind speeds for wind storms in Ibadan caused extensive damage to many buildings
Changes in complex extremes		
Increased summer drying over mid-latitude continental interiors and associated risk of drought	Decreased water resource quantity and quality; increased risk of forest/bush fire; decreased crop yields and higher food prices	Low-income groups often facing more water constraints and more vulnerable to food price rises
Increased tropical cyclone peak wind intensities, and mean and peak precipitation intensities	Increased risk to human life and damage to property and infrastructure; risk of infectious disease epidemics; increased coastal erosion and damage to coastal ecosystems and coral reefs	Many informal settlements are on sites most at risk; poor quality housing and lack of risk-reducing infrastructure increases risk
Intensified droughts and floods associated with El Niňo events in many different regions	Decreased agriculture and range-land productivity in drought-prone and flood-prone regions	Impact on food availability and prices
Increased Asian summer monsoon precipitation variability	Increased flood and drought magnitude and damages in temperate and tropical Asia	In many cities in Asia, those most at risk of flooding are mainly low-income groups

Projected changes	Examples of likely impacts	Impacts on low-income groups
Changes in the mean		
Water availability	Reduced water availability in many locations – with obvious impact on agriculture and on cities where fresh water availability declines significantly	In cities facing constraints or shortages of freshwater supplies, it is likely that low-income areas will be the most affected
Sea-level rise	Coastal erosion, land loss, more floods from storm surges; hundreds of millions of urban dwellers living in low elevation coastal zones	Many low-income settlements with poor quality housing and lacking drainage infrastructure are also in coastal locations most at risk from rising sea levels and storm surges
Higher average temperature	Disease vector range spreading, worsening air quality, higher water demand and water loss	

Source: This draws mostly on Table SPM-1 in the summary for policy makers in McCarthy et al. (2001), supplemented and added to with material drawn from Parry et al. (2007).

Table 3 Examples of likely impacts on urban populations from climate change

Most informal settlements lack risk-reducing infrastructure, such as functioning storm drains and paved roads and paths. Most cities in sub-Saharan Africa and many in Asia have no sewers and storm drains – or if they do, these only serve a small proportion of their population and certainly not those living in informal settlements. Most houses in informal settlements are poorly built, and more liable to collapse when hit by storms or floods. Many informal settlements develop on dangerous sites – for instance flood plains or unstable slopes – because housing on safer sites is too expensive for them. It is also very rare for people living in informal settlements to have insurance for their homes, health or possessions – and no business will insure someone who faces very high risks and has very limited capacities to pay.

When storms or floods hit cities, it is generally low-income groups that are impacted most in terms of deaths, injuries and loss of housing. This is especially true when they live in informal settlements. The devastation caused by storms and flooding to cities cannot be entirely attributed to climate change. A city government's ability or failure to manage city growth, to ensure that risk-reducing infrastructure is in place (for most cities especially functioning storm water drainage systems) and that low-income groups can find shelter on safe sites, is key. Having early warning systems in place when storms approach, and flood emergency action measures to ensure those most at risk can and do move to safer locations when needed is also critical.

SECTION 8

Developing effective urban environmental management

The last 30 years have shown that polluting emissions in cities can be controlled, and liquid and solid wastes better managed and often reduced. In many cities, significant improvements are often possible simply through city governments giving more attention to applying existing environmental legislation and making better use of existing infrastructure and equipment.

8.1   Involving all city stakeholders

Pollution control in urban areas centres on reducing or removing pollution that comes from the gaseous, liquid and solid wastes of different groups: industries (from large formal industries to small, informal ones), other enterprises and institutions (including government) and individuals/households. It also includes applying pollution control to the transport systems used by each of these. Here we review examples of urban pollution control and reduction, these include many initiatives led by city or municipal governments, civil society and particular enterprises (or groups of enterprises). The short sections below give more details of each. Note that these are not tightly bound categories and interactions between actors and strategies are important. It was often city government that stimulated and supported innovation among industries in pollution control. The improvements in city government action was often led or catalysed by civil society organisations that included federations or networks of urban poor groups.

8.2   City government-led initiatives

Each city has its own story and larger (regional and national) context in regard to the scale and nature of urban pollution, who is impacted, whether and where these have been addressed and how this was done. This makes any summary of city government-led initiatives difficult. Box 5 gives the example of how Surat has moved from being one of India's dirtiest cities to one of its cleanest (Vedachalam and Riha, 2015).

Box 5 Surat, the plague and floods

Surat is one of India's most prosperous cities. It has a population of around 4.5 million. The city specialises in diamond cutting and polishing although it also has a large industrial base of both large- and small-scale industries. Two disasters – a plague epidemic in 1994 and a very serious flood in 2006 – helped reshape the city government's social and environmental policies.

The city also had a poor reputation for cleanliness; despite its wealth. The city authority had failed to provide basic sanitation, clean drinking water and solid waste collection for much of the population. In 1994, plague broke out, killing 52 people and causing 1.5 million to move out of the city from fear of contagion. This obviously brought great disruption to the city's economy too and discouraged new investment.

In response to the plague, the city government prioritised the provision of cleaner water and the management of excreta and solid waste. In 1995, a new Commissioner took charge of the municipal government and prioritised environmental health and increasing local government effectiveness. This included transforming the quality and coverage of solid waste collection and management and introducing charges for households and industries that were not putting their wastes in bins. The street cleaning also improved. The municipality's public health care system was strengthened and a disease surveillance system set up. The proportion of the population served with water increased and detailed plans were developed to extend the drainage and sewerage network. By 2010, the piped water system reached 95% of the municipality's population and sewers were extended to 86%. Many 'slums' were upgraded with provision for water, sanitation and solid waste collection much improved. The municipal government's structure was also changed from a vertical hierarchy to a more decentralised structure within 38 election wards grouped into seven administrative zones. Surat came to be considered one of the cleanest cities in India.

The city government also had to take action on flooding. Surat is located on the Tapi River, which flows into the Arabian Sea 16 km from the city centre. Heavy precipitation in and around the city triggers floods but so too does heavy precipitation upstream and high tides. Since 1979, there have been five major floods. The 2006 flood and some earlier ones occurred because of emergency discharges of the Ukai dam 94 km upstream of the city centre. It inundated three-quarters of the city area. Official estimates suggest that 150 people died (although unofficial estimates suggest more than 500). The flood also brought huge disruption to the city economy.

Measures taken by the municipality to reduce flood risks include hardening power supplies, communications and other essential services. During the monsoon in particular, the municipality clears its drainage and sewer systems to increase the capacity to manage floodwaters. Evacuation procedures have been enforced and some of the residents most at risk from flooding have been relocated. Water levels are also monitored from the reservoir behind the Ukai dam to give more time for flood warnings and the warning system has been improved, and now includes warnings sent via SMS to mobile phones.

Sources: Ghosh (1998), Bhat et al. (2013)

The growing importance of urban areas in relation to national economies, employment structures and populations is evident in almost all low- and middle-income nations. The rapid growth of most large cities has produced very serious pollution problems.

As noted earlier, most cities also have limited funding in relation to their responsibilities. But there is a demand for pollution control by citizen and community initiatives, which can lead to local and national policy and law-making (Robins and Kumar 1999). Evidence of their effectiveness in other locations, rising public expectations, the "slow squeeze" of regulation as well as corporate responsibility programmes and market pressures from consumers and investors also contributes to the pressure on governments to take action (ibid). So too does the increasing evidence on health impacts and economic impacts – including those of indoor and ambient air pollution.

An important part of greater effectiveness in pollution control in high-income and some middle-income nations has been the growth in competence, accountability and transparency in city governments.

This includes democratically elected city and municipal governments and often elected mayors that bring a commitment to better environmental management. This often includes support from higher levels of government and national or state/provincial governments; for instance, in providing a legal base for action on pollution control or incentives.

City governments can take measures to reduce urban poverty that also contribute to reducing pollution and building greater resilience to climate change.

Measures could include expanding and improving provision for water, sanitation and household waste collection and management. Addressing the very large backlog in basic infrastructure (especially in informal settlements) is central to good environmental health and pollution control. It can also bring very large improvements in health and can contribute to greater resilience to disasters and climate change.

Many of the best examples of this come from Latin America where a stronger local democracy or a return to democracy (and with elected mayors and city governments) and real decentralisation (including stronger financial bases for city government investments) has underpinned a very large expansion in infrastructure.

This includes provision for water, sanitation, drainage and solid waste collection (Galilea Ocón 2014) as well as much environmental improvement (Velasquez, 1998; Lopez Follegatti, 1999; Menegat, 2002; Almansi, 2009; Dávila, 2009). These initiatives usually receive the support of central governments and are often complemented by new legislation on environmental issues. The evidence for this can be seen in a range of indicators that include census data showing the very large increase in the proportion of various nations' urban population (or of particular cities' population) with water piped to their homes, connections to sewers and solid waste collection services (for the most up-to-date coverage see Galilea Ocón, 2014, for Latin America and, more generally, UCLG, 2014; see also Hardoy et al., 2001; Campbell, 2003; Satterthwaite, 2009). Measures often include better management of solid and liquid wastes at a city scale (including increased recycling) and measures to reduce air pollution (both industrial and motor vehicle related). These environmental improvements are often associated with more scope for participation (including participatory budgeting) and a new generation of elected mayors that are strongly committed to environmental improvements (Menegat, 2002; Cabannes, 2004; Davila 2009). One city that has innovative environmental management within democratic structures is Manizales in Colombia (see Box 6 and the four papers listed on this in the annotated bibliography). There are also examples of city governments extending their environmental innovations to include climate change adaptation and mitigation. Durban has made much progress on environmental issues (see the cluster of papers on this in the annotated

bibliography).

Box 6 Manizales

Manizales, a medium-sized city in Colombia (with around 450,000 inhabitants) has had a range of environmental policies. These began in 1990 with a city-wide environmental profile and assessment of disaster risks associated with urban development. A local environmental policy (BioManizales) was developed in 1993 and an action plan (Bioplan-Manizales) approved in 1995 with widespread consultation and these became integrated into the municipal development plan and the municipal budget. The Bioplan included measures to protect and revitalise the city's rich architectural heritage, improve public transport (partly funded by a tax on petrol), reduce the risk of landslides and relocate the population living on steep slopes that are at high risk of landslides. The relocation programme was linked to the development of eco-parks throughout the city, some on the land that had slopes that were too dangerous for permanent settlement and others with important ecological functions. For instance, one was integrated into the city's watershed and another focused on conserving biodiversity. Some of the eco-parks are managed by community associations, who also manage community plant nurseries and 15 neighbourhood parks. Community-based environmental initiatives helped to generate jobs, for example, managing eco-parks, running tree nurseries and increasing recycling. Community- or neighbourhood-based environmental action plans have also been developed. One for Olivares commune (one of 11 communes in Manizales and also the one with the lowest average income) identified the main environmental problems and also the area's environmental resources on which their neighbourhood agenda could build.

The city developed an innovative indicators programme - the 'environmental traffic lights'. Through this, progress with regard to social conditions, community involvement, natural resource use, energy efficiency and waste management in each of its 11 communes is tracked. Data on current conditions and trends in each commune are displayed in public places. They are called traffic lights because, for each indicator, public boards show whether things are improving (green), getting worse (red) or are relatively stable (amber). Environmental observatories set up in different parts of the city also help to monitor progress.

Two challenges have been getting coordinated plans and actions across sectors and sustaining the policies through different mayors. Support for the Bioplan from key municipal secretariats often waned. When new mayors were elected, some did not see these environmental policies and disaster risk reduction as a priority. Civil society pressure and the key role of the Instituto de Estudios Ambientales (IDEA) within the Manizales campus of the National University helped maintain policies even when mayors were not supportive.

The municipal development plan 2012 to 2016 integrates environmental policies, disaster risk reduction and climate change adaptation. The current administration strengthened environmental management through creating the Secretariat for the Environment and has a commitment to revalue Bio Manizales and to focus on sustainable development.

Sources: Velasquez (1998, 1999), Hardoy and Velasquez Barrero (2016)

A stable government is important for the continued implementation of pollution control measures.

Box 7 provides an example of a city where an elected city government with strong support from the inhabitants addressed a whole range of environmental and social issues that included pollution control. This case is also notable for a city government seeking to act simultaneously on environmental, social and economic issues and for having a succession of mayors from the same political party that gave continuity and coherence to public policies over many years. The city government increased the role of its Environment Department, in response to the fact that all sectors needed to take environmental issues seriously and address these in coordination with all the different government areas and sectors involved. This proved much harder in practice than initially expected. Comparable challenges have faced the environment department in the city of Durban. Here, as in most cities, the environment department is relatively weak in comparison to much larger sectors (including public works) and its effectiveness depends on getting buy-in from these.

Box 7 The role of local government in addressing environmental issues; the case of Rosario

With the political stability of prolonged governance by the same elected party, the city of Rosario succeeded in widespread environmental reform. Rosario, with a population of 1.1 million is the third largest city in Argentina. It forms the core of Greater Rosario, which has a total population of approximately 1.5 million. From 1998 to 2011, under two mayors (both of whom served two terms), the city government developed a strong environmental policy that included improved public transport, much increased recycling and expansion of public space and measures to reduce flood risk (which now includes addressing climate change).

What is perhaps more notable is that this has been combined with a strong social policy and with strategic urban planning. This seeks to integrate environmental issues and support local economic development and measures to secure the city's economic success. The large expansion of public space involved the city government working with private landowners to restore the riverbank area and create many new parks and other public spaces. Social policies included the modernisation and expansion of health care and the introduction of a community-oriented city police force. Support for participatory budgeting and decentralisation, enhanced the role of municipal district centres and concentrate many public services and support community programmes in each of the city's six districts. The city has an integrated mobility plan (Plan Integral de Movilidad Rosario) to promote the use of clean and renewable energy, discourage the use of private cars, encourage more trips by public transport and reduce pollution and GHG emissions

The city government faced many challenges. These included its limited capacity to reduce unemployment (although the city government has done much to support local economic development) and the difficulties of working with national and provincial governments and neighbouring municipalities controlled by different political parties. For climate change adaptation, challenges relate to the limited funding and relevant data and the challenge of responding to pressing and competing interests.

Sources: Almansi (2009), Hardoy and Ruete (2013)

8.3   City government–civil society initiatives

Progress is directly related to the capacity and accountability of local governments, but this does not prevent innovative approaches to the challenges.
The innovations noted above are concentrated in middle-income countries where local governments have the technical and financial capacities to act in response to local demands and are more accountable. In low- and lower-middle-income nations where city and municipal governments have far more limited technical and financial capacities (and often less accountability), there has been less progress but also considerable innovation in local government–civil society partnerships. The evidence for the effectiveness of this approach is most common in Asia and Africa and this focuses more on the environmental health priorities of those living in informal settlements, as it is driven by organisations formed by their inhabitants and supporting civil society organisations.

One of the best known of these (and also one of the largest in terms of scale) is the community-driven sanitation developed and supported by the Orangi Pilot Project–Research and Training Institute in Pakistan.
This has reached hundreds of thousands of urban dwellers. This Institute has also provided support for better quality housing, school improvements and finance in informal settlements (Hasan, 2006, 2008; Hasan and Raza, 2011). What makes this example particularly noteworthy is its capacity to pull in city government. Hasan (2006) makes the distinction between 'small pipes' that community organisations can install within their neighbourhood (including piped water, sewers and storm drains) and the 'big pipes' that include water mains, trunk sewers and storm drains, and management of these at a city scale that requires city governments to provide or contract. Here, the official water and sanitation utility worked to provide the trunk water and drainage infrastructure into which the community-installed systems could integrate.

Other examples of this approach highlight how partnership between city government and community organisations can lower costs and speed implementation. Having a city government that sees the necessity of working with the inhabitants of informal settlements – and working with their organisations – is crucial. Many cities have federations or networks of grassroots organisations formed by slum/shack dwellers that are working in partnership with local governments to expand or improve provision for water, sanitation and drainage and support housing improvement (see, for instance, Banana et al., 2015). Over 100 cities have funds jointly owned and managed by federations or networks of urban poor groups and local governments (see Satterthwaite and Mitlin, 2014, for many examples; see also www.sdinet.org).

One of the most interesting international programmes (focused on Asia) has been the Asian Coalition for Community Action, through which catalytic funding has been provided for over 1,000 community initiatives.
Support was also provided for community initiatives linking together and seeking partnerships with local governments. There are now many examples of successful local government–civil society partnerships (Asian Coalition for Community Action, 2010; Papeleras et al., 2012; Satterthwaite and Mitlin, 2014).

Another powerful example of this combination of government and community action is the work of the Community Organizations Development Institute (CODI) in Thailand.
This is a national government agency that provides loans to organised communities to upgrade their own settlements and supports negotiation for infrastructure provision from local government or utilities (Boonybancha, 2005; Satterthwaite and Mitlin, 2014). More details of this are given in Box 8.

However, it is worth recalling the discussions in Section 4 on the challenges and opportunities - especially the comparisons between cities in local government budgets per person that show how low these are in cities in low- and many lower-middle-income nations.

Box 8 The Community Organizations Development Institute (CODI) in Thailand

CODI is a national institution that funds and supports community organisations living in informal settlements in getting tenure and upgrading or finding secure land on which they can rebuild their homes. It developed from an earlier initiative launched in 1992 called the Urban Community Development Office (UCDO) and CODI was established to continue and extend this work. The emphasis on supporting community-managed savings and loan groups and community networks extended to 30,000 rural community organisations, and many community networks that CODI supports include both rural and urban community organisations.

CODI developed the Baan Mankong ('secure housing') programme for upgrading and secure tenure in January 2003. This channels government funds in the form of infrastructure subsidies and housing loans direct to low-income communities, which plan and carry out improvements to their housing environment and to basic services. Baan Mankong was set up to support low-income households and their community organisations and networks to work with local governments, professionals, universities and NGOs in their city to survey all low-income communities, and then plan an upgrading programme to improve conditions for all these. Upgrading existing settlements is supported whenever possible; if relocation is necessary, a site is sought close by to minimise the economic and social costs to households. The programme imposes as few conditions as possible in order to give communities, networks and stakeholders in each city the freedom to design their own programme. The challenge is to support upgrading in ways that allow urban poor communities to lead the process and generate local partnerships, so that the whole city contributes to the solution. By April 2012, the Baan Mankong program had led to the upgrading of over 91,000 houses across 270 towns.

Sources: Boonyabancha (2005), Mitlin and Satterthwaite (2014)

8.4 Controlling industrial pollution

8.4.1 Environmental regulation instruments

Many of the most polluting industries in low- and middle-income nations are using out-dated technologies that have higher levels of pollution. Pressures on industries to invest in pollution control or new cleaner technologies are lessened by the lack of pollution control legislation or its implementation (that is often linked to the political influence of these industries' owners).

Environmental regulation instruments are typically categorised according to three criteria:

- whether they dictate the abatement decisions of firms (command and control) or create financial incentives for abatement
- whether they require a regulator to monitor emissions

- whether they involve government investment in abatement technologies.

Blackman (1999) includes a useful summary of pollution control instruments (see Table 4).

	Direct	Indirect
Command and control	Emission standard (cap on level of emissions)	Technology and process standards (mandated abatement technology or production process)
Economic incentive	Emissions fee	Green taxes (on dirty inputs or outputs)
	Marketable permits for specific emissions	Green subsidies
Government investment	Communal treatment facilities Research and development on clean/pollution prevention Technologies	
Information based	Public disclosure programmes on firms' environmental performance Educational programmes on pollution and its control	

Source: Based on table in Blackman (1999)

Table 4 The range of pollution control instruments

8.4.2 Control of pollution from fossil fuels

Most urban air pollution comes from fossil fuel use – in power stations, businesses, households and motor vehicles. Its control centres on reducing pollution generation at source (for instance through shifts to cleaner fuels or cleaner technologies for households, businesses, motor vehicles and thermal power stations) and the use of pollution-control equipment that removes or reduces pollution from emissions. This is usually underpinned by particular standards for ambient air quality (as discussed earlier) and legislation on standards for particular sources (e.g. motor vehicles and industries). Air pollution control technology can reduce or remove particulate and gaseous pollutants from thermal power plants and industries and help reduce air pollution from mobile sources (motor vehicles, ships and planes).

8.4.3 Sustainable industrial development

From the 1990s, a key shift can be seen from a focus on controlling pollution to a focus on stimulating sustainable industrial development throughout the entire product lifecycle.
The 1990s witnessed a significant shift among the enlightened sections of the global business community away from denial and resistance to change towards a more proactive approach, seeking to go "beyond compliance" (Robins and Kumar, 1999). There was also more evidence that "properly designed environmental standards can trigger innovations that lower the total cost of a product or improve its value – ultimately, this enhanced resource productivity makes companies more competitive not less" (Porter and van der Linde, 1995). Many companies have made public commitments to improved environmental performance and signed up to codes of conduct and/or sought certification in ISO standards relating to environmental practice. More recently, there has been a growing interest in the green economy – and in its potential contribution to pollution reduction, employment and lower GHG emissions. Table 5 highlights the shift from control to eliminating pollution and waste in the production process, first through steps to improve efficiency, then by institutionalising pollution control and other environmental issues into mainstream manufacturing and, finally, by restructuring production to make zero emissions the norm (Robins and Kumar, 1999).

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	FIRM	CITY	NATION
Step 1: Control	End of pipe technology	Relocate dirty industries	End of pipe regulation
Step 2: Efficiency	Cleaner production	Collective environmental services	Environmental assessment
Step 3: Institutionalise	Lifecycle environmental management	Eco-industrial estates	Integrated pollution control
Step 4: Restructure	Zero emissions	Carrying capacity planning	Extended producer responsibility

Source: Robins and Kumar (1999)

Table 5 Four steps to sustainable industrial production in cities

Addressing air pollution from transport includes not only measures to reduce emissions from motor vehicles but also measures to reduce private automobile use.
This can be achieved, for instance, through creating incentives for compact urban development, better public transport and space for walking and bicycling.

In most cities, there is a need for pollution control within the informal economy.
There are examples of local governments working with those exposed to high levels of pollution (for instance, working with waste pickers to make their work less dangerous). There are also examples of informal waste pickers or waste collectors becoming organised and negotiating a role in formal waste management systems (Fergutz et al., 2011; Parizeau, 2013) In Brazil, there is a national movement of waste pickers made up of more than 500 registered waste picker cooperatives and associations while in Colombia an organised movement of waste pickers in Bogotá set up the association of recyclers which have helped negotiate roles for their members (Wiego cooperatives, no date).

There are a few other case studies on pollution control in the informal economy to draw on.
Examples include Biller and Quintero (1995) who discuss how best to address pollution from informal tanneries in Bogotá and informal brick kilns in Mexico. Blackman et al. (1999) include one of the most detailed discussions on pollution control in the informal sector, illustrated by case studies of informal brick kilns in four cities in Mexico. This paper highlights the difficulties in controlling pollution-intensive informal activities since these have few ties to government and are often small, numerous and geographically disbursed, which makes them difficult to monitor. The paper raises two points that have a more general relevance. The first is that government pollution control measures were initiated by the municipal governments, and were not national policy. The second is that the most appropriate choices for pollution regulation generally depends on the informal enterprises being organised and not too politically weak. Dasgupta (1997) discusses how to control pollution from informal enterprises involved in lead smelting in Kolkata and suggests a need for this to include information dissemination on how businesses could comply with environmental legislation and the costs and benefits of different pollution control or reduction options.

8.5 City-wide planning and management

For any city, effective environmental management (and beyond this building resilience to disasters and climate change) depends on a capacity and willingness to manage urban expansion and land-use. This was central to many of the innovations in Curitiba and in Rosario (as outlined in Box 7). There are a range of tools and methods developed over the last few decades to support better city-wide environmental planning and to recognise the importance of strategic planning. This includes the many cities that have developed 'Local Agenda 21s' that were identified in the UN Earth Summit in 1992 as crucial for the implementation of the larger 'Agenda 21' (see Hardoy et al., 2001 for details). Many Local Agenda 21s also had significant roles for civil society (see Miranda and Hordijk, 1998). More recently, many city governments have innovated on building resilience to disasters (see for instance Johnson and Blackburn, 2014) and to climate change (Revi et al., 2014). The growing recognition internationally of the need for more attention to urban issues and to governing urban growth (see, for instance, the latest draft goals for the post 2015 Sustainable Development Goals) has focused more attention on city planning and land-use management but has also raised fears that this might include a return to bulldozing informal settlements.

More effective city-wide environmental planning and management also depends on the availability of relevant data; for instance, on environmental quality and service provision. Many city governments have expanded their reporting on environmental issues; see, for instance, how the city of Manizales has been reporting on a range of environmental indicators for each district in the city within the environmental traffic lights (Box 6).

8.6 Multi-level governance

Different levels of government (national, state/provincial, metropolitan, municipal) have different roles and responsibilities that need to be coordinated. In discussions of disaster risk reduction and climate change adaptation in urban areas, much has been made of 'multi-level governance' (see the discussion of this in the IPCC's Fifth Assessment; Revi et al., 2014). This also applies more widely to the control of urban pollution. It generally falls to national governments to develop the legal basis that sets the framework for air quality, water use and solid and liquid waste water discharges, and for penalising those who pollute. To work, this also needs a system to monitor compliance (and much of this may depend on lower levels of government for implementation).

National governments need to establish not only the broad policy framework of regulatory controls but also economic incentives and attention to the environmental impacts of public investments. This needs to be integrated into core government policies, such as finance and tax, trade, technology, industry, energy and transport as well as environmental protection and development cooperation (Robins and Kumar, 1999). Box 9 below gives the example of a national government providing incentives for city governments to address environmental issues through a city award scheme

Box 9 *Adipura* **(Noble City Award) in Indonesia**

In 1983, the National Government's Ministry for the Environment established the Adipura (Noble City) award to encourage Indonesian cities and urban regions to address environmental issues. It sought to encourage city governments to reduce domestic waste pollution, improve housing quality and involve the community in managing the living environment. It included indicators on the physical conditions as well as on the quality of environmental management. Judges were drawn from the Ministry for the Environment, universities and representatives from communities that were not from the city being assessed. The award was presented each year by the President of Indonesia. It helped to stimulate integrated efforts by all actors (public, private and the community) to make cleaner, healthier, cities. Cities that almost managed to reach the Adipura standard were given the Clean City Certificate. It was stopped for a few years after the fall of President Suharto, but was rejuvenated during Megawati's presidency in 2002. Every year, there is an *Adipura* contest for different size categories of cities: metropolitan cities (with more than a million inhabitants), big cities (0.5–1 million), medium cities (100,000–500,000), and small cities (up to 100,000). Additional categories include cities with the best urban–forest ratio, best city markets and best city parks.

Sources: Santosa (2000), Lassa and Nugraha (2014)

Metropolitan and municipal governments usually have key roles (and may be the initiators for innovative environmental policies that include pollution control). In many middle-income nations, progress has been made in setting environmental standards (especially for air pollution) and implementing them. However, this often requires measures taken by the largest polluters that are politically difficult to enforce. In low-income and many middle-income nations, local governments lack the funding and technical capacity to make conventional command and control measures work. For instance, regulators with the capacity to measure emissions and impose sanctions are needed in addition to support from environmental regulatory institutions and judicial, legislative and data collection institutions (Blackman, 1999). Pollution control also needs changes to traditional spatial planning, assessment and zoning procedures, investments at collective infrastructure services and support for innovation and shared learning within industry, particularly among small- and medium-sized enterprises. It also needs mechanisms to ensure the public accountability of industry to citizens and the wider community and that address issues of bribery and corruption.

Environmental management and governance in an urbanising world

9.1 Recognising how much environmental priorities differ between urban centres

The need for action is being recognised. The need for governments and international agencies to give more attention to urban areas in relation to poverty reduction, economic success and local and global environmental performance is finally getting the attention it deserves – although clarity on how best to address this is still lacking.

Table 6 shows the range and relative importance of different environmental problems among four categories of urban centre. The first category has urban centres in which the environmental problems are those associated with poor environmental health and not with high levels of industrial pollution, resource use and waste. Most urban centres in most low-income and many middle-income nations fall into this category. At the other extreme are cities in high-income nations where the main environmental problems are no longer within the city but in the collective impact of the consumption and waste produced by city inhabitants and city businesses on regional and global resource bases and systems. The other two categories fall within these two extremes. Of course, most urban centres do not fit neatly into one of these categories, but the table does highlight the way in which the scale, nature and relative importance of environmental problems differ between cities of different size and wealth.

If we consider the full range of environmental problems within cities, some are generally less serious, the higher the per capita income. Examples of this include the quality and extent of provision for water and sanitation. However, this is not simply a relationship between per capita income levels and extent of provision, since the quality and extent of provision is also strongly influenced by the quality of government. Some cities in relatively low-income nations are well served and some cities in nations with much higher incomes are not.

Some environmental problems increase with per capita incomes, especially GHG emissions and solid waste levels per person (although with considerable variation in levels between countries with comparable per capita incomes). Some environmental problems are generally more serious, the higher the per capita income but the increase can be moderated, halted or even reversed by government regulation; for instance, the pollution of city water bodies, traffic accidents and air pollution from motor vehicles and industries. Much of the literature on how environmental problems change with income levels gives too little attention to the extent to which the environmental problems are related to the competence and capacity of government. Effective government includes setting and enforcing environmental and occupational health regulations and ensuring adequate provision of environmental infrastructure, especially for water, sanitation and drainage. The government, and the polluting industries, should also be responsive to citizen groups and their demands for action.

Environmental problems and influences	Most urban centres in most low-income nations and many middle-income nations	More prosperous cities in low and middle-income countries including many developed as industrial centres	Prosperous major cities/metropolitan areas in middle- and high-income countries	Cities in high-income countries
ENVIRONMENTAL HAZARDS WITHIN THE URBAN ENVIRONMENT				
1. Those linked mainly to inadequate provision for - water supply and sanitation - drainage - solid waste collection - primary health care	Much or most of the urban population lacking water piped into the home and adequate sanitation. Also many or most residential areas lacking drainage and many residential areas at risk from flooding. Many or most residential areas also lacking services for solid waste collection and health care, especially the poorer and more peripheral areas.	Piped water supplies and relatively hygienic forms of sanitation reaching a considerable proportion of the population but most low-income households not reached, especially those in informal settlements on the city periphery. For those that are reached, often it is only through communal provision (e.g. standpipes, shared latrines) and of poor quality. Solid waste collection and health care usually reaching a higher proportion of the population but still with 30-60% of the population unserved.	Generally acceptable water supplies for most of the population. Provision for sanitation, solid waste collection and primary health care also much improved, although 10-30% of the population still lacking provision (or adequate provision). The proportion of people lacking adequate services generally smaller, but in very large cities, this can still mean millions who lack basic services. In large metropolitan areas, service provision often least adequate in the weakest, peripheral municipalities.	Provision of all four services for virtually all of the population.

Environmental problems and influences	Most urban centres in most low-income nations and many middle-income nations	More prosperous cities in low and middle-income countries including many developed as industrial centres	Prosperous major cities/metropolitan areas in middle- and high-income countries	Cities in high-income countries
2. Those linked to physical and chemical hazards in the home and workplace	The main hazards associated with poor quality and overcrowded living and working environments – and evident in the large health impact of domestic and workplace accidents. There may be serious occupational hazards among certain small-scale and household enterprises; also for much of the workforce in many smaller industrial and mining centres.	A great increase in problems with occupational health and safety at all levels and scales of industry. Government often not giving occupational health and safety adequate priority. A high proportion of low-income households living in illegal or informal settlements with high risks of accidental injuries, especially if they settle on dangerous sites.	Improved government supervision or worker organisation to ensure improved occupational health and safety. Often, a decline in the proportion of the population working in hazardous jobs. A rise in the contribution of traffic accidents to premature death and injury. Improved provision of water, sanitation, drainage and health care lessening physical hazards in residential areas.	Road accidents remain one of the most serious health threats. Occupational health problems lessened through much better health and safety standards. Active programmes usually promoting injury reduction for homes and on the roads.
3. Those linked to air pollution	Often serious indoor air pollution, where coal or biomass fuels are used as domestic fuels, especially where indoor heating is needed. Small industrial or mining centres can have high levels of air pollution.	Often severe problems from industrial and residential emissions. Indoor air pollution in many households lessened as those who can afford to do so switch to cleaner fuels.	Increasingly important contribution of motor vehicles to air pollution. Perhaps less from industry, as city's economic base becomes less pollution intensive and as measures begin to be taken to control industrial emissions.	Motor vehicles are the major source of air pollution; little or no heavy industry remains in the city and the control of air pollution becomes a greater priority for citizens.
RENEWABLE RESOURCE USE				
1. Land/soil	Urban expansion taking place with few or no controls, or where controls exist, they are largely ignored.	Urban expansion continuing to take place with few or no land-use controls; often rapid growth in informal settlements, including illegal land sub-divisions; loss of farmland to expanding urban areas, to demand for building materials and aggregate, and often to land bought up by speculators.	More controls imposed on urban expansion but these often prove ineffective as illegal residential developments continue, as much of the population cannot afford to buy or rent the cheapest "legal" land site or house. Different groups often in conflict over-use of best	Where there is concern for agricultural land loss, land use often regulated, perhaps to the point where house prices increase from constraints on land supplies for new housing. Where there is less concern, often large loss of agricultural land to suburban ex-urban developments.

Environmental problems and influences	Most urban centres in most low-income nations and many middle-income nations	More prosperous cities in low and middle-income countries including many developed as industrial centres	Prosperous major cities/metropolitan areas in middle- and high-income countries	Cities in high-income countries
			located undeveloped land sites or agricultural land for urban purposes.	
2. Freshwater	Generally, the wealthier the city, the larger the use per capita with many large wealthy cities also having to draw on the water resources of an increasingly large area. Certain industries often having particularly high demand for water. A strong emphasis on water conservation can considerably reduce per capita consumption in wealthy cities; in all cities, reducing water losses can increase water availability. Many cities face competition for available water resources from agriculture or hydropower.			

NON-RENEWABLE RESOURCE USE

Generally the wealthier the city, the higher the consumption of fossil fuels and other mineral resources, although again, there are very large variations between cities with comparable per capita incomes. A strong citizen and government commitment to reducing automobile dependence and waste reduction, and also to re-using, reclaiming and recycling can keep down per capita consumption figures in wealthy cities. Now there is growing concern for 'sustainable consumption', which also implies much lower levels of non-renewable resource use in wealthy cities.

GENERATION OF BIODEGRADABLE AND NON-BIODEGRADABLE WASTES

1. Water pollution	The main water pollution problems arise from a lack of provision for sanitation and garbage collection, except in industrial or mining centres.	Most local rivers and other water bodies polluted from industrial and urban discharges and storm and surface run-off.	Severe problems from untreated /inadequately treated industrial and municipal liquid wastes that are usually dumped without treatment in local water bodies.	Much improved levels of treatment for liquid wastes from homes and businesses. Concern with amenity values and toxic wastes.
2. Solid waste disposal	Open dumping of the solid wastes that are collected; many wastes not collected.	Mostly uncontrolled open land dumps; mixed wastes.	A proportion of landfills controlled or semi-controlled.	Controlled sanitary landfills, incineration, some resource recovery (which can encouraged by taxes on wastes sent to landfills).
3. Hazardous waste management	No capacity but also volumes generally small.	Severe problems; limited capacities to deal with it.	Growing capacity but often still a serious problem.	Moving from remediation to prevention.

Environmental problems and influences	Most urban centres in most low-income nations and many middle-income nations	More prosperous cities in low and middle-income countries including many developed as industrial centres	Prosperous major cities/metropolitan areas in middle- and high-income countries	Cities in high-income countries
4. Household generation of non-biodegradable wastes (including GHG emissions)	Very low levels per capita.	Generally low levels per capita.	Generally intermediate levels per capita.	Generally high levels per capita, although large variations between cities with comparable per capita incomes linked to number of motor vehicles per person and their use, density, commitment to energy efficiency, etc.
OTHER ENVIRONMENTAL HAZARDS				
	No provision by public authorities for disaster preparedness; disasters (floods, storms, etc.) often common with severe damage and loss of life. In cities with an industrial base, inadequate provision to guard against industrial disasters and to act to limit the damage and loss of life.		Some provision for disaster preparedness.	Increasingly sophisticated disaster preparedness.

Source: A modified and updated version of a table in Bartone et al. (1994)

Table 6 Typical environmental problems for urban centres of different sizes and within nations with different levels of income

There is also the issue of whether environmental pollution is being addressed or transferred by wealthier cities. Environmental problems appear to be less serious in wealthier cities (or generally within urban centres in wealthier nations) but they may be simply being transferred to other people, other ecosystems or into the future. As cities get larger and the residents wealthier, so they can transfer their environmental problems away from their homes and neighbourhoods to other people and regions. They also transfer responsibility for these problems to someone else (see McGranahan et al., 2001).

9.2 Three key challenges

Three key challenges should be highlighted.

1. The economic, social and environmental determinants of health in urban centres need to be recognised (as illustrated by Figure 7 below).
This figure also makes clear the importance of environmental determinants in homes, workplaces and the wider city. It also shows the range of determinants that influence urban living and working conditions including the competence and capacity of local government and the support it receives from higher levels of government. It details the determinants within the urban population that includes its capacity to organise and to influence health outcomes.

Figure 7 The many economic, social and environmental determinants of health in urban areas
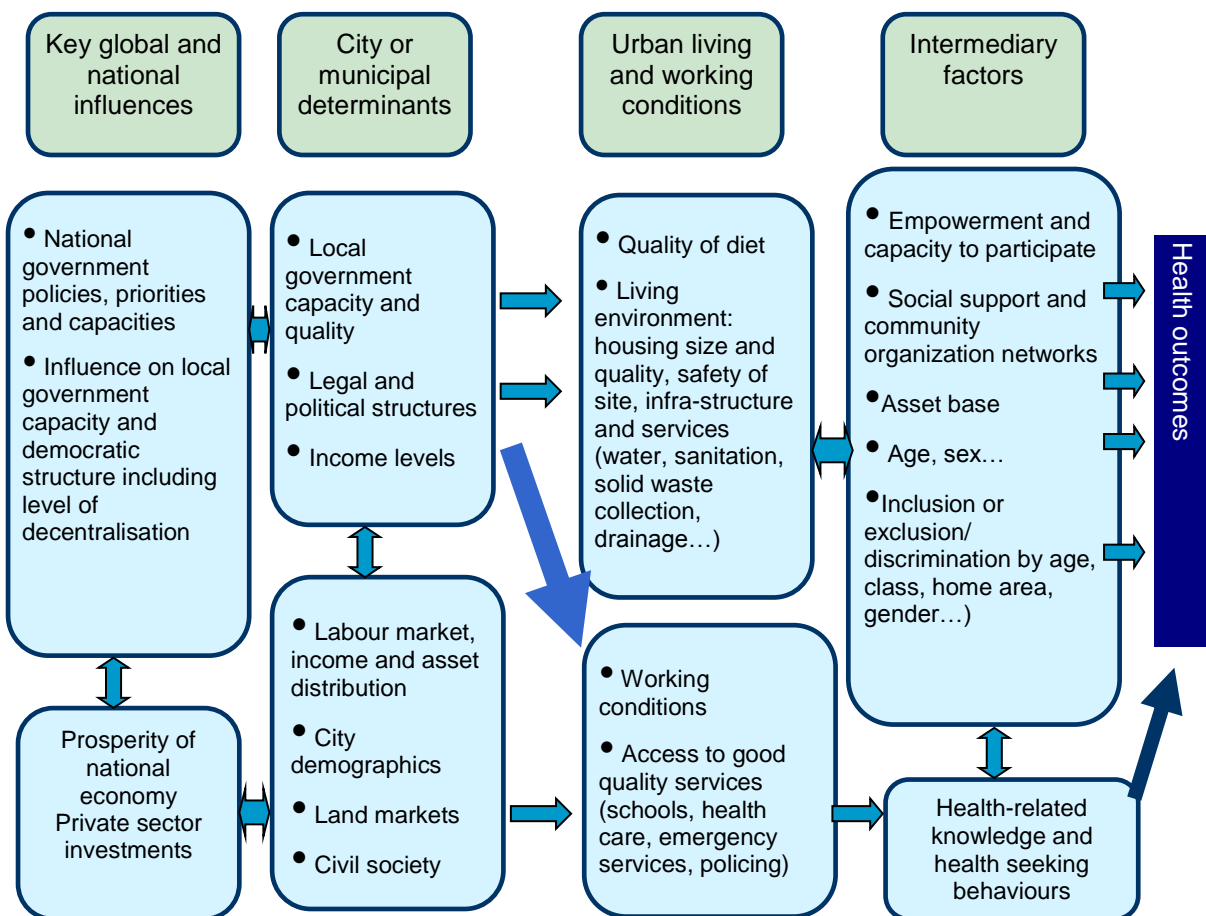
Source: Mitlin and Satterthwaite (2013)

A focus on government-led strategies to address environmental issues would focus on the city and municipal determinants in the second column of Figure 7 while a focus on environmental governance would widen this to include citizen and civil society organisation, action and engagement with local government. The key global influences need attention too – including the poor record on pollution for many corporations involved in mining and mineral extraction and processing and oil and gas abstraction.

2. The environmental health and pollution control needs and priorities of those most at risk and most vulnerable to pollutants need to be understood and addressed.
It is important to consider who within the urban population faces higher risks from pollutants and how these might be addressed. It is clear that these include those who live in informal settlements lacking risk-reducing infrastructure and services, those who use dirty fuels for cooking and heating (especially with inadequate ventilation) and those who work in occupations with high occupational health risks.

Consideration is also needed as to how risks and vulnerabilities vary by gender and by age. For instance, the health and development of embryos, infants and young children are far more at risk from many chemical pollutants than older children and adults. Women (and often girls) from low-income households often face higher risks from the particular tasks for which they have responsibility. Examples include: the higher exposure of women to indoor air pollution from dirty fuels because they spend longer indoors and do most of the cooking; and higher risks from faecal-oral diseases in households lacking toilets as they manage and dispose of excreta/toilet wastes and wash soiled clothing. Women and girls often have large time burdens from having to collect water and to dispose of solid wastes. When they lack toilet facilities in the home, they face greater harassment and risk of violence when defecating in the open and may face higher risks of violence when accessing communal or public water supplies or toilets.

3. Ways to support the different departments within local governments, with what are usually different and often competing urban agendas, to work together need to be found.
Environmental management and governance has relevance to all parts of government – as in 'poverty reduction and universal provision of services' (with its strong focus on environmental health), 'disaster risk reduction' (much of which is identifying and acting on risks from extreme weather), 'climate change adaptation' (which as noted earlier has to incorporate new risks or increased risk levels into disaster risk reduction and service provision) and 'climate change mitigation' (attention to where GHG emissions within the city and its surrounds can be kept down or reduced).

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Figure 8 The different urban agendas
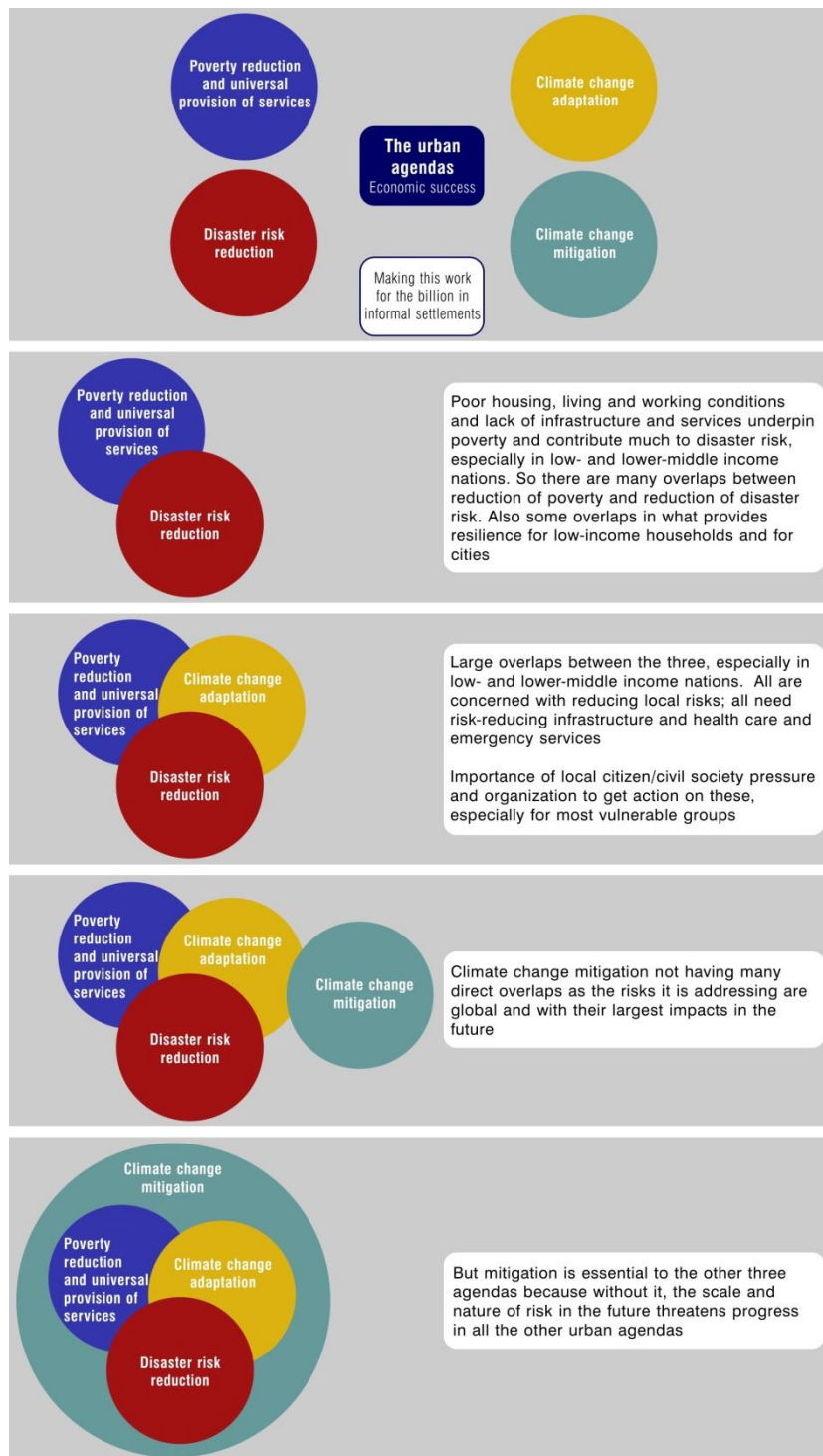
9.3 Looking to the future: global goals, local actions

There is a growing consensus within global discussions on environment and development (and on climate change) that urban areas require more attention. The Report of the High Level Panel of Eminent Persons on the Post-2015 Development Agenda states that "The post-2015 agenda must be relevant for urban dwellers. Cities are where the battle for sustainable development will be won or lost" (High Level Panel of Eminent Persons

on the Post-2015 Development Agenda, page 17). The current draft of the Sustainable Development Goals includes a goal to make cities and human settlements inclusive, safe, resilient and sustainable. It also includes a target to ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums by 2030. This draft also makes many commitments to universal provision for basic services that in urban areas will require more competent, accountable and better resourced local governments.

This guide highlights how decentralisation and better urban governance has contributed to major improvements in urban environments in many Latin American nations.
This could also be applied in Africa and Asia, but this is an intensely political issue. In addition, international agencies are structured to work with and through national governments, so any support they provide for cities needs national government support.

Thus, in concluding the discussion of urban pollution, it is the quality of local (municipal, city, metropolitan) governance that is most important for reducing it, especially for low-income groups.
Obviously, the higher the per capita income of city inhabitants, the more potential for good environmental quality as city inhabitants can afford to pay more for environmental infrastructure and services and as city government has a larger resource base on which to draw. If local government does not act on this, wealthy groups may retreat to gated communities (or even gated cities). 'Good local governance' backed by the needed legislation and financial support can ensure much improved environmental quality even in cities and smaller urban centres with relatively low per capita incomes.

Urban environmental management and governance need to add addressing climate change adaptation and mitigation to their responsibilities.
This includes taking advantage of overlaps and minimising conflicts between the different aspects of the urban agenda highlighted in Figure 8. Obviously, this is a politically sensitive issue for nations (and urban centres) that currently have low levels of GHG emissions and who worry that measures to reduce such emissions will constrain their development. However, the urgent need to reduce global emissions to avoid dangerous climate change requires all nations to contribute. Without action on mitigation, even wealthy cities with high adaptive capacities will not be able to protect themselves (Revi et al., 2014). The increasing scale and range of risks from climate change will have many of its most serious impacts in low-income nations. As Table 7 highlights, a large part of the world's urban population lives in urban centres with very little capacity to adapt to climate change and very large lags in risk-reducing infrastructure and services.

There is recognition of the potential of well-governed cities to contribute much both to adaptation and to mitigation. From this has emerged more discussion of low-carbon cities (that includes discussions of optimal densities) and of the potential economic advantages for cities of developing or supporting green economies. There are also economic and employment opportunities from better environmental management. Environmental management is also increasingly viewed through a resilience lens – and this has brought new insights to policy and practice for national policies and for building local and city-wide resilience and the information base needed to underpin this.

Indicator Clusters	Very little adaptive capacity or resilience/ 'bounce-back' capacity	Some adaptive capacity and resilience/ 'bounce-back' capacity	Adequate capacity for adaptation and resilience but needs to be acted on	Climate resilience and capacity to bounce forward	Transformative adaptation
The proportion of the population served with risk-reducing infrastructure (paved roads, storm and surface drainage, piped water, etc.) and services relevant to resilience (including health care, emergency services, policing/rule of law) and the institutions needed for such provision	0–30% of the urban centre's population served; most of those unserved or inadequately served living in informal settlements	30–80% of the urban centre's population served; most of those unserved or inadequately served living in informal settlements	80–100% of the urban centre's population served; most of those unserved or inadequately served living in informal settlements	Most/all of the urban centre's population with these and with an active adaptation policy identifying current and probable future risks and with an institutional structure to encourage and support action by all sectors and agencies. In many cities, also upgrade ageing infrastructure	Urban centres that have integrated their development and adaptation policies and investments within an understanding of the need for mitigation and sustainable ecological footprints
The proportion of the population living in legal housing built with permanent materials (meeting health and safety standards)				Active programme to improve conditions, infrastructure and services to informal settlements and low-income areas. Identify and act on areas with higher/increasing risks. Revise building standards.	Land-use planning and management successfully providing safe land for housing, avoiding areas at risk and taking account of mitigation
Proportion of urban centres covered	Most urban centres in low-income and many in middle-income nations	Many urban centres in many low-income nations; most urban centres in middle-income nations	Virtually all urban centres in high-income nations, many in middle-income nations	A small proportion of cities in high-income and upper-middle-income nations	Some innovative city governments thinking of this and taking some initial steps
Estimated number of people living in such urban centres	1 billion	1.5 billion	1 billion	Very small	
Infrastructure deficit	Much of the built-up area lacking infrastructure (including piped water, paved roads and covered drains)			Most or all the built-up area with infrastructure	
Local government investment capacity	Very little or no investment capacity			Substantial local investment capacity	
Occurrence of disasters from extreme weather	Very common			Uncommon (mostly due to risk-reducing infrastructure, services and good quality buildings available to almost everyone)	
Examples	Dar es Salaam, Dhaka	Nairobi, Mumbai	Most cities in high-income nations	Cities such as New York; London, Durban and Manizales with some progress	Copenhagen

Indicator Clusters	Very little adaptive capacity or resilience/ 'bounce-back' capacity	Some adaptive capacity and resilience/ 'bounce-back' capacity	Adequate capacity for adaptation and resilience but needs to be acted on	Climate resilience and capacity to bounce forward	Transformative adaptation
Implications for climate change adaptation	Very limited capacity to adapt. Very large deficits in infrastructure and in institutional capacity. Very large numbers exposed to risk if these are also in locations with high levels of risk from climate change	Some capacity to adapt, especially if this can be combined with development but difficult to get city governments to act. Particular problems for those urban centres in locations with high levels of risk from climate change	Strong basis for adaptation but needs to be acted on and city government and many of its sectoral agencies influenced	City government that is managing land-use changes as well as having adaptation integrated into all sectors	City government with capacity to influence and work with neighbouring local government units. Also with land-use changes managed to protect ecosystem services and support mitigation
NB: For cities that are made up of different local government areas, it would be possible to apply the above at an intra-city or intra-metropolitan scale. For instance, for many large Latin American, Asian and African cities, there are local government areas that would fit in each of the first three categories					

Sources: This table was constructed to provide a synthesis of key issues, so it draws on all the sources cited in Chapter 8 of IPCC (2014)

Table 7 The large spectrum in the capacity of urban centres to adapt to climate change

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The latest round of IPCC reports include much greater detail and coverage of urban areas, including many issues relevant to urban pollution. See for instance the long and detailed chapters on urban areas in Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2014: Impacts, Adaptation and Vulnerability* (Chapter 8) and in *Climate Change 2014: Mitigation of Climate Change* (Chapter 12). The full text of both can be downloaded from the IPCC's web site.

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3: Challenges and opportunities

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4: Urban pollution in the home and neighbourhood

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http://www.who.int/mediacentre/factsheets/fs292/en/
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http://www.who.int/water_sanitation_health/hygiene/emergencies/envsanfactsheets/en/index1.html#
Burden of disease for water and sanitation:
http://www.who.int/water_sanitation_health/diseases/burden/en/
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http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/EXTUSWM/0,,menuPK:463847~pagePK:149018~piPK:149093~theSitePK:463841,00.html

5: Urban pollution in the workplace

Occupational health and safety:
http://en.wikipedia.org/wiki/Occupational_safety_and_health
http://www.ilo.org/global/topics/safety-and-health-at-work/lang--de/index.htm

Environmental and occupational cancers:
http://www.who.int/mediacentre/factsheets/fs350/en/

Lead poisoning and health: http://www.who.int/mediacentre/factsheets/fs379/en/

6: Urban pollution at the municipal, city or metropolitan scale

Outdoor air pollution and health: http://www.who.int/mediacentre/factsheets/fs313/en/

This also has links to:
- WHO Air quality guidelines and to data on air pollution levels in over 1,600 cities
- Review of evidence on the health aspects of air pollution (REVIHAAP)

There are also estimates for some countries on the costs of pollution in monetary terms and as a percentage of GDP. These are not available for individual cities but they are useful for showing the high costs of pollution. For instance, a study on India suggested that total damages from environmental damage pollution were equivalent to 5.7% of GDP – and outdoor air pollution and indoor air pollution were responsible for the highest shares. Water supply and sanitation were also significant contributors.

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7: Cross-boundary issues for urban pollution

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Towards a real-world understanding of less ecologically damaging patterns of urban development – EandU Brief 14; available at http://pubs.iied.org/10547IIED.html?s=EUB

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8: Evidence of effective approaches to urban environmental management

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