Datong, China.
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PART
05

# The Urban Environment and Climate Change

## Quick Facts

1. In their quest for economic growth, Asian cities have not paid sufficient attention to urban environment and climate change issues.
2. In most Asian cities today, the average ecological footprint is in excess of five hectares per head, which is lower than in some other regions but suggests that current consumption patterns are unsustainable.
3. Urban growth in Asia is not environmentally sustainable. Existing infrastructure development and growth patterns may lock Asian cities into unsustainable consumption and production models for years to come.
4. Air pollution in Asia causes as many as 519,000 premature deaths every year.
5. Water supplies and food security are becoming a critical challenge in many urban areas.
6. The Asia-Pacific region stands to be the most affected by climate change, calling for changes to energy use and costs, transportation systems and building designs.
7. Asian cities are among the most vulnerable in the world to natural disasters, with many informal settlements located in fragile environmental areas on shorelines and major river basins.
8. Climate change will have a significant impact on the future development of Asia's coastal cities.
9. Adapting to climate change is a vital challenge for poorer Asian countries such as Bangladesh, as well as the smaller Pacific and Indian Ocean island states, due to very limited resources and options.
10. Due to the effects of climate change, urban and rural areas alike will face the challenges of water supplies, food security and eco-refugees.
11. Among urban areas, the poor are most vulnerable to climate change.

## Policy Points

1. Massive investment in basic services is needed to improve the sustainability of Asian cities.
2. Asian cities must improve their air quality to reduce premature deaths caused by air pollution and to maintain their competiveness.
3. As most of Asia's future demographic growth is to occur in cities, these are where the problem of climate change must be addressed most urgently.
4. The energy efficiency of transport systems should be assessed and monitored with a view to reducing fossil energy inputs while facilitating mobility. Energy-efficient building designs should be promoted to reduce greenhouse gas emissions.
5. Solid waste can be used as a resource, as demonstrated in several Asian cities.
6. Asian cities have just started to take adaptation measures in response to climate change. Most countries need more capital spending on urban infrastructure. Managing massive relocation of climate-change refugees requires careful planning which should begin now, rather than later when disasters become more intense.
7. If Asia's urban development is to become more sustainable, governments and communities must give priority to better urban planning and management of urban development, improvements to environmental management, and better environmental governance on a region wide scale.


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# 5.1 Introduction

Solid waste dumped on a road in Kathmandu, Nepal. **©UN-HABITAT/Bharat Dahiya**

"In Asia and the Pacific, overall, there has been a coincidence of rapidly expanding economies, poverty and substantial future consumption pressures, as well as a natural resource base that is more limited than any other in per capita terms. Thus, a focus on meeting human needs and improving well-being with the lowest possible ecological cost is more relevant in Asia and the Pacific than in any other global region" (ESCAP, 2008a:8). In their quest for economic growth, Asian cities have not paid sufficient attention to environmental and climate change issues.

The state of the urban environment in the Asia-Pacific region is very much a tale of two types of city. Conurbations in the more developed countries – Australia, Brunei Darussalam, Japan, New Zealand, the Republic of Korea and Singapore – are clean, well-managed, prosperous and safe places to live. In contrast, expanding cities in newly industrialized and rapidly developing countries, which together concentrate large proportions of Asia's urban populations, experience serious environmental, urban management, poverty and development problems. Therefore, to a majority of urban Asians, daily routines are a struggle: earning a living is fraught with risks, and the quality of life is poor.

From a topographical point of view, many Asian cities – in both developed and developing countries – are located along coastal zones and river floodplains. This makes them particularly vulnerable to the threatening effects of climate change and other natural disasters. From this perspective, urban centres in the Pacific islands are even more at risk than those in Asia.

With modernization, cities are becoming wealthier, as incomes and consumption rise and poverty tends to recede. However, this has often come at a significant cost: unmanaged urban development and poor environmental governance have resulted in mounting pollution, traffic congestion, income disparities and social inequity. Most Asian cities are poorly equipped to manage the effects of natural disasters, climate change, contaminated or unstable land and health pandemics. Many will need massive investments in infrastructure, public services, institutional capacity and environmental programmes if basic security, health, safety and overall conditions are to improve for the majority of urban residents.

Faced with poverty and unemployment, Asian governments have given high priority to economic growth and development through industrialization. Many have accepted that environmental issues are associated with this approach, but consider that these can be addressed once the nation reaches a certain level of development, by which time it is believed that nations can allocate more public funds to environmental management and improvements.

▲
Sydney, Australia. **©Walter Quirtmair/Shutterstock**

This approach to development was first modelled by Kuznets (1955) as an "inverted-U" function that combines environmental degradation and wealth. According to the Russian-born Nobel laureate, economic inequality increases over time while a country is developing, and begins to decrease once average income has reached a certain point. Applying this notion to environmental conditions suggests that, in countries aiming to reduce poverty and raise living standards, development initially occurs at the expense of the environment. Once a nation achieves a certain level of income per head, the environment tends to improve. Admittedly, many of the problems with Asian urban development bear similarities to those experienced in now-developed economies as they underwent rapid urbanization more than a century ago. Nevertheless, in modern Asian cities the scale, background and pace of urban change are unprecedented in human history. Moreover, climate change could have far-reaching effects on Asia's cities, and greatly compound existing problems. The implication is that the Kuznets paradigm is unviable, and that fresh, innovative approaches to urban development and environmental management are required.

The environmental challenges cities are facing in developing Asia come on a scale never seen before in the history of human development. Urban environmental issues are commonly known as the 'brown agenda' (i.e., environmental health issues, as opposed to the 'green' agenda, i.e., ecological sustainability). Bartone *et al.* (1994), describe the 'brown agenda' as a set of problems closely linked to poverty, such as those relating to inadequate water, sanitation, drainage and solid waste services, poor urban and industrial waste management, and air pollution. In view of the increasingly significant challenges of natural disasters and the impacts of climate change on cities, Bigio & Dahiya (2004:xiv) have developed an "*expanded brown agenda*," which includes four environmental goals for urban areas: (i) Protect and enhance environmental health; (ii) Protect water, soil, and air quality from contamination and pollution; (iii) Reduce the impact of urban areas on natural resources on a regional and a global scale; and (iv) Prevent and mitigate the impacts of natural disasters and climate change on urban areas. The need to address brown agenda issues in Asian cities has been emphasised by many authors (Bartone *et al.*, 1994; Bigio & Dahiya, 2004; Roberts & Kanaley, 2006).

Although the state of the environment in Asian cities inspires widespread pessimism, the situation is not entirely devoid of promising signs. Governments and expanding urban middle classes are increasingly aware that environmental degradation results from an unsustainable approach to urban and economic development. The challenge is to maintain economic development while substantially reducing environmental damage (see Box 5.1), and it is particularly acute for governments, civil society and the business sector in Asia. Few solutions have been found so far, but many promising initiatives offer opportunities for replication across the region.

This chapter draws on information from a range of reports and data sources to provide a summary perspective on the current state of the environment in Asian cities, outlining some possible pathways to improved urban development and environmental management.

Issues related to climate change will require fresh approaches to mitigation and adaptation, and more specifically with regard to urban development, logistics management, energy sourcing new technologies and 'cleaner' production systems. This chapter presents examples and case studies that demonstrate good practice and show how some Asian cities have solved some complex environmental problems.

# 5.2
# The defining features of Asia's urban environmental challenges

Informal settlements on the bank of a canal in Manila, Philippines. **©Shadow216/Shutterstock**

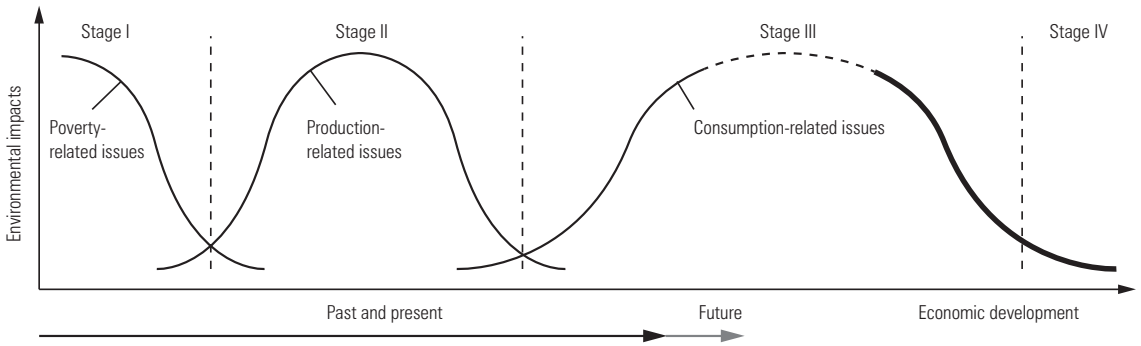
## 5.2.1 The dynamics of economic development and urban environmental issues

The environmental risks facing Asian cities are related to three major issues: (i) poverty (see Chapter 4); (ii) industrial production modes (air and water pollution); and (iii) increasing consumption (higher carbon dioxide emissions, water pollution and land degradation). Bai & Imura (2000) have put these risks in perspective under the form of a model of urban environmental evolution. They propose a four-stage process in the development of urban environmental issues in relation to economic growth (Figure 5.1).

Stage I of the development cycle is characterized by *poverty*: it involves issues like demographic growth and migration to cities, high informal-sector employment, lack of safe drinking water, and inadequate sanitation. In Stage II, *industrial* pollution-related issues arise as a result of the urban concentration of particulate matter and/or sulphur dioxide. Stage III is dominated by *consumption*-related issues, such as urban waste and increasing carbon dioxide emissions per head. Based on China's and Japan's experiences, Bai & Imura (2000) can suggest a time-span for each stage. Stage IV involves a shift towards what has become known as an 'eco-city'[1] (Roseland, 1997) with a focus on sustainability; in other words, in this final stage cities reduce the use of non-renewable resources and adapt to climate change (the 'positive economic outcomes' in Figure 5.1).

A major difference between previous patterns of urbanization and what is happening in Asian cities today is the time-span of each phase, and the complexity of the issue (Bai, 2003). The development stages of Asian cities are the shortest in history and come squeezed together in relatively tight succession, especially in countries like India and China. In Japan's Kitakyushu, for example, Stage 1 lasted about 15 years and Stage II spanned 10 to 12 years – from poverty to fully-fledged industrial development over a single generation or so. Moreover, the environmental issues associated with the expansion of Asian cities are arising much faster than experienced by the now-developed world (Marcotullio *et al.*, 2005). In addition, many Asian cities are facing all three types of issues concurrently (Marcotullio, 2008): for instance, Hong Kong, China, today is still facing poverty, industrial development and waste issues. Virtually none of Asia's cities have effectively overcome Stage III issues; none have reached the 'eco-city' stage and embarked on truly sustainable pathways (Ooi, 2007), even though some early signs of such progress are emerging in Singapore, Hong Kong, China, and some Japanese cities. This is a most welcome development, since it is essential for the sustainability of Asian cities.

FIGURE 5.1: **URBAN ENVIRONMENTAL PROBLEMS AND POSITIVE ECONOMIC OUTCOMES**




*Source: Bai & Imura (2000)*

### 5.2.2 Globalization drives urban development

Globalization has played a significant role in the expansion of Asian cities (see Chapter 3). Much of their growth has been driven by direct investment from foreign and multinational corporations, as these took to relocating labour-intensive, less-technology-dependent and environmentally hazardous industries to Asia's developing cities where labour costs are lower, working conditions poorer, and environmental standards less stringently defined or enforced. More recently, large national corporations in countries like China and India have expanded and diversified and now lead the industrialization process in many cities.

Together with economic progress for Asia, foreign direct investment (FDI) has enabled developed countries to externalize environmental costs while improving the quality of their own urban environments, in the process lowering the costs of many goods and services. In many cases, national governments and urban authorities in Asia have provided very attractive tax and other incentives to secure foreign direct investment projects, with the jobs, exports and build-up in foreign exchange reserves that come with them. For many Asian countries, this has brought greater economic prosperity and development, but often at a heavy cost to the environment (see Box 5.1).

Another undesirable outcome of globalization in Asia has been the prevalence of lax labour and environmental laws, and particularly poor enforcement of those relating to the discharge of factory emissions and the treatment of waste. Health and safety standards in factories are low, leading to significant environmental health problems among workers, especially in the textile-apparel, chemical and metal-processing industries (Locke, 2003). While low labour costs are a significant factor in export competitiveness (for instance, apparel production in Delhi and Dhaka), productivity remains low and employees are unlikely to challenge objectionable workplace routines and procedures for fear of losing their jobs.

### 5.2.3 Mega-demand for land and natural resources

The rapid expansion of Asian cities creates enormous demand for natural resources and land for industrial, commercial and residential purposes as well as for energy-production infrastructure. On average, Asia's combined urban population grows by over 45 million a year, resulting every day in the conversion of more than 10 sq km of (mainly productive) rural land to urban uses. More than 20,000 new housing units are needed every day to meet basic needs for shelter, creating a huge demand for construction materials and an additional six million ('mega') litres of potable water (Roberts & Kanaley, 2006). Much of this water draws down on existing aquifers, many of which are becoming depleted or contaminated.

Asian cities are among the most densely populated in the world. These very high densities have been there for a long time and today arise from the failure of governments and markets to provide land, infrastructure and housing to accommodate the massive inflows of people migrating to cities in the hope of employment and better services. The resultant serious overcrowding and environmental problems affect public health and living conditions. On the one hand, higher densities can result in higher concentrations of environmental pollution and related problems; on the other hand, they have the benefit of lower consumption of land and other natural resources per head, together with economies of scale in the provision of public transport and other urban services. As a result and for all their shortcomings, Asian cities tend to feature much smaller ecological footprints[2] (see next section) compared with cities in other parts of the world, but this comes with a lower quality of life.

Though still relatively high, Asia's urban demographic densities have been on the decline since the 1990s. Based on a selection of cities across the region, Angel *et al.* (2005) estimated the annual demographic growth rate at 2.6 per cent per year on average, compared with 5.5 per cent for urban surface areas, the net effect being an overall decline in urban

## BOX 5.1: THE SHENZHEN ENVIRONMENT OUTLOOK: BALANCING ENVIRONMENT AND DEVELOPMENT CHALLENGES

In recent years, Shenzhen has grown from a small border town with a population in the thousands and an area of a few square kilometres into one of the largest cities in China, with an area of 7 million square kilometres and over 10 million residents. This makes the city a typical example of the rapid industrialization and urbanization that has taken place in China, including the challenges municipalities face when trying to balance the competing demands of socio-economic development and environmental protection.

The challenge called for a wide-ranging assessment of existing conditions and future needs and constraints. This is where the UN Environment Programme (UNEP) stepped in with its capacity building scheme in 'Integrated Environmental Assessment '. The venture involved a variety of stakeholders, including scientists, academics, government officials and civil society representatives. The *Shenzhen Environment Outlook 2007* report was the outcome of this joint effort.

The report assessed the city's rapid development over a period of two decades and identified the major environmental challenges (first and foremost air quality, land and water resources) as well as socio-economic driving forces. Based on four distinct scenarios for the future and a system dynamics model, participants identified a number of policy options to enhance environmental quality and sustainability.

Participants concurred that if sustainable economic growth was to be maintained in Shenzhen, the current model was to be changed. The options were as follows:

- A *business-as-usual* approach may maintain relatively brisk growth rates in the short term, but in the long run, the city would face increasing constraints because of high energy consumption and associated heavy pollution.
- An *environment-friendly* scenario would impose constraints on economic development under the form of stringent environmental standards.
- Those scenarios promoting development based on *resource security* and *high-end industries* were found to strike an acceptable balance between economic growth and environmental preservation.

An imbalance between the supply of and demand for water is one of the major challenges confronting Shenzhen. Although all four scenarios gave some consideration to water saving and use of reclaimed water and sewage, only the 'Resource Security' scenario made this a top priority, as it envisaged the use of all forms of water resources (including sea and rain water) in order to match supply and demand in a consistent sort of way.

The policy options took the form of comprehensive strategies focussing on various areas. Since publication in 2007, these have fed into policies and programmes dealing with industrial restructuring and transformation, efficient use and reuse of natural resources, deployment of an inter-city environmental protection system in the Pearl River Delta, and development of monitoring framework for sustainable urban development.

The *Shenzhen Environment Outlook 2007* has proved so useful that a second report is currently under development. The participatory process behind it brought environmental issues to the attention of various stakeholders and the general public in order to catalyse broad-based responses and action.

*Source: Peking University & UNEP (2007)*

density of 3.4 per cent on an annual average basis. The reverse side of declining urban densities is a sharp rise in operational and maintenance costs, especially those of energy and utilities. If demand for land continues at the current pace until 2030, more than 73,000 sq km of (mostly valuable) agricultural land will be lost to urban development, which may seriously affect food security in countries like Bangladesh and the Philippines.

The decline in population densities is partly associated with a new phenomenon in which manufacturing relocates to the edges of large cities in huge industrial estates, some in excess of 3,000ha; these combine the benefits of better access to transportation and services and cheaper land prices compared with more central urban areas, and provide room for expansion. However, lack of adequate waste treatment facilities turns these sites into major sources of pollution. At the same time, industrial relocation exercises a 'pull' effect on low-income workers, who leave more central areas to settle in housing or fringe villages and towns on the periphery of metropolitan centres (Tacoli, 1998). Expanding middle classes, too, are looking for more spacious living environments and moving to lower-density suburban developments and new master-planned towns. This emerging development pattern is a significant factor behind an insatiable demand for energy, for domestic appliances (e.g., air-conditioning) as well as transportation and construction materials (Ziegler, 2006).

### 5.2.4 The ecological footprints of Asian cities

The 'ecological footprint' is an average measure of the amount of land required to sustain one individual (Rees & Wackernagel, 1994). Planet Earth can offer a nominal 1.7 global hectares per head (ghph) of habitable land to support the needs of the human race. Now in most Asian cities, the average ecological footprint is in excess of five hectares per head, indicating that current consumption patterns are unsustainable. Although the footprints of Asian cities tend to be smaller than those in developed countries, they are on an upward trend, a phenomenon that is not without consequences for the global environment.

Differences in ecological footprint assessment methods make values difficult to compare. Still, the footprint provides a useful measure of current and evolving urban or nationwide consumption patterns and is becoming a popular measure of urban sustainability. Governments in many developed countries use it to guide development, monitoring and evaluation of resource-saving policies on a national, city and even household scale.

Anecdotal evidence suggests that ecological footprints are expanding much faster in more developed North Asian countries such as the Republic of Korea, Japan and China than in South-East and South Asia. An author like Cole (1999) estimated that the average ecological footprint in India expanded from 0.97ha per head in 1971 to 1.3ha in 1995, a 34 per cent increase over a 24-year period. By comparison, Singapore's ecological footprint stands at 7.1, compared with Hong Kong, China's 6.08, Taipei's 4.75, Tokyo's 4.25 and Seoul's 4.20 (Ng, 2008). Research on eight Chinese cities (Xiao-dong *et al.*, 2005) found that their ecological footprints ranged from 3.4 ghph in Shanghai to 1.31 in Chongqing, with Beijing's estimated at 3.06 ghph.

### 5.2.5 High vulnerability to climate change impacts

Asian cities are seriously exposed to the likely impacts of climate change. From a topographical point of view, most of the larger cities in the tropical and subtropical climate zones are low-lying and prone to severe flooding and storm damage. Temperature is another factor: under the tropics, sanitary and organic wastes decompose quickly, accelerating the concentration of contaminants and the spread of disease in urban areas. Seasonal wind patterns and the geography of many cities often give rise to what is known to experts as 'inversion traps' where little air movement combines with high concentrations of particulates. High humidity rates provide a favourable climate for the breeding of harmful bacteria and disease, at the same time reducing the shelf life of fresh food and other organic products. With their lack of planning and high demographic densities, cities in tropical and subtropical coastal zones or flood plains (such as are often found in Asia) are much more vulnerable to natural disasters and potential pandemics than those in other regions of the world.

Climate factors exacerbate urban poverty in cities, affecting water supply and sewerage systems, with direct effects on the low-income households in environmentally fragile areas. The increasing impact of climate change on cities compounds the vulnerability of people in need of sustainable access to safe drinking water and adequate sanitation, and can also cause displacement of people. The factors behind climate change add to cities' vulnerabilities to disease: beyond air pollution, these factors also threaten failures in food and water security, loss of livelihoods, more natural disasters and more degradation of ecosystems. Some of these factors are discussed under "The challenge of climate change in Asian cities" in Section 5.4.

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Peri-urban expansion of Shimla, India. **©Jason Gutierrez/IRIN**

# 5.3
# Environmental conditions in Asian cities

Ho Chi Minh City, Viet Nam. Collectively, motor vehicles are one of the main sources of urban air pollution in Asian cities. **©Alvin Ganesh/Shutterstock**

Environmental problems vary significantly across countries and cities depending on respective degrees of economic development, urban form[3], geographic location, climate, and population density. Generally speaking, the problems in Asia's more developed economies are less severe, although their consumption patterns are unsustainable, too. The true environmental costs associated with consumer product imports from lesser-developed countries in the region are externalized. The effect is that both developed and developing cities in Asia (as in the rest of the world) are continuing to defer the full environmental costs associated with economic development and production.

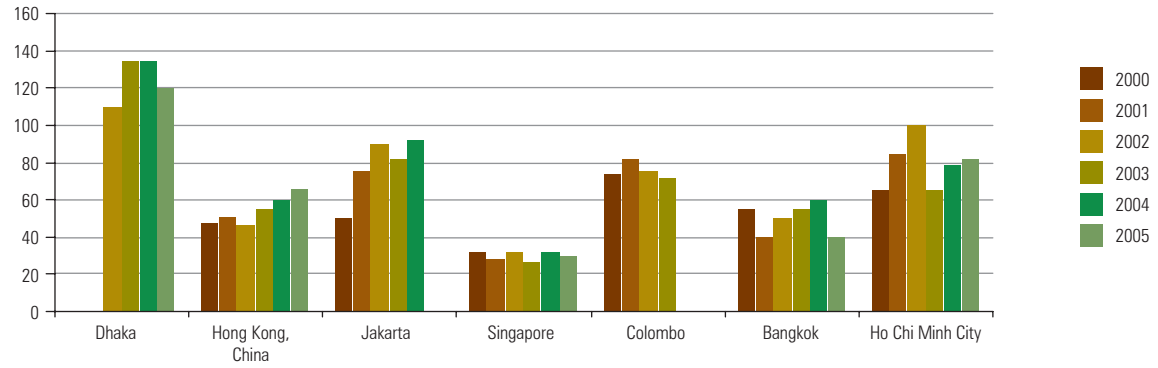
This section addresses some of the more significant environmental problems arising from the rapid expansion of Asian cities. Also included are case studies of good practice.

## 5.3.1 Air quality

Air pollution in Asia is generated from two primary sources (World Bank, 2009):

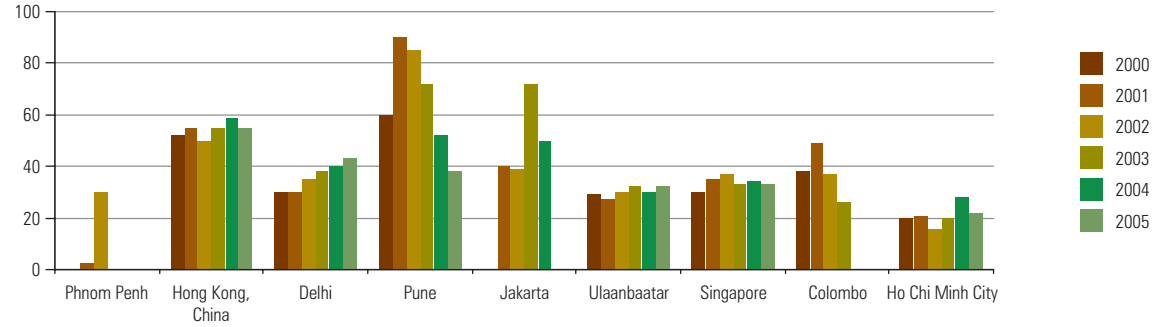
- *Stationary sources*: These include power plants and industrial outputs as well as residential and commercial buildings, and waste incineration. Coal- and oil-fired power plants are usually the largest urban sources of sulphur dioxide emissions because of the large amounts of fuel they consume (World Bank, 2009). The open burning of rubbish (Mahar *et al.*, 2007), and emissions from small-scale industries, are also significant contributors. The smoke and fumes from cooking and heating can generate considerable indoor air pollution.
- *Mobile sources*: Collectively, motor vehicles are one of the main sources of urban air pollution in Asian cities (Schwela *et al.*, 2006), although their contribution varies

CHART 5.1: **MICRO-PARTICULATE MATTER IN SELECTED ASIAN CITIES (MICROGRAMS PER CUBIC METRE)**



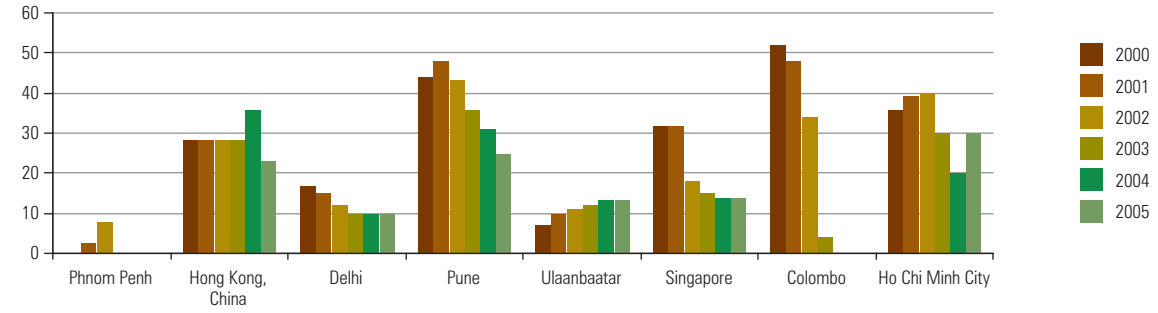

*Source: Asian Development Bank (2006b)*

CHART 5.2: **NITROUS DIOXIDE IN SELECTED ASIAN CITIES (MICROGRAMS PER CUBIC METRE)**




*Source: Asian Development Bank (2006b)*

CHART 5.3: **SULPHUR DIOXIDE IN SELECTED ASIAN CITIES (MICROGRAMS PER CUBIC METRE)**




*Source: Asian Development Bank (2006b)*

significantly across countries and cities. Relatively large amounts of vehicle emissions can be attributed mainly to poorly maintained vehicles, poor fuel quality and inadequate traffic management (World Bank, 2009). The problem has been exacerbated by rapid and unplanned expansion, leading to large increases in vehicle numbers and the many air-quality and health-related problems that come with it.

The World Health Organization (WHO) ranks urban outdoor air pollution as the 13th greatest contributor to disease and death worldwide (Potera, 2004). Another report from the same source estimated that air pollution in Asia caused as many as 519,000 premature deaths every year, mostly in cities, and contributed significantly to the mounting numbers of cardiopulmonary and other respiratory illnesses (HEI, 2004:41; WHO, 2005).

Many urban dwellers in Asia suffer from extremely high exposure to inhalation of micro-particles (i.e., particles of 10 micrometres or less – '$PM_{10}$') as well as to sulphur and nitrous dioxide emissions (Schwela *et al.*, 2006; WHO, 2005). However, information on air quality is of variable quality, or altogether missing for many cities. No comprehensive survey

can be found that provides a comprehensive picture of the current status of, and changes in, urban air quality across Asia. At best, a range of studies provides measures of change in air quality in specific cities.

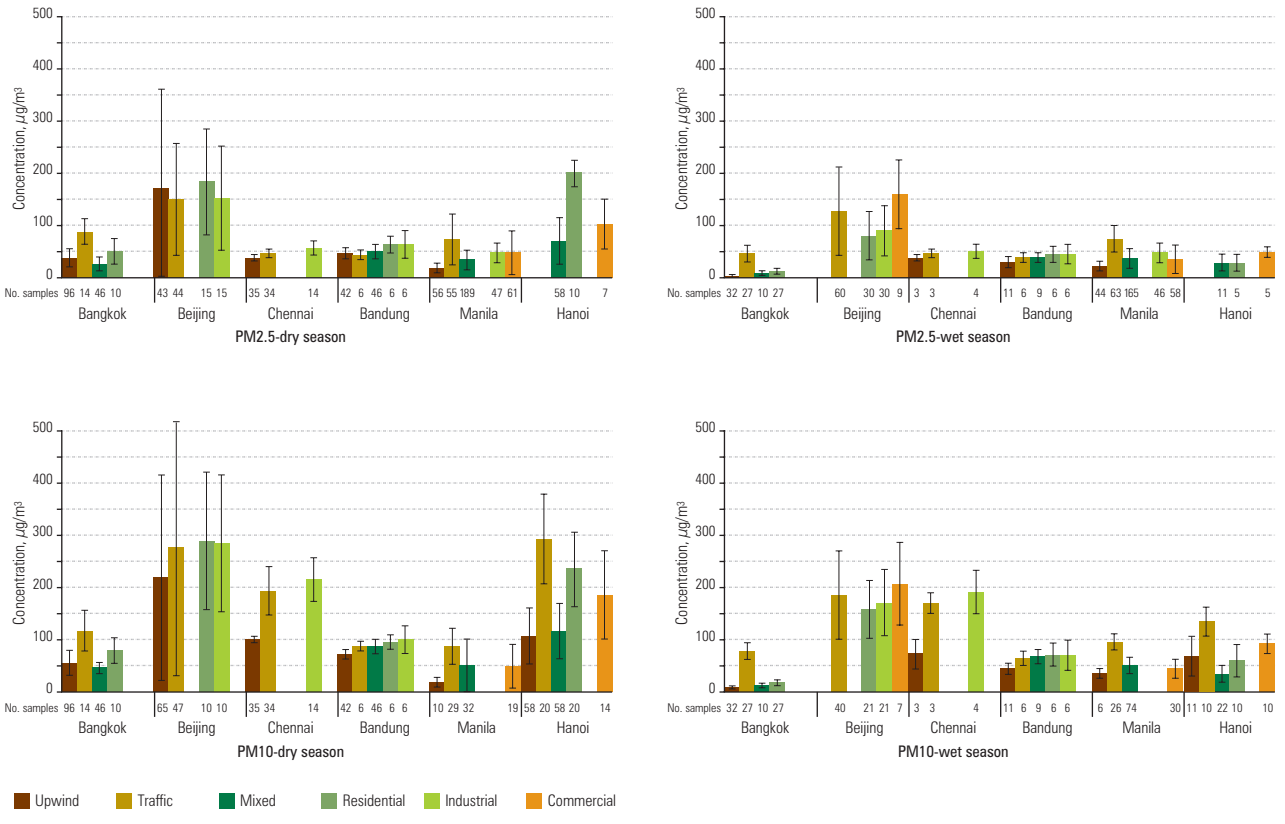
Charts 5.1 to 5.3 depict the atmospheric concentration of two components of air pollution ($PM_{10}$ and nitrous dioxide) in a sample of Asian cities. In Bangkok, Dhaka and Ho Chi Minh City, air quality is poor though slightly improving (ADB, 2006b; Schwela *et al.*, 2006). In Colombo and Pune, air quality is improving, too. In contrast, it is declining in Jakarta, Phnom Penh and Ulaanbaatar due to increasing rates of vehicle ownership, high manufacturing concentrations in inner city areas, poor vehicle engine maintenance, and burning of low-quality coal and wood in cooking-cum-heating stoves (as is the case in Ulaanbaatar, for instance).

Despite major efforts by many countries to reduce vehicle air pollution, success has been limited, mainly because of ineffective controls (World Bank, 2009). In some cities, air quality has declined because of the rapidly increasing numbers of new vehicles and the large numbers of old, poorly maintained vehicles (especially buses) (Baldasano *et al.*, 2003). In many cities, two-stroke motor (tri)cycles are a major source of urban pollution. Potera (2004) estimates that nearly 100 million two-stroke vehicles are in operation in South-East Asia, each producing approximately 50 times the pollution of an ordinary four-stroke automobile. Some cities, such as Delhi (see Box 5.7 below) and Dhaka, have taken steps to phase out two-stroke engines and introduce cleaner fuels and other emission reduction measures to improve air quality. In Ho Chi Minh City, Jakarta and Pune, these efforts involve improvements in traffic management, public transport and policing.

Coal is still used in heavy industries and for electricity production in large cities like Beijing, Delhi, Seoul and Shanghai (Mage *et al.*, 1996) and is a major factor in air pollution. Many cities in Asia are moving to substitute natural gas or electricity for coal for domestic uses (heating and cooking). The proportions of diesel-fuelled vehicles remain significant and, collectively, are further major contributors to emissions in Bangkok and Seoul, for instance (Panther *et al.*, 1999). In Manila, poor management of emission controls for diesel buses adds significantly to pollution. Open burning of domestic and industrial waste is still common practice in some cities, including Jakarta, again making significant contributions to air pollution.

In South-East Asia, forest fires are yet another significant source of air pollution in a number of cities. Not only does resulting pollution cause public health hazards, it also affects the performance of local economies. According to the UN

CHART 5.4: **AVERAGE DRY- AND WET-SEASON PARTICULATE CONCENTRATIONS: $PM_{2.5}$ (A) AND $PM_{10}$ (B) IN SIX ASIAN CITIES**




*Source: Kim Oanh et al. (2006:3372)*

Environment Programme and other sources (Cotton, 1999; UNDP, 2007; UNEP, 2007), in 1997 the haze from forest fires in Indonesia cost the whole South-East Asian population the equivalent of US $1.4 billion, mostly under the form of short-term medical costs in cities. Forest fires have also had a major impact on quality of life and the tourism industry in the region's cities (Hall, 2000).

Air pollution contributes significantly to the increased acidity of rain falling in Asian cities, especially in China (Foell *et al.*, 1995; Schwela *et al.*, 2006). It often happens that air pollution in one area causes acid rain in others: for instance, the World Bank (2007a) found that six provinces in China (Shanxi, Henan, Anhui, Hubei, Hunan and Jiangxi) caused 50 per cent of the acid rain in the whole country. Still in China, over half the estimated acid rain-related damage to buildings occurs in three provinces: Guangdong (24 per cent), Jiangsu (16 per cent), and Zhejiang (16 per cent). Cross-border pollution has become an issue in southern China's Pearl River Delta (Lee, 2002), partly due to relocation of polluting industries further inland and away from more developed coastal cities (Bai, 2002).

***Emissions by source***

The factors contributing to air pollution vary significantly across the region. Research on particulate emissions in six Asian cities (Kim Oanh *et al.*, 2006) found that the concentrations ($PM_{10}$ and $PM_{2.5}$ (i.e., particles less than 2.5 micrometres in diameter)) in Bandung, Bangkok, Beijing, Chennai, Hanoi and Manila were markedly higher in the dry than in the wet season. The authors found substantial increases in local particulate emissions during the dry season (see Chart 5.4) and suggested that burning of coal for heating (in China), open biomass burning, road dust/soil suspension and stagnant meteorological conditions all contributed to the increases.

Of the six cities in the survey, Beijing featured the highest volume of particle emissions, especially during the dry season, with dust, traffic, residential and industrial sources all contributing to atmospheric pollution. Combined particle emissions ($PM_{10}$) from all of these sources exceeded 140 mg/m$^3$, which is well above World Health Organisation standards. In Hanoi, the primary contributors to pollution are traffic and residential burning of fossil fuels for cooking and heating. In the other four conurbations in the survey (Bandung, Bangkok, Chennai and Manila), pollution rates of around 100 mg/m$^3$ have been recorded during the dry season, mainly due to traffic and industrial emissions. In those cities, emissions in the residential sector tend to decline in the wet season. With the exception of Beijing, the cities surveyed were in coastal locations, where temperature inversion effects are scarce. Pollution is often much worse in inland conurbations, especially in China and India and during the dry season. It is incumbent on these cities to introduce much stricter conditions on transport and industrial emissions if air quality is to improve in the future.

## 5.3.2 Water management

Asia is host to some of the world's most arid and water-rich biomes. Drylands are characterised by low soil moisture, low rainfall and high evaporation rates. They are further divided into hyper-arid and arid (deserts), semi-arid (grasslands) and dry sub-humid (forest) areas. Drylands are found in East Asia (China and Mongolia), Central Asia (Kazakhstan) and South Asia (India and Pakistan) (Safriel *et al.*, 2005). Indeed, 11 major deserts can be found in Asia including the Gobi (straddling Mongolia and China), Betpak-Dala (Kazakhstan) and the Cholitan and Thar deserts (India, Pakistan). In Asia's dry land areas, 38 per cent of the population resides in cities.

In contrast, South-East Asia receives abundant rainfall and has ample water resources. Annual renewable water resources per unit of land area range from 2,200 to 14,000 m$^3$/ha across most of the subregion. South-East Asia is also host to several major river systems including 200 in Indonesia and 20 in Thailand. The cross-border Mekong River is 4,600 km in length and drains 800,000 sq km of land. Among the largest lakes in the region are Tonle Sap (Cambodia), Lake Toba (Indonesia), Laguna de Bay (Philippines) and Lake Songkhla (Thailand) (ESCAP, 2005).

Even in water-rich areas, however, concerns over the sustainability and continuing quality of supplies have become prominent urban issues (UNEP, 2002; Marcotullio, 2007). The major river systems in China (Yellow River and Yangtze) and South Asia (Ganges, Brahmaputra) are drawing excessive water and are heavily polluted. Both these systems have their origins in the Asian high plateau region, where ice caps and glaciers are receding due to climate change. As a result, urban and agricultural water use will be affected by reduced or uneven flows in these river systems in the future. This will call for greatly improved water conservation involving complex negotiations between many countries.

Threats to water resources result from many factors, including inadequate fresh water and sanitation infrastructures, river pollution, groundwater overuse, flooding and drought. This section reviews some of the constraints these factors entail for Asian cities, focusing on their effects on human health and environmental quality, and highlighting some of the more relevant good practices in the region.

***Water supply***

In most Asian cities, supplies of safe drinking water have generally improved since 1990, enabling access by more than 90 per cent of the population. Between 1990 and 2008, the proportion of urban populations with access to improved water supply declined in countries such as Bangladesh, Indonesia, Lao PDR, Myanmar, Nepal and Pakistan, while remaining constant at 93 per cent in the Philippines. Overall, although water supply has made significant progress in Asian cities, safety and reliability remain major challenges, especially where climate change reduces the availability of potable water sources (Chilton & Kinniburgh, 2003).

Today in most Asian cities the problem has less to do with *access* than with the *quality* of potable-water services. In Chennai and Mumbai, for instance, authors like Dasgupta (2000) and Guttikunda *et al.*, (2003) found that coverage was 100 per cent and 97 per cent respectively, but then water was available for only four or five hours a day (Imura *et al.*, 2005b). These findings point to a serious concern, namely, water resources currently available to Asian cities are becoming severely depleted.

According to one United Nations indicator, a country can be considered to be 'water-scarce' if total withdrawals are greater than 40 per cent of annual water resources (UNESCO, 2003b). An Asian Development Bank survey of 18 cities indicates that most were drawing down more than 60 per cent of annual replenishment volumes, and in Chengdu and Shanghai (China) the rate was greater than 80 per cent (ADB, 2004, 2005). Therefore, the challenge for local authorities is to identify the most appropriate means of capturing and treating 'grey' (sullage or wash water) and 'black' (sewage) water at local level.

Another future challenge for many urban authorities in Asia is the maintenance and/or replacement of the older segments of water-supply systems, many of which are plagued by serious amounts of leakage. In Kathmandu, for example, the distribution system loses 35-40 per cent of clean water through leakage; in Karachi, the proportion is 30 per cent and in Chennai, 25 to 30 per cent. The Delhi Water Board has admitted that although the city needs 3.6 billion litres of water per day, available supplies are restricted to 2.9 billion litres because of leakage and other inefficiencies (Chatterjee, 2002). Water leakage leads to subsurface logging which can cause major health hazards; this is because when mains' water pressure drops, contaminated groundwater is siphoned back into the system. Leakages also reduce revenues for water utilities and, more significantly, raise the costs of water for the poor (Agrawal, 2008:2). The relationship between water losses, costs and poor environmental conditions for the lower-income segments of the population has been known for a long time (Muiga & Reid, 1979).

All Asian cities will need to make greater efforts to improve water management if they are to avoid further contamination of supplies and meet increasing demand, including for improved sanitation. Enhanced public awareness of water conservation is also essential if the costs of treatment and the incidence of water-related and sanitation-related diseases and infection are to be reduced. Governments must play a more direct role in raising public awareness about the benefits of sanitation and safe drinking water. This will require effective communication with all segments of the urban population in order to produce the desired behavioural outcomes. Greater equity in the pricing of water is also required to avoid a situation where the poor are paying many times more for water than those better off (purchasing from street vendors, for instance).

### *Sanitation and wastewater*

Since 1990, a majority of countries in Asia have managed to enhance the access of urban populations to improved sanitation, to the exception of a few where this proportion has marginally declined. The issue of access to sanitation is discussed in Chapter 4.

Few Asian cities have the capacity or resources to deploy large-scale wastewater treatment facilities. This is because dense housing and narrow roads combine with land ownership and compensation issues to act as major constraints on any deployment of large-scale treatment systems. Consequently, communal septic tanks, small-bore sewerage and local treatment facilities, appear as the most viable and cost-effective alternative ways of improving urban sanitation and reducing industrial water pollution in Asia's newly developed urban and peri-urban areas. Urban planners must keep in mind that these alternatives require a medium- to long-term vision, as municipal authorities must in the first place purchase or otherwise secure appropriate land plots for these facilities ahead of construction; otherwise, they will likely be faced with the difficult task of acquiring suitable land at some later point in time, when prices are likely to be higher and compensation might be required. Protracted compensation settlement procedures and disputes are major causes of delays for many large-scale environmental improvement projects involving water supply and sanitation.

Urban populations must also be assured that governments will take action on issues related to safe drinking water and sanitation on an equitable basis. Affordability of services is crucial to improving the overall environmental condition of cities in the region. Research in Myanmar (Bajracharya, 2003:148) and the Lao People's Democratic Republic (Lahiri & Chanthaphone, 2003) found that earning income to survive was already such a struggle that most households could not afford latrines.

These findings suggest that (as happened in Europe over a century ago) subsidies can have a major role to play if access to water and sanitation is to improve for poorer households. Therefore, responsibilities for these two basic services in urban centres must be better defined and more clearly allocated. This issue requires increased engagement from public-sector utilities, which are generally the largest providers of water and sanitation services (UN-HABITAT, 2006). On the other hand, the current and future roles of a range of private and community-based service-providers in improved and extended drinking water and sanitation services should be promoted. In short, effective and participatory water and sanitation systems must be well adapted to specific local conditions.

### *Drought*

Parts of Asia have experienced significant periods of drought, including those tropical areas (Java and Sumatra) where abundant rainfall is more typical. Droughts are classified into four interrelated categories which Liu (2007:3) defines as follows:

> "Meteorological drought, being climatic variables (precipitation, humidity) and the duration of the dry period; Hydrological drought is associated with effects on surface or subsurface water supplies (i.e., stream flow, reservoir, lake levels, and ground water); Agricultural drought links impacts of meteorological drought to

agriculture, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, crop failure; and Socio-economic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply."

With rapid demographic growth, all four types of drought have become serious problems for Asia, especially China and the southern subregion, with many cities struggling to keep up with the demand for water. Drought caused by the El Niño effect in the Pacific is also leading to excessive urban drawdowns on groundwater supplies (Carter *et al.*, 2001), as is particularly the case in Pakistan and India.

Droughts can have significant effects on food supplies to cities, as happened in 2006 in Chongqing (Western China) where the overall cost was estimated at US $1.04 billion (Liu, 2007). Earlier, in 2004 and on the back of a short wet season, drought conditions developed rapidly across a vast area from Central China to Southern Thailand to Luzon in the Philippines. This led to significant food shortages and concomitant price increases, especially in smaller cities and towns.

***Flooding and catchment management***

Flooding is an increasing problem in Asian cities. As urban areas reduce impermeable surfaces, sub-soil drainage is reduced and the likelihood of flooding becomes higher. In many parts of the region, flooding is also exacerbated by higher rainfall intensities. An estimated 46 million people living in Asian cities are threatened by storm-related flooding every year (World Bank, 2008). This number can only increase as populations grow and the risk of flooding rises (as a consequence of climate change, for instance – see section 5.4). Nicholls *et al.* (2007) found that of the 136 port cities worldwide that are exposed to once-in-a-century coastal flooding, 38 per cent are in Asia. Six of the 10 major port cities most at risk (in terms of exposed population) of flooding and inundation are Ho Chi Minh City, Guangzhou, Kolkata, Mumbai, Osaka-Kobe and Shanghai.

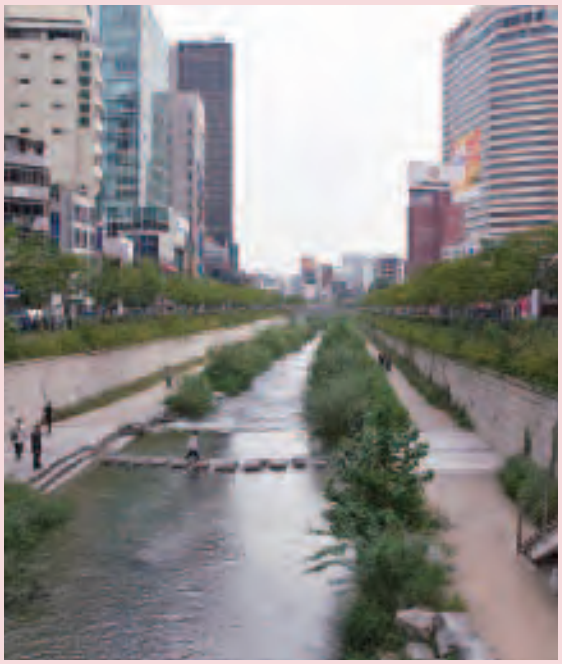
It is not just the coastal cities of Asia that are increasingly vulnerable to flooding. Inland cities such as Dhaka, Hanoi, Phnom Penh and Wuhan are also experiencing increasingly severe seasonal flooding (World Bank, 2007b), and poor catchment management is a significant factor. Jakarta, a city criss-crossed by 13 rivers and many Dutch-built canals, has been seriously damaged almost every year by massive flooding triggered by tropical rains. The 2009 floods were particularly severe. When floodwaters reach the city's concrete drainage channels, hydrological efficiency increases, and the resulting acceleration of volumetric flow causes severe damage to low-lying, low-income settlement areas where streams meet the coastline. Some cities, like Seoul, have embarked upon major projects to improve catchment management (see Box 5.2).

In many Asian cities, flood mitigation is impeded by poor catchment management in peri-urban areas as well as rubbish accumulation and dumping in the drainage system. A related problem is that vegetation loss continues unchecked in most peri-urban areas and the urban hinterlands of most Asian cities, causing increased erosion and siltation of storm water drainage systems. As rains and run-off become more intense,

## BOX 5.2: WATER STREAM REGENERATION: GOOD PRACTICE FROM SEOUL

Environmental awareness and economic productivity went hand-in-hand when authorities in Seoul rehabilitated a water stream running in the middle of one of the city's most active business areas. In the mid-1950s, the Cheonggyecheon Stream stood as a symbol of the poverty inherited from colonialism and World War II. Having turned into an open sewer in the very heart of the capital, the stream was simply 'covered up' by a busy motorway. Half a century later, this was the noisiest and most congested area in the city. The only way of resolving the problem was to do something radical with the motorway.

In June 2001, newly elected mayor Lee Myung-bak fulfilled an electoral promise and demolished the motorway to kick off a regeneration process that garnered strong support from the population. The objective was two-fold: making the area attractive to business, foreign financial institutions and tourism, for the sake of economic revitalization; and recovering national pride and the values of traditional culture with the rehabilitation of historical landmarks such as the Gwangtonggyo Bridge (1545). Rehabilitation of the stream was completed in 2005.



▲ Cheonggyecheon Stream, Seoul. **©Ken McCown**

As the picture shows, the rehabilitation demonstrates a sense of environmental awareness in the middle of a major business centre, with nature and modern life coexisting in harmony. This success could lead to some more 'green' projects in Seoul, mixing preservation of historical features with proper traffic management, exclusive pedestrian areas, eco-friendly zones and competitive business districts. The project could also inspire other Asian cities – in China, for example – looking to highlight a rich cultural heritage as they build prosperous economies.

*Source: Referenced from Rinaldi (2007)*

the size of gullies increases, undermining buildings along urban streams and storm water channel systems, especially in hill cities like Kathmandu and Shimla.

Land disputes and the anticipated increases in the value of land when converted from rural to urban uses make reforestation difficult in urban areas (Long & Nair, 1999). Nevertheless, progress has been made in some cities. Hong Kong, China, Singapore and Kuala Lumpur have each launched urban forestry projects in water catchment areas for the sake of conservation and environmental management in a bid to improve water quality and reduce flooding (Corlett, 1999; Kuchelmeister, 1998; Webb, 1999).

Ground subsidence is another factor behind increased flooding in cities like Dhaka, Jakarta, Shanghai and Tianjin. For instance, a Chinese geological survey found that 46 cities in the country were subsiding due to excessive pumping of groundwater and the weight of high-rise buildings (*China Daily*, 2003). In Indonesia, a report from the Bandung Institute of Technology estimated the subsidence rate in Jakarta's low-lying coastal areas at 8.7 mm a year (Suciu, 2008). A related World Bank-funded study predicted that by 2025, Indonesia's capital could be between 40 cm and 60 cm lower than it is now if nothing is done to check the pumping out of the city's artesian aquifers (Colbran, 2009). The implications for Jakarta and other coastal cities in Asia facing similar problems are potentially significant. Millions would need to be relocated, or expensive dyke systems constructed, to prevent inundation of low-lying coastal settlements. For many cities, it may already be too late to prevent further ground subsidence. In these cities, flooding and inundation can be expected to become a more frequent problem.

### 5.3.3 Solid waste management

Many cities face serious solid waste management problems, despite significant government efforts to improve services and facilities. In the world as a whole, solid-waste dumping contributes 3 per cent of greenhouse gas emissions (Stern, 2007); on the other hand, more than 72 per cent of total greenhouse gas emissions occurring under anaerobic conditions could be avoided by altering the ambient aerobic/oxidizing conditions (Ritzkowski & Stegmann, 2007). In many developing countries, solid waste management is often inadequate, as is sanitary and industrial waste disposal due to technical and financial constraints. All countries in the region have environmental legislation and policies in place to manage solid waste collection and disposal, but in the lesser-developed countries enforcement is often poor, or local communities are unaware or dismissive of the regulations. In many cities, polluters go unpunished. It is not uncommon for people to discard or burn waste openly on vacant land, while factories dispose of toxic and other solid wastes in unmanaged and informal dumps (Visvanathan & Norbu, 2006).

The amounts and nature of urban solid waste differ greatly from one Asian city to another (Idris *et al.*, 2004), although in most, the mixed waste stream features large proportions of biodegradable matter (Chiemchaiisri *et al.*, 2007), which reduces opportunities for recycling. Even in more developed countries, where the proportions of non-biodegradable waste are the highest, recycling rates are low compared with those in Europe, for instance. Tokyo recycles more than 50 per cent of its solid waste, Singapore 44 per cent and Hong Kong 35 per cent (Visvanathan & Norbu, 2006). By comparison, in the Netherlands and Denmark recycling rates are in excess of 90 per cent (EEA, 2007). Informal recycling provides a significant source of income for the poor in many Asian cities as they recover various materials and products. For instance in Manila, the Payatas waste management site provides employment for over 4,000 households and recycles 6 per cent of the total waste disposed of at the dump site (Vincentian Missionaries, 1998).

Table 5.1 details estimations of the volumes of solid waste generated in urban areas in Asian countries in 1995 together with projections for 2025. The volumes and nature of solid waste depends mainly on population size, degree of affluence, and the efficiency of the reducing, reusing and recycling processes. For example, Ho Chi Minh City's population of 5.3 million is growing at 2.5 per cent per year, or almost twice as fast as Viet Nam as a whole (1.3 per cent) (World Bank, 2002). The solid waste generation rate in Ho Chi Minh City is 1.3 kg/person/day compared with the nationwide urban rate of 0.7 kilo and 0.3 kilo in rural areas (Klundert, 1995). In Beijing, the nature and calorific value of solid waste has changed dramatically over recent years: total carbon dioxide emitted from solid waste treatment, for example, increased by a factor of 2.8 between 1990 and 2003 (Xiao *et al.*, 2007). However, in many Asian cities, waste management is characterized by inefficient collection and unsanitary disposal conditions (Imura *et al.*, 2005a; Inanc *et al.*, 2004).

Waste collection services are very deficient in many Asian cities, but are improving. In China, 60 per cent of urban solid waste is collected, compared with 70 per cent in the Philippines (Idris *et al.*, 2004). Those communities without municipal waste collection services routinely dump wastes into water bodies, on open land, or at sea (Inanc *et al.*, 2004). Several local governments, civil society groups and local communities have found new solutions to improve solid waste management in many Asian cities. The Integrated Resource Recovery Centre (IRRC) approach now promoted by the Economic and Social Commission for Asia and the Pacific (ESCAP) and Waste Concern goes one step further with a paradigm shift which demonstrates that solid waste management, when linked to carbon financing, can be a highly profitable business (see Box 5.3).

In India, Exnora International, a non-governmental organisation established in Chennai in 1989, has developed the eponymous concept along these lines: to "formulate and practice EXcellent, NOvel and RAdical ideas in solving problems of society involving the same people who are the sources or originators of the problems" (Exnora International, 2010). With regard to solid waste management, the Exnora concept has given rise to community-based organizations called Civic Exnoras, which focus on self-help solid waste management by local communities. Since 1989, about 5,000 such groups have been established in India.

Open dumping is the dominant solid waste disposal method

TABLE 5.1: **URBAN SOLID WASTE – GENERATION RATE (SELECTED ASIAN COUNTRIES)**

| Country | 1995 | | 2025* | |
|---|---|---|---|---|
| | Urban Population (1,000s) | Urban Generation Rate (Kg/Per Head/Day) | Urban Population (1,000s) | Urban Generation Rate (Kg/Per Head/Day) |
| Bangladesh | 27 786 | 0.49 | 72 844 | 0.60 |
| China | 374 257 | 0.79 | 851 430 | 0.90 |
| India | 253 473 | 0.46 | 523 202 | 0.70 |
| Japan | 81 079 | 1.47 | 85 877 | 1.30 |
| Republic of Korea | 34 935 | 1.59 | 42 910 | 1.40 |
| Lao People's Democratic Republic | 836 | 0.69 | 4 050 | 0.80 |
| Malaysia | 11 468 | 0.81 | 27 188 | 1.40 |
| Mongolia | 1 289 | 0.60 | 2 172 | 0.90 |
| Myanmar | 11 372 | 0.45 | 25 539 | 0.60 |
| Nepal | 2 356 | 0.50 | 10 717 | 0.60 |
| Philippines | 33 786 | 0.52 | 64 951 | 0.80 |
| Singapore | 3 480 | 1.10 | 5 362 | 1.10 |
| Sri Lanka | 3 131 | 0.89 | 3 788 | 1.00 |
| Thailand | 18 208 | 1.10 | 30 679 | 1.50 |
| Viet Nam | 16 202 | 0.55 | 41 371 | 0.70 |

**Projections*
*Source: World Bank (1999); United Nations (2010)*

in most Asian cities. This is the case with more than 60 per cent of the waste in Bangkok, for instance (Chiemchaiisri *et al.*, 2007). Inadequate collection and disposal of solid waste in urban Asia is a source of health hazards and environmental degradation (UN-HABITAT, 2010b). Therefore, combined management of public awareness, political will and public participation is essential if many of the municipal solid waste issues facing Asian cities are to be addressed.

One of the more significant issues is the degradation of organic waste. This not only creates unpleasant odours but also contaminates local surface and groundwater. Decomposition can lead to eutrophication[4] and putrefaction of streams and ponds, resulting in localized outbreaks of water- and vector-borne diseases. Problems with putrescible waste are most acute in tropical cities. Failure of urban planning and law enforcement to ensure proper disposal of putrescibles is increasing exposure to disease, especially in peri-urban areas.

## 5.3.4 The urban biosphere

The urban biosphere comprises the natural physical features, soil, hydrology, vegetation, flora and wildlife that can be found in cities. UNESCO (2003a) promotes the creation or preservation of urban biosphere reserves. Many such reserves include peri-urban and urban hinterland areas. Designation of urban biosphere reserves is part of the 1995 Seville Strategy (UNESCO, 2006). Cities that have adopted, or are considering, urban biosphere schemes include: Brighton and Hove, UK; Canberra; the Mornington Peninsula, Melbourne; (ACT, 2006); Cape Town; New York City; São Paulo; and Seoul. In Sri Lanka, a proposal to turn Kandy, a major religious and ecological landmark, into an urban biosphere is under consideration.

Current changes to urban biospheres – i.e., the clearing of natural vegetation for urban development – have direct, significant effects on micro-climates, vegetation regimes, soils, run-off and the biodiversity of Asia's urban habitats (Dick & Rimmer, 1998; Hara *et al.*, 2008; McGee, 2008); however, more research on the benefits of urban biospheres is needed. Detailed research on urban land conversions is constrained by the poor quality or volume of bio-data, especially in smaller cities. Conversion of agricultural to urban land has been most widespread in China and India (Fazal, 2000; Zhao *et al.*, 2006a, 2006b) to the extent that it is now a cause of concern for future food security.

The description and measurement of the urban areas that might be included in biospheres give rise to definitional and methodological issues across countries. One thing is clear, though: conversion of natural, agricultural and coastal foreshore areas in Asia is occurring at a very brisk pace as the combined population of cities grows by 45 million every year (Roberts & Kanaley, 2006). Against this background, urban biospheres offer the potential for Asian cities to devise policies and development practices that recognise and manage environmental and cultural heritage and values in a more sustainable way.

### *Loss of biodiversity*

Urbanization has a devastating effect on vegetation and wildlife, leading to the loss of biodiversity. In Shanghai, for instance, the number of native plant species in the Sheshan area and on Dajinshan Island has decreased by almost half over the last two decades, contrasting with large increases in the number of non-native species (Zhao *et al.*, 2006b). If they are to preserve or restore biodiversity, it is important for Asian cities to focus on native species in dedicated, well-managed urban and peri-urban habitats (McKinney, 2002). In a bid to restore biodiversity and mitigate the 'heat island' effect[5], cities like Seoul use urban biospheres to make urban areas 'greener', i.e., planting trees and gardens on rooftops, and revegetating

## BOX 5.3: A VIABLE, INTEGRATED WASTE MANAGEMENT SYSTEM FOR URBAN ASIA

Current solid waste management systems in Asia are strained and landfill space is fast becoming scarce. Local governments face increasing costs of disposal – while public health and the environment suffer from the effects of untreated solid wastes. Between 60 and 80 per cent of municipal solid waste in Asia's developing countries is made up of organic material. This waste is currently sent to landfills and dumps, where it contributes to greenhouse gas emissions.

If they are to meet this challenge, cities need efficient, low-cost solutions that improve waste collection, provide better working conditions for waste pickers and capitalize on the high organic content of the waste. The Economic and Social Commission for Asia and the Pacific (ESCAP) has identified the decentralized compost plants developed by Waste Concern, a non-governmental organization in Bangladesh, as an approach that met the above criteria.

Since 2005, ESCAP, together with Waste Concern and local partners, has tested and further refined the approach in Matale, Sri Lanka and in Quy Nhon, Viet Nam. Since 2007, both plants have been operating on a self-financed basis under a public-private partnership arrangement. As part of a new initiated regional project, ESCAP has launched this refined approach, known as 'Integrated Resource Recovery Centres' (IRRCs) in several smaller cities in Asia.

The centres operate as decentralized facilities that treat between two to 20 tons of waste per day and depending on local conditions, and include compost plants, recyclable waste processing, biogas digesters and, where needed, bio-diesel plants. The centres allow local authorities to turn as much as 80 to 90 per cent of waste into resources within municipal boundaries, with only 5-10 per cent disposed of at the landfill.

Segregation of waste at the source is the key for ensuring good quality compost. The centres work closely with local communities and households to sort their waste, separating materials that can be recycled and organic waste that can be composted. Staff collect pre-sorted waste from households, markets and businesses and bring it to the centre for processing. The waste is then sorted a second time and any recyclable materials, such as bottles and cans, are removed and sold. Organic waste, including plants, vegetables, fruit and other natural materials, is composted and sold, too. In some cases, key nutrients are added, turning raw compost into "designer" organic fertilizer.

The centres have demonstrated that they can operate as self-sustaining, profitable public-private partnerships (PPPs). By dint of their simple technology, they can be built and operated at low cost. This means that initial capital investment can be recovered early and profits can be sustained throughout operation. Because the centres reduce methane, a potent greenhouse gas, using an approved methodology, they are eligible to the Clean Development Mechanism (CDM), which enables them to sell their carbon credits to recover capital costs.

In most developing towns and cities, as much as 20 to 30 per cent of any waste generated is collected, sorted and recycled by informal collectors and junk dealers. The centres hire waste pickers and provide them with better, more stable incomes and safer working conditions. They also buy recyclables from other itinerant waste pickers at fair, transparent prices.

*Source: ESCAP*

degraded urban open spaces (Kwi-Gon Kim, 2004). Other cities such as Putrajaya, south of Kuala Lumpur, are deploying artificial wetlands and lakes along urban drainage systems (Yuen *et al.*, 2006). One of the best examples of urban biosphere restoration is the Can Gio mangrove forest east of Ho Chi Minh City, an area that was almost destroyed by defoliant spray and clearing during the unification war. High degrees of biodiversity have been restored to the mangrove forest, which today is host to more than 200 species of fauna and another 52 of native flora.

***Urban soils***

Urban soils in Asian cities are altered structurally and functionally by human activity. They are becoming increasingly contaminated by the heavy metals and chemicals contained in industrial wastes.

The full extent of urban soil degradation in Asia is unknown, but in many older cities large areas of land where the topsoil is contaminated can be found. Significant increases in the contamination of soils, especially by cadmium, copper, lead and zinc, have been reported in parts of Bangkok (Wilcke *et al.*, 1998), Danang-Hoian, Viet Nam (Thuy *et al.,* 2000) and Mumbai (Krishna & Govil, 2005). Urban soils in Manila and Hong Kong, China are also increasingly contaminated by some heavy metals (Xue Song Wang e*t al.*, 2005). Contamination of urban soils by toxins and heavy metals increases the risk of groundwater contamination, which can have a direct effect on human health, especially in low-income communities that largely or exclusively rely on this type of water. Groundwater supplies in many of Asia's larger developing cities, such as Delhi, Dhaka, Jakarta and Ho Chi Minh City, are facing severe toxicity (Chilton & Kinniburgh, 2003; Mukherjee *et al.*, 2006).

These examples go to show that soil contamination raises a specific and dangerous environmental problem. Moreover, developers may be cautious about engaging in redevelopment projects on former industrial sites, which typically feature high concentrations of heavy metals; this is because of potential future litigation issues, on top of the unknown costs associated with cleaning up contaminated soil and the removal of dangerous chemicals such as dioxins.

Authorised and unauthorised urban waste disposal sites are another source of contamination. Increased degrees of soil toxicity and contamination from such sources have been reported around industrial sites in Dhaka, Hanoi and Ho Chi Minh City (Chilton & Kinniburgh, 2003), and along urban roads in Shanghai (Shi *et al.*, 2008).

### 5.3.5 Poor urban environment and health

Large numbers of people are in poor health in Asian cities, due mainly to malnutrition, poverty, cramped living conditions, polluted air and contaminated water. Many lack access to adequate medical facilities and other health services. Poor workplace and safety conditions also contribute to ill health and are responsible for high numbers of accidents, especially on construction sites and in factories.

Even in more developed cities, where many of these issues have been addressed, other environmental health problems

are emerging, including increased incidence of mesothelioma related to the use of asbestos (Takahashi *et al.*, 1999), pulmonary disease and bronchial asthma, and regardless of declining air pollution (Guo *et al.*, 2008). Obesity is also emerging as a significant health problem in Asian cities as a result of both changes in diet and a reduction in physical exercise as populations make greater use of motorized transport (Tee, 2002).

The emergence of viral diseases such as severe acute respiratory syndrome (SARS) and avian flu in the past decade posed serious threats to Asian urban populations and economies. The risk of a major pandemic in Asia remains very high (Bloom *et al.*, 2005): the frequent combination of high population densities and unsanitary conditions is particularly conducive to the breeding, mutation and spread of disease. A recent World Economic Forum report on global risks pointed to the increasing threat of pandemic disease arising out of the conditions prevailing in many Asian cities (WEF, 2006).

Although it is difficult to isolate the adverse human health effects of air pollution from those of other lifestyle factors such as smoking, many authors have pointed to a relationship between exposure to air pollution and health effects in Asia (Baldasano *et al.*, 2003; Parekh *et al.*, 2001; Resosudarmo & Napitupulu, 2004; Wong *et al.*, 2001), with significant medical and economic costs. The World-Bank (2007a), for example, found that the health costs of air and water pollution in China amounted to 4.3 per cent of gross domestic product. When the non-health effects of pollution such as loss of productivity are added, the total cost of air and water pollution in China was estimated at 5.8 per cent of total output.

In most Asian cities, rapid demographic growth has been accompanied by increasing contamination of aquifers by industrial, agricultural and urban pollution (Bai & Shi, 2006; Karn & Harada, 2001) and, in coastal cities, by seawater seepage into water supplies (Marcotullio, 2001). The use of contaminated water from lakes, rivers and shallow wells causes diseases such as diarrhoea, intestinal worms, viral hepatitis, typhoid and other infections across Asia, and tropical countries in particular (WHO, 2003). Children and women, especially among the urban poor, usually bear the burden of fetching water, often from contaminated sources. If public health is to improve in Asian cities, situations must be prevented where poor sanitation and drainage continue to pollute (ground) water supplies.

### 5.3.6 Urban liveability

'Liveability' indicators can provide useful measures of the quality of life in urban environments. The notion refers not only to economic and social well-being, but also to the quality of the environment and, especially, environmental services. For instance, Fukuoka is considered as one of the most liveable cities in Asian and Pacific region as well as the world (see Box 5.4). Well-devised liveability indicators have been compiled for cities around the world, including Asia. The Economist Intelligence Unit (EIU) runs an annual survey of 215 cities worldwide that provides a global ranking of the 'most liveable' based on 39 criteria, ranging from personal safety to the quality of public transportation.

Table 5.2 shows the liveability index and rankings for a selection of Asian cities. Singapore, nine cities in Japan, Kuala Lumpur, Taipei, Shanghai and Hong Kong, China come top in the region, although none features in the top 30 worldwide. All offer good living standards. Chinese cities have become more 'liveable' in recent years due to massive capital expenditure on public amenities and increased availability of consumer goods subsequent to the country's admission to the World Trade Organization. Emerging business centres such as Bangkok, Taipei and Kuala Lumpur have also become more 'liveable' since the 1997-8 Asian financial crisis. Less-developed cities, especially those where the threat of unrest or terrorism is an issue, fare much worse, with Vientiane, Karachi and Dhaka ranking in the lowest liveability categories (Mercer, 2007).

TABLE 5.2: **LIVEABILITY INDEX FOR 37 ASIAN CITIES (2007)**

| Rank | City | Country | Index |
|---|---|---|---|
| 34 | Singapore | Singapore | 102.5 |
| 35 | Tokyo | Japan | 102.3 |
| 38 | Yokohama | Japan | 101.7 |
| 40 | Kobe | Japan | 101.0 |
| 42 | Osaka | Japan | 100.5 |
| 54 | Nagoya | Japan | 99.5 |
| 55 | Tsukuba | Japan | 98.3 |
| 63 | Yokkaichi | Japan | 96.2 |
| 69 | Omuta | Japan | 94.9 |
| 70 | Hong Kong | China | 94.3 |
| 73 | Katsuyama | Japan | 91.4 |
| 75 | Kuala Lumpur | Malaysia | 88.9 |
| 83 | Taipei | Taiwan, Province of China | 86.5 |
| 100 | Shanghai | China | 81.6 |
| 101 | Johor Baharu | Malaysia | 81.2 |
| 103 | Kaohsiung | Taiwan, Province of China | 80.7 |
| 109 | Bangkok | Thailand | 76.8 |
| 110 | Yeochun (Yosu) | Republic of Korea | 76.3 |
| 113 | Ulsan | Republic of Korea | 75.0 |
| 131 | Guangzhou | China | 70.3 |
| 132 | Rayong | Thailand | 69.3 |
| 136 | Colombo | Sri Lanka | 66.3 |
| 142 | Jakarta | Indonesia | 63.7 |
| 145 | Shenyang | China | 63.0 |
| 148 | New Delhi | India | 62.4 |
| 150 | Ho Chi Minh City | Viet Nam | 62.0 |
| 151 | Mumbai | India | 61.7 |
| 153 | Bangalore | India | 61.3 |
| 157 | Hanoi | Viet Nam | 60.1 |
| 158 | Islamabad | Pakistan | 59.8 |
| 159 | Chennai | India | 59.3 |
| 161 | Jilin | China | 57.9 |
| 163 | Lahore | Pakistan | 56.5 |
| 169 | Vientiane | Lao PDR | 55.0 |
| 175 | Karachi | Pakistan | 52.9 |
| 184 | Almaty | Kazakhstan | 49.4 |
| 185 | Yangon | Myanmar | 49.3 |

*Source: EIU (2007)*
*NB: International 'liveability' surveys do not necessarily include the same sets of cities.*

## BOX 5.4: **A COMPACT, DYNAMIC AND LIVEABLE CITY: FUKUOKA, JAPAN**

▲
Fukuoka City. **©Fumio Hashimoto/Fukuoka City**

Fukuoka is located on the southern island of Kyushu in Japan, roughly 1,000 kilometres from Tokyo. Japan's eighth largest city with a population of 1.5 million, Fukuoka enjoys a unique geography, surrounded by the ocean to the north and spacious green suburbs and gentle mountains towards its southern outskirts. It has all the features of a modern urban centre, but none of the rush of a congested mega-city. The interplay of geography and people shapes its character, which is best described as open and friendly. Fukuoka is considered as *'Japan's most liveable city'* by a number of foreign publications. The *New York Times* once saw the city as "a time capsule of modern design' and as 'one of the best places in the world to see the works of world-class contemporary architects side by side."[1]

Even among local business people and their families, Fukuoka is regarded as the most liveable city[2] when they compare living conditions with others in Japan. In a recent survey, over 90 per cent of respondents said they were satisfied with and proud of their city.[3]

Fukuoka offers a high quality of life, enabling a good balance between development and the environment, city and suburbs, modernity and tradition. Commuting is almost stress-free. An efficient public transportation network linking overground and underground railways with bus routes has reduced commuting times to less than half an hour for nearly 50 per cent of the population. Both the airport and the beach are 15-minutes' underground rides from city centre. As most of the populated areas in the city are flat, an estimated 250,000 have been cycling to work or school as a matter of routine long before the environment became a mainstream issue.

Another factor behind Fukuoka's recognised quality of life is the combination of well-managed, innovative infrastructure and basic services. The city is home to the 'Fukuoka Method', a semi-aerobic landfill waste management process that has been replicated in a number of developing countries. Having experienced several severe water shortages these past few decades, Fukuoka is the only city in Japan with its own large-scale seawater desalination plant, which can produce up to 50,000m$^3$ (or the volume consumed by roughly 250,000 people) of high quality water every day. The facility supplements river/dam water sources, about which information is publicised daily to raise public awareness on water conservation. Fukuoka is also testing hydrogen as a new source of 'clean', sustainable energy.[4] So far, a pilot scheme (the largest of its kind in the world) has nearly 150 households running entirely on hydrogen power.

The city sits next to, and benefits largely from, the rich natural, agricultural and industrial resources of the surrounding areas of the Fukuoka Prefecture. Over the past several years, the London-based lifestyle magazine *Monocle* has consistently ranked Fukuoka as Japan's second 'most liveable city' (after Tokyo), and 14th among 25 in the world[5]. Prior to that, Fukuoka had been designated 'Best City in Asia' on three occasions by a Hong Kong-based magazine[6]. It is also noteworthy that Fukuoka has been home to UN-HABITAT's Regional Office for Asia and the Pacific since 1997.

Fukuoka is also considered as the 'gateway city to Asia' in Japan, with a number of direct flights to major destinations in the region. The city has historically developed through business, trade and cultural exchange with the region, and this tradition, combined with two-way Asian influences is still very visible today. Fukuoka houses Japan's only museum of modern Asian art. The city's annual film festival is unique in Japan as it features films from the various countries in the region. With its multicultural urban fabric and cosmopolitan outlook, the city has absorbed new and diverse ideas which people bring from Asia and beyond. Fukuoka is host to twelve universities and the workforce is relatively young; moreover, creative industries such as computer games, animation, fashion, design, and leading-edge technologies such as hydrogen energy, robotics and nanotechnologies are proving very attractive for young professionals from outside.

Based on this experience, a "Fukuoka Model" might be a city where the authorities and the population cooperate to create a well-organized transportation system as well as innovative and sustainable basic services; where careful attention is paid to architecture, tradition, the arts and culture; where planning efforts are made to sustain local or nearby agriculture and sources of fresh food, and where advantage is taken of location – in Fukuoka's case, its proximity to the ocean and other major Asian cities.

[1] *The New York Times,* September 24, 2006
[2] Government of Japan, 2003 *Housing and Land Survey*
[3] 2006 Fukuoka Citizen Attitude Survey (over 90% of respondents said Fukuoka was either 'liveable' (60.8%) or 'somewhat liveable' (33.2%)
[4] 'Fukuoka Strategy Conference for Hydrogen Energy', a joint research and practice initiative by Kyushu University, Fukuoka Prefecture, Fukuoka City, other public and private partners, and 600 private companies participating. Also: John Arlidge, 'Hy-life: Welcome to the world's first hydrogen town'. London: *Sunday Times,* 4 July 2010.
[5] *Monocle* magazine No. 35, vol. 04 July/August 2010:37: 'Fukuoka: Japan's 8th largest city punches above its weight in every way'. The city ranked 16th in 2009 and 17th in 2008 in the *Monocle* survey.
[6] *Asiaweek,* 'Asia's Best Cities' survey. Fukuoka ranked first in 1997, 1999, 2000, and second in 1998

*Source: Sachiyo Hoshino, UN-HABITAT*

# 5.4
# The challenge of climate change in Asian cities

Dhaka, Bangladesh. Rising sea levels have led many 'eco-refugees' to live on boats. **©Manoocher Deghati/IRIN**

## 5.4.1 To what extent do Asian cities contribute to climate change?

The Asia-Pacific region's exposure and sensitivity to climate change is bound to have significantly adverse physical, economic and social consequences. Cities in Asia are likely to be among those most affected by climate change: due to size, geographic location and elevation, they are especially vulnerable to frequent extreme weather events such as droughts, floods, cyclones and heat waves (McGranahan *et al.*, 2007). Many are located along coastlines and Lebel (2002) points out for example, that a one-metre rise in sea levels could lead to losses of 34,000 sq km of land in Indonesia and 7,000 sq km in Malaysia; in Viet Nam, the areas at risk include 5,000 sq. km in the North (the Red River Delta), and 15,000–20,000 sq km in the South (the Mekong Delta). Moreover, it is clear that the energy demands of urban areas – including Asia's rapidly growing cities – are a major contributing factor to the production of greenhouse gases (Grimm *et al.*, 2008; Stern, 2007; World Bank, 2008). For example, Dhakal & Imura (2004) report that in 1998, while Tokyo's carbon dioxide emission volume per head was 4.84 tons, Beijing's was 6.9 tons and Shanghai's reached 8.12 tons.

Estimates vary as to the total contribution of the world's cities to greenhouse gas emissions. According to Satterthwaite (2008), this could be as low as 40 percent. Others suggest that as much as 78 per cent of worldwide greenhouse gas emissions from fossil fuels can be attributed to urban areas (Grimm *et al.*, 2008). Asia-Pacific regional estimates have yet to be calculated. More accurate estimates have been made for energy use, of which a combined 66 per cent can be ascribed to the cities of the world (IEA, 2008).

### *Energy, transportation and climate change*

In Asia and the Pacific, energy consumption has expanded rapidly along with economic growth, especially over the past two decades. Moreover, despite volatile oil prices, total consumption of primary energy keeps growing in most countries. In 2006, over 80 per cent of the region's total primary energy supply was derived from fossil fuels, including coal, with the remainder split between nuclear power, hydropower and traditional fuels (biomass) such as wood and animal dung. Less than 0.25 per cent came from geothermal or other new and renewable energy sources. As one might expect, fossil and traditional fuels dominated where access to electricity was poor. Since 1990, the region's total energy

consumption has increased significantly on the back of substantial increases in electric generation capacity in order to support rapid economic development (ESCAP, 2008b).

High energy consumption has placed a tremendous burden on the region's fragile natural environment. In many Asian countries coal remains the main source of energy for the business sector, accounting for 44 per cent of total primary and 57 per cent of total commercial energy consumption in 2004, compared with world averages of 25 per cent and 28 per cent, respectively. Projections show that rapidly growing China and India will together account for 79 per cent of the expected increase in world coal consumption between 2005 and 2030 (Raufer, 2009).

The immediate fallout of urbanization and economic growth in Asia is increased energy demand for transportation. In urban metropolitan areas, transportation is estimated to account for one-third or more of total emissions of the main greenhouse gases contributing to climate change: carbon dioxide, methane and nitrous oxide (World Bank, 2006). Although technological change and the implementation of tighter emission norms have produced a decline in greenhouse gas emissions per car, these have kept growing overall on the back of increasing urban car numbers across Asian and Pacific region.

It is estimated that the number of vehicles in Asia will increase by more than four times in the next 20 years. Asia's share of global energy consumption is expected to multiply by nearly three from the current 6.5 per cent to 19 per cent by 2030 (see Table 5.3).

TABLE 5.3: **PROJECTED CHANGES IN ENERGY USE FOR TRANSPORTATION, 2006-2030**

| Country | Vehicle Population (Million) | | Energy Use (Mtoe)* | |
|---|---|---|---|---|
| | 2006 | 2030** | 2006 | 2030** |
| Australia | 14 | 18 | 38 | 49 |
| New Zealand | 2 | 4 | 6 | 11 |
| Japan | 78 | 87 | 213 | 239 |
| Republic of Korea | 16 | 31 | 43 | 85 |
| Malaysia | 7 | 24 | 20 | 66 |
| Thailand | 10 | 45 | 28 | 123 |
| Indonesia | 8 | 46 | 22 | 126 |
| India | 23 | 156 | 64 | 428 |
| China | 32 | 390 | 88 | 1 069 |
| Pakistan | 2 | 8 | 7 | 22 |
| **Total** | **192** | **809** | **527** | **2 218** |
| **World Total** | **928** | **2 080** | **8 084** | **11 664** |
| **Share** | | | **6.5 %** | **19 %** |

** Million tons of oil equivalent ('megatoe')*
*** Projections*
*Source: International Energy Agency, Energy Outlook 2007*

### *Buildings and climate change*

Buildings can be resource-intensive; they contribute 8 per cent of greenhouse gas emissions around the world (Stern, 2007). Most of these emanate from building use and maintenance, and the rest from construction materials, the production of which involves significant amounts of energy. However, according to the International Energy Agency, buildings account for as much as 40 per cent of total end-use of energy and about 24 per cent of greenhouse gas emissions in the world (Laustsen, 2008). Accounting for the difference between these two figures is the way end-user demand is calculated or apportioned. In countries like China, the Republic of Korea and Japan, buildings – especially high-rise – tend to be made of materials with high embodied energy (i.e., the materials were energy-intensive to manufacture). On top of this, building design has little regard for the local environment (ESCAP, 2009). For instance, in those regions with high temperatures, buildings with large numbers of windows facing the sun during the hottest part of the day substantially increase air-conditioning requirements and, therefore, energy consumption and operating costs. Many urban planners now recognize the importance of passive energy-efficient design in buildings – all the more so as the payback period for energy-efficient improvements in buildings can be relatively short.

Although the specific contribution of urban Asia to climate change is difficult to evaluate at this point, the more general trends that underpin rising greenhouse gas emissions in Asian cities have been extensively documented (Chilton & Kinniburgh, 2003; DFID, 2004; Parry *et al.*, 2007; Preston & Suppiah, 2006; Rockefeller Foundation, 2004; UNCCD, 2009). These trends include the following: rapid population growth, rising personal wealth and consumption, increased vehicle ownership, higher demand for energy, and a lack of taxes or controls on greenhouse gas emissions that might encourage the development of more energy efficient technologies. According to the United Nations Population Fund, demographic expansion is one of the primary drivers of climate change, and one that might be among the more difficult to tackle (UNFPA, 2009). Available data makes it difficult to ascertain the extent to which climate change in Asia is driven by human or natural phenomena, and the only sure thing is that man's role in the more dangerous aspects is significant (Schneider & Lane, 2006).

## 5.4.2 The effects of climate change on Asian cities

The impacts of climate change on Asian cities will be significant. They will affect not only the human, but also the physical, economic and social environments. A World Wildlife Fund report (World Wildlife Fund, 2009) focuses on 11 major Asian cities most likely to be affected significantly by climate change: Dhaka, Jakarta, Manila, Kolkata, Phnom Penh, Ho Chi Minh City, Shanghai, Bangkok, Kuala Lumpur, Singapore and Hong Kong, China. The report lists Dhaka

as the most vulnerable and in Bangladesh a roundtable on climate change estimated that in the next few decades over 20 million of the country's coastal area residents would have to seek refuge from rising sea levels (Muniruzzaman, 2010). Many people who are living in these and thousands of other cities and towns across the region face increasing uncertainty about their future, with millions potentially exposed to upheaval and relocation as 'eco-refugees'. Managing massive relocation will be challenging, and requires careful planning which should begin *now*, rather than later when natural disasters brought on by climate change become more intense.

### *Production, profitability and consumption*

From an economic point of view, Asian cities find themselves exposed to a double threat from climate change and its effects. One is very direct: beyond the prospects of mass relocation away from rising sea levels (Satterthwaite *et al.*, 2007), climate change also stands to reduce clean water supplies and productive (agricultural) soil areas, on top of exposing cities to higher risks of storm damage and flooding. Altered rainfall patterns will affect the ability of rural areas to supply food to cities. The implications for food security will be significant, especially as desertification makes further progress in countries such as China and India (Douglas, 2009).

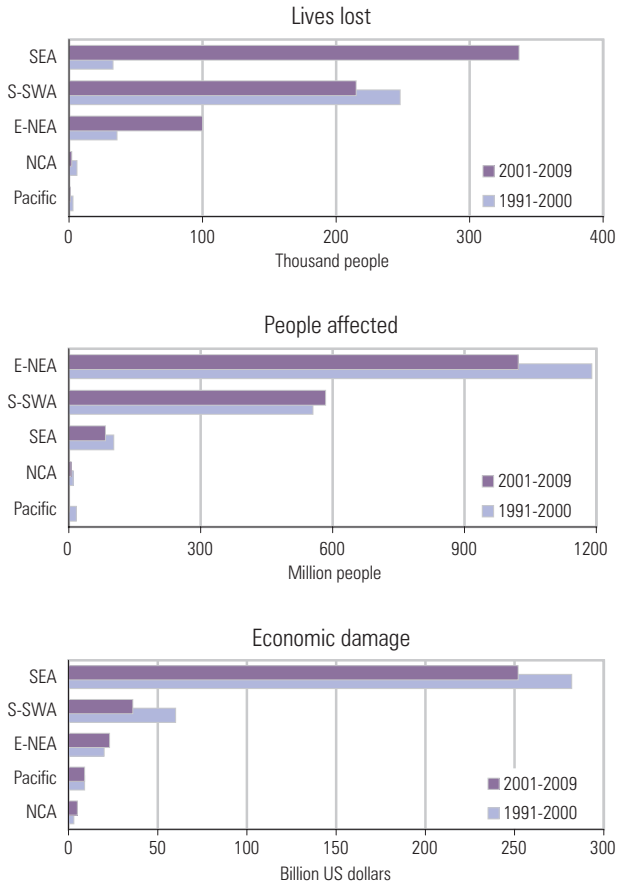
On top of this, many manufacturing centres are located along coasts or other flood-prone areas, and as part of Asia's 20 per cent share in world output some cities and countries have become dominant in a number of sectors, threatening regional and worldwide economic disruption.

The other threat from climate change on Asian economies is of a more indirect nature. Despite the failure of nations to reach an agreement on global emissions reductions at the Copenhagen Climate Change conference in December 2009, developed countries are likely to introduce emission trading schemes or carbon taxes in the future. This will probably increase production costs, dampening demand for manufactured and assembled goods and eroding the profitability of this sector in the region. A new international arrangement on climate change might impose similar demands on other nations, especially Asian industrializing countries. Emission trading schemes or carbon taxes may lead to a reduction in consumption and slow down urban economic growth in Asia. However, according to the Stern Report (2007), these effects will be relatively small *if* countries in the region act upon climate change *now*, rather than procrastinate for a decade or more.

### *More natural disasters*

Climate change will increase the risk of storm and flood damage in many cities in the region. Nicholls *et al.* (2007) found that Bangkok, Dhaka, Guangzhou, Hai Phong, Ho Chi Minh City, Jakarta, Kolkata, Mumbai, Shanghai and Yangon – all located under the tropics – are the world's most exposed cities to increased flooding due to climate change. Many Asian cities lie on coastal plains, which are bound to suffer more frequent flooding from tidal surges and storm damage (Kreimer *et al.*, 2003).

CHART 5.5: **THE CUMULATIVE IMPACT OF NATURAL DISASTERS BY ASIAN SUBREGION, 1991-2009**




*Key: SEA: South-East Asia; S-SWA: South and South-West Asia; E-NEA: East and North-East Asia; NCA: North and Central Asa.*
*Source: ESCAP (2010:220)*

Exposure to extreme weather events – heat waves, tropical cyclones, prolonged dry spells, intense rainfall, tornadoes, thunderstorms, landslides or avalanches – is already high in the Asia-Pacific region. The problems caused by drought will likely increase with climate change and desertification in western China and South Asia, with devastating effects on both water and food supplies as well and urban economies. Coming on top of those resulting from urban expansion, losses of agricultural land due to inundation and other climate-related events can only affect food security in cities. Relocation of eco-refugees will pose a significant challenge, requiring new urban settlements which will further reduce the amounts of land available for food production. In some Pacific Island countries, entire populations – rural and urban alike – will need to be relocated and resettled hundreds or thousands of miles from their home countries.

Over the course of the 20th century, Asia accounted for 91 per cent of all deaths and 49 per cent of all damage due to natural disasters (UNCCD, 2009). More than half a million lives have been lost as a direct result of major climatic events since the 1970s (DFID, 2004). Many of these catastrophes

▲ Floods in Northwestern Pakistan, August 2010. **©Abdul Majeed Goraya/IRIN**

have affected the region's cities. This situation points to a clear need to address climate change, especially through adaptation.

ESCAP has summarised the region's recent experience as follows: "In Asia and the Pacific the greatest damage is caused by storms and earthquakes – and 2009 was another disastrous year. From January to September 2009, there were 42 disasters, of which 16 were floods, following tropical storms (...). By November 2009, these disasters had affected more than 6.8 million people, left 155,850 homeless, and caused more than US $227 million in economic damage. The death toll is, however, much smaller than [the previous] last year, when two major disasters, the Sichuan earthquake and cyclone Nargis, struck the region killing 232,255 people" (ESCAP, 2010:219).

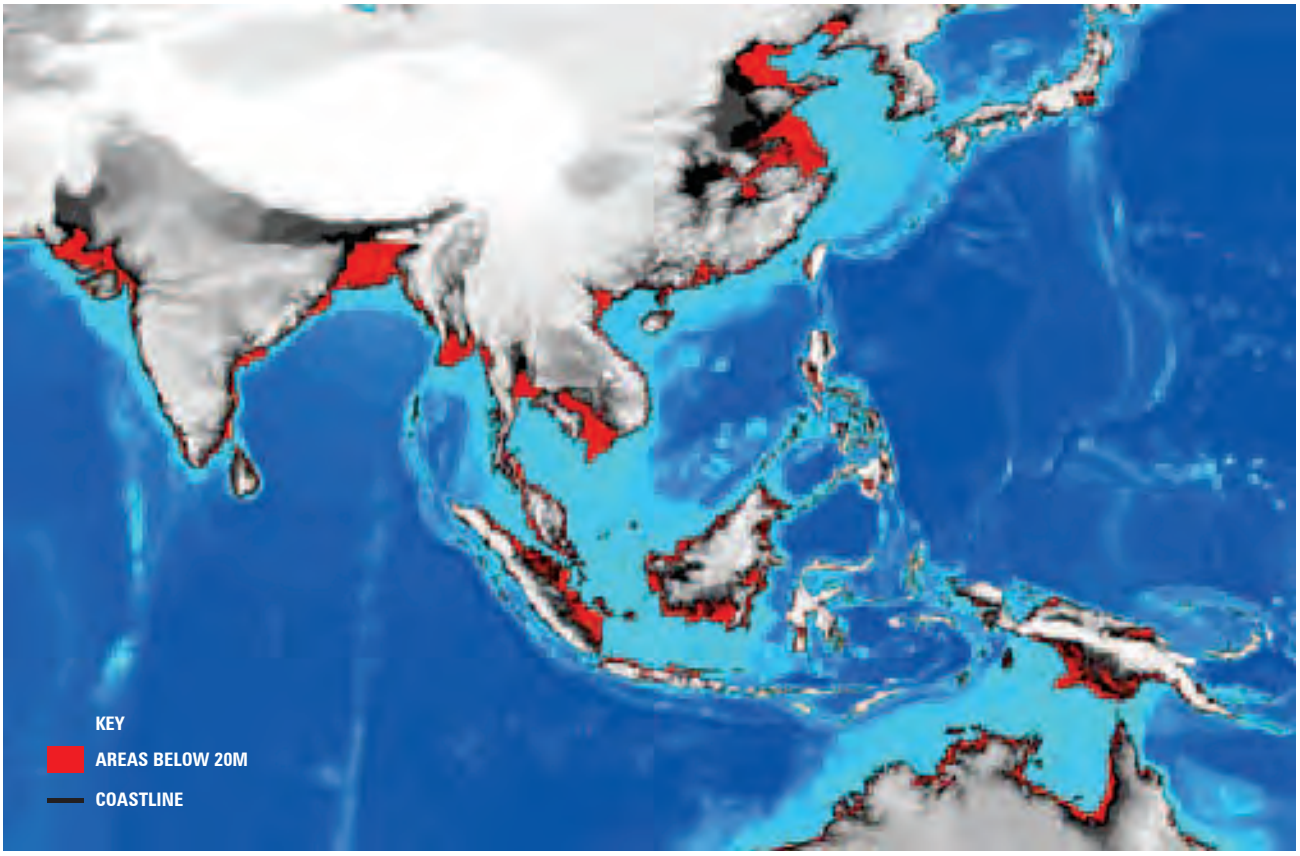
### *Rising sea levels*

Climate change is expected to bring about a significant rise in sea levels (see Figure 5.2). An estimated 54 per cent of Asia's urban population lives in low-lying coastal zones (UN-HABITAT, 2008). Particularly vulnerable are those conurbations spreading across deltas and low coastal plains such as, again, Ho Chi Minh City, Dhaka, Bangkok, Jakarta, Kolkata and Manila; much of which would be inundated by even small rises in sea levels (Woodroffe, 2005). Island-states, such as Maldives and Tuvalu, are particularly exposed (Farbotko, 2005).

McGranahan *et al.* (2007) estimated that in the year 2000, a total 238 million people lived in cities located in Asia's Low Elevation Coastal Zone (i.e., less than 10 metres above sea level) which as a result of climate change is potentially exposed to rising sea levels and storm surges (the total, i.e., including rural, population at risk was 466 million). This number rose to an estimated 304 million in 2010.[6] An estimated 18 per cent of Asia's urban population lives in low-lying coastal zones. The authors added that 75 per cent of all people living in areas vulnerable to sea level rises are in Asia, with the poorer nations most at risk. As for individual cities, Dhaka, Jakarta, Mumbai and Shanghai – all with populations exceeding 10 million – are seen as particularly exposed. Bangladesh is projected to lose 17.5 per cent of its land area if the sea level rises by one metre (IPCC, 2008). Millions of people would have to be displaced away from Dhaka, the national capital, and most of the country's agricultural and transportation network would be lost. In Shanghai, a similar one-metre rise in sea levels would flood one third of the city, displacing as many as six million people (Hinrichsen, 2000).

Although climate change can affect different places in different ways, urban areas will be especially vulnerable

FIGURE 5.2: **LAND AREA LESS THAN 20M ABOVE SEA LEVEL IN ASIA**




*Source: Brooks et al. (2006:11)*

(Kelkar & Bhadwal, 2007; Lindley *et al.*, 2006) because of high demographic densities, high thermal mass (i.e., capacity to store heat and therefore to smooth out daily fluctuations in external temperature) of buildings, and relatively low vegetation cover (Whitford *et al.*, 2001). On top of this, the Maldives and Sri Lanka, both small island nations, face energy shortages and have unique adaptation needs (Halsnaes & Shukla, 2008). Other large cities away from coastal zones will be vulnerable to more frequent and severe droughts, which will induce shortages in clean drinking water, along with sanitation risks, high temperatures and serious air pollution.

### *Heat islands*

One of the most significant factors associated with climate change will be an increase in the urban 'heat island' effect. Depending on the intensity of global warming, temperatures are projected to rise between one and six degrees Celsius over the course of the 21st century, but in cities the increase is likely to be more pronounced as a result of heat entrapment from temperature inversion and the absorption of solar radiation by paved or other covered land surfaces (Shimoda, 2003). In Hong Kong, China, air-conditioning already accounts for about one-third of total residential electricity consumption (Lam, 2000), and with higher temperatures this proportion can only increase. According to Wang *et al.* (2008), annual production of room air-conditioning units in China stood at 31.35 million in 2003 and has been growing every year by an average 25 per cent or so. In China's urban areas, most housing units have their own air-conditioner. No wonder that across South-East China, where Hong Kong, Guangzhu and the Pearl River delta are located, mean surface temperature has increased 0.05 degree Celsius per decade under the impacts of urbanization (Zhou *et al.*, 2004). Therefore, it is essential to improve residential and commercial air-conditioning to offset the expected increases in electricity demand, especially where power is from non-renewable sources. Moreover, population sizes in East Asia's eight mega-cities (Bangkok, Beijing, Ho Chi Minh City, Manila, Pyongyang, Shanghai, Seoul and Tokyo) are associated with significant increases in the magnitude and extent of urban 'heat island' effects (Hung *et al.*, 2006). On top of increasing ambient air and surface temperatures in and around cities, heat islands stimulate ozone formation and urban pollution, and excessive heat reduces human productivity. In short, urbanization places a heavy burden on the urban physical environment in Asia.

Climate change will also affect health as well as building designs and energy costs. As most of Asia's future demographic growth is to occur in cities, these are where the problem of climate change must be addressed most urgently.

## BOX 5.5: ASIA SPEARHEADS UN-HABITAT'S NEW CLIMATE CHANGE INITIATIVE

"Cities have no control over the local impacts that result from a global change in climate. They can only anticipate what the effect might be, calculate the risks and decide the level of response" (UN-HABITAT, n.d.a). This unprecedented, complex challenge is the rationale behind the *Cities and Climate Change Initiative (CCCI),* which is part of UN-HABITAT's Global Sustainable Urban Development Network (SUD-Net) (see Box 5.8). Given its particular exposure to climate change and its effects, the Asia-Pacific region comes under special focus in this broad-ranging endeavour, which builds cities' capacities in many areas, from vulnerability assessment to governance to policy development and implementation.

Climate change and its effects pose a major threat to cities in the developing world, including their increasing role as 'economic engines' for whole countries and the associated capacity to reduce poverty. Against this background, the UN-HABITAT Initiative pursues the following four objectives:

- to promote active climate change collaboration between local governments and their associations;
- to enhance policy dialogue so that climate change is firmly established on the agenda;
- to support local governments in developing climate change action plans;
- to foster awareness, education, and capacity-building strategies that support the implementation of climate change strategies.

As far as Asia and the Pacific are concerned, climate change and its effects threaten to amplify the vulnerability of a region that is the most populated, most exposed (flooding, drought), most disaster-prone (cyclones, earthquakes, tsunamis) and second poorest in the world.

Even before its formal launch in March 2009, a pilot scheme had been introduced in Sorsogon, the Philippines, a city under the double threat of cyclones and rising sea levels. Since then, the Initiative has also been deployed in South America and Africa, but the Asia-Pacific region dominates the list of participating cities (nine, of which four in Pacific island countries) and the scheme is under serious consideration in China and Viet Nam (see Table 5.4).

As part of the specific CCCI Asia-Pacific strategy, it is expected that by 2015, 300 cities in the region will have enhanced their climate change resilience and have started reducing greenhouse gas emissions. This double objective is to be achieved in partnership with the Asian Development Bank, the World Bank, the Rockefeller Foundation, bilateral development partners, other UN agencies, non-governmental organisations s and academic institutions. The Asia-Pacific strategy takes a three-pronged approach:

(i) Support city-level climate change adaptation and mitigation, including revised urban plans.
(ii) Support national climate change and urban policy review in order to strengthen the national response to the urban dimension of climate change.
(iii) Support Asia-Pacific-wide advocacy and knowledge management, and build capacities for widespread up-scaling

By the time eight Asia-Pacific cities joined the Initiative in March 2010, the pilot scheme in Sorsogon (population: 151,000) demonstrated how it could be deployed for best effect, including nationwide (UN-HABITAT, 2009; n.d.b). A comprehensive participatory vulnerability and adaptation assessment identified vulnerable locations, populations and sectors. In a series of participatory meetings, including several city-wide consultations, climate change adaptation and mitigation options were agreed and prioritized based on broader needs. A shelter plan is under development while land-use and sector development plans come under revision. The livelihoods of the more vulnerable groups are strengthened as part of an ongoing strategy which also includes improved shelter. On top of all this, Sorsogon has introduced a "win-win" energy saving scheme and strengthened disaster preparedness plans. As far as upscaling is concerned, the lessons learned in Sorsogon have been mainstreamed into the Climate Change Act of the Philippines (2009). This statute is exemplary as it attempts to bring clarity to the institutional approach to climate change, stressing the multi-sector dimension and emphasising the role of local authorities in implementation. Another upshot of the pilot scheme took the form of a 'vulnerability assessment tool' which enables the sharing of the lessons learned in Sorsogon across the whole Filipino archipelago. for the whole of has been developed to share the lessons learned in the Philippines. The tool has by now been included in the curriculum of the country's Local Government Academy.

TABLE 5.4: **THE CITIES AND CLIMATE CHANGE INITIATIVE (CCCI) ASIAN-PACIFIC STRATEGY**

| Cities/Countries | Achievements |
|---|---|
| Sorsogon, the Philippines | Comprehensive Vulnerability Assessment and Greenhouse Gas Audit. Identification of key adaptation actions and implementation. Revision of Land-Use Plan and Development plan. Strong engagement with national stakeholders. Replication in other cities. |
| Batticaloa and Negombo, Sri Lanka | Vulnerability and Greenhouse Gas Assessments in both cities. National Study on Cities and Climate Change. National Climate Change Policy to include urban issues. |
| Port Moresby, Papua New Guinea | Vulnerability Assessment ongoing, Greenhouse Gas Assessment and National Study on Cities and Climate Change. |
| Port Vila, Vanuatu | Vulnerability and Greenhouse Gas Assessments and National Study on Cities and Climate Change. |
| Apia, Western Samoa | Vulnerability and Greenhouse Gas Assessments and National Study on Cities and Climate Change. |
| Lami, Fiji | Vulnerability and Greenhouse Gas Assessments and National Study on Cities and Climate Change. |
| Pekalongan, Indonesia | Vulnerability Assessment completed, Action Planning. |
| Ulaanbaatar, Mongolia | Vulnerability and Greenhouse Gas Assessments and National Study on Cities and Climate Change. |
| China | Translation of the Vulnerability and Greenhouse Gas Assessment tools and roll-out through select cities. |
| Viet Nam | National Study on Cities and Climate Change, supported by a comparative analysis of city-level Vulnerability Assessments to strengthen the Sorsogon-developed tool. |

*Source: UN-HABITAT Regional Office for Asia and the Pacific*

## BOX 5.6: **CLIMATE CHANGE ADAPTATION: A 'FLUID' ALTERNATIVE FOR BANGKOK**

▲
'Solid' vs. 'fluid' construction*. **©Danai Thaitakoo**

Of all major cities in Asia, Bangkok stands among those most at risk from climate change and its by-effects. With modern techniques and impressive infrastructure, prevention and mitigation could cost billions – unless, that is, Thai authorities instead opt for a mix of secular local wisdom and state-of-the-art research, as advocated by some scientists.

The Thai capital is located in the middle of a low-lying flat area dominated by orchards to the west, rice fields to the east, shrimp farms along the coast and fish farms in the lowlands. The settlements over the length and breadth of the Chao Phraya River delta used to support an elaborate network of market towns interconnected by natural and constructed waterways, which helped turn the city into a major trading centre. Indeed, today's much sought-out combination of climate change adaptation and economic development has been a fact of life for centuries in that part of central Thailand.

The liquid element is so ubiquitous that Bangkok is known as 'the city of three waters'. These include the tides of the Gulf of Siam, the river, and tropical monsoons. Across the delta, heavy rainfalls compound the perennial conflict between high tides and the river, causing seasonal flooding in some parts of the city despite the presence of floodwalls and pumping stations. The problem is that in the future, climate change (including rising sea levels) may tamper with long-standing hydrological patterns in a much more destructive way.

Since the area is totally controlled by hydrological and climatic factors, the temptation is to keep these under check with rigid flood protection structures. Now these would inhibit the natural flow of water; natural life behind them would become static and slowly die as the dynamics and nutrient flow of water are stymied. Since they resist any changes in water levels or volumes across the area, barriers would destroy the age-old consistency between land and the liquid element. In this perspective, water no longer is seen as the lifeline it has been for centuries in this area; instead, it appears as a hazard that must be tackled head-on or altogether eliminated. The resulting disjunction between land, water and population would cause much more damage to land use and hydrological patterns than did the post-World War II rapid increase in built-up areas.

Resilience does not mean rigidity. Instead of a 'solid', centralised system, it is better to adjust local practices to the levels of water. This 'fluid' perspective does not represent a return to any pre-modern, locally controlled, human ecosystem watershed model. What is needed is a restoration of the canal network and hydrological matrix based on scientific monitoring and networked technologies. This alternative is characterized by dynamic flow management systems which interact locally through locks and adjustable check dams, weirs and water gates. Sub-catchment watershed management is based on a system of small polders which, together with canal networks, can accommodate local water surpluses or droughts depending on the season.

The rationale behind this 'fluid' alternative is that flexible and open traditional structures allow for the natural flow of water. This is all the more important as the Bangkok area's cultural, social and economic life is tied to the dynamics of water, with resilience and adaptation evolving over time with seasonal flows. In this way, the consistency between land, water and local populations is restored: water is one aspect of vulnerability, but it remains manageable.

In terms of governance, the 'fluid' alternative calls for a bottom-up approach for the sake of participatory, sustainable development. In this patchwork of urban and agricultural areas, localized air, water and food quality management could be made visible and publicly accessible along canals and orchards. These physical connections could act as 'feedback loops' between farmers, consumers and policymakers, opening up a fresh eco-cultural landscape.

This comprehensive approach to the role of ecosystems in urban design (including housing, see below) combines the notion of fluidity with indigenous practices in the Chao Phraya Delta and state-of-the-art urban ecosystem research.

**'Solid' vs. 'fluid' construction* - The house on the left exemplifies the 'solid' approach to climate change. Sitting on rubble and soil, the property hinders the natural flow of water and restricts the accommodation and retention of higher volumes. The house on the right espouses the traditional, 'fluid' approach: standing on stilts above the water, it does not disturb the natural flow and allows for higher volumes. The 'solid' approach braces for the excess water which the 'fluid' alternative stands ready to accommodate.

*Source: Thaitakoo & McGrath (2010)*

### 5.4.3 Responding to climate change: Adaptation and mitigation

Faced with climate change, cities must improve planning and building capacities for adaptation (responding to effects) and/or mitigation (reducing the causes). The larger greenhouse gas-producing nations and cities must give greater priority to *mitigation*, and for that matter reduced individual demand for energy. Poorer, lower emitting nations must concentrate on *adaptation*. Failure in Copenhagen in late 2009 to agree on a detailed successor agreement to the Kyoto Protocol should not preclude developed countries from agreeing on a new scheme that can offset the costs of mitigation and adaptation in developing countries.

***Adaptation***

Since Asian cities are particularly vulnerable to climate change, they need substantial strengthening of adaptive capacities (Adger *et al.*, 2003). Many Asian cities also find themselves grappling with the issue of 'readiness': this refers to the argument that more urgent and pressing environmental issues are requiring all their attention, and that they are not prepared today to tackle climate-change adaptation given their specific economic stages of development or financial and human capacities, or degrees of citizen awareness (Bai, 2007b). This is where UN-HABITAT's new Cities and Climate Change Initiative (CCCI) can help, with a regional strategy that is well adapted to the special threats and needs associated with Asia and the Pacific (see Box 5.5).

The starting point for climate change adaptation is the assessment of impacts, vulnerabilities and adaptive capacities. Such assessments should include financial needs as well as an economic, social and environmental evaluation of adaptation options. A good starting point would be relatively simple, citywide assessments that draw on national and sub-national climate change data, map past weather-related effects on the city and provide an overview of vulnerable sectors, locations and people. Once there a general consensus has emerged over the likely local effects of climate change, in-depth assessments can follow, sector by sector.

Although mainstreaming climate change considerations, such as land use and comprehensive or integrated planning, in citywide planning, is recommended, specific adaptation plans may be warranted. This can, for example, involve viable alternatives to prevent floodplains from being developed or built up. In general, 'no-regrets' or 'win-win' adaptation options should be preferred. Such options have significant benefits in common, which make them viable even in the absence of any threat from climate change; they may address environmental priority areas (for example, coastal erosion) or support good social policies (such as slum upgrading).

Upgrading urban infrastructure in anticipation of climate change would only in exceptional cases be a priority issue for cities. However, if infrastructure, particularly water and sanitation, bridges and dykes, needs upgrading, any long-term climate change scenarios must become part of financial planning. Rainwater harvesting and ground water recharging are now widely accepted methods to reduce flooding and prepare for droughts.

The World Bank (2009) has highlighted ecosystem-based adaptation (and in particular reforestation to reduce surface water run-off, and the rehabilitation of floodplains and urban wetlands to reduce flooding, together with coastal zone management, such as mangrove replanting and reef rehabilitation) as a viable alternative to "hard" infrastructure, particularly when the broader eco-system services are taken into consideration.

The "greening" of roofs and cities in general, including urban agriculture, can further reduce flooding as well as the heat island effect.

Also recommended is the strengthening of health systems, such as surveillance of, and early response to, vector-borne diseases in light of changing disease patterns (WHO, 2009). The "hardening" of the health infrastructure is also crucial (ibid.), ensuring that frontline services are minimally disrupted during disasters.

Although retrofitting housing on a large scale would be very costly, a revision and better enforcement of building standards would not be too taxing for most local authorities.

Improving disaster preparedness would be the single most important climate change adaptation measure in coastal cities exposed to tropical cyclones (as well as in other disaster-prone areas), ranging from community-based early warning and response systems to better coordination and response capacities of specialised services.

Asian cities should also look to improve adaptive capacities among all stakeholders, such as urban poor communities, local and national governments, and non-governmental organisations (Rockefeller Foundation, 2009). Adaptation to climate change also calls for reduced future vulnerability and risks for residents. For example, improved methods and materials for low-income housing can significantly reduce the consequences of catastrophic storms on poorer communities.

Regarding climate change adaptation, the role of traditional knowledge and location-specific approaches cannot be underestimated. Over time, local communities in various cities and countries have made efforts at climate change adaptation. These location-specific amendments to human settlements have typically built on traditional knowledge and local practice. In Bangkok, local communities have adapted to rising water levels with a 'fluid' concept of human settlements, which has served them well (see Box 5.6).

Whereas UN-HABITAT takes a worldwide perspective on information-sharing, the Asian Cities Climate Change Resilience Network (Rockefeller Foundation, 2009) focuses on a specific region. In this effectively complementary role, the Asian Network, too, acts as a catalyst for information-sharing, funding, action and other partnerships between cities, institutions, financiers and consultants in a joint effort to enhance the resilience to climate change of economically deprived and vulnerable people. The purpose is to devise models and methodologies for assessing and addressing risk through the active engagement of various cities. Institutions in four countries – India, Indonesia, Thailand and Viet Nam –

## BOX 5.7: **WHEN INDIA'S SUPREME COURT ENDORSES THE CASE FOR CLEAN AIR**


▲
Compressed Natural Gas-powered auto-rickshaw in Delhi, India.
**©Paul Prescott/Shutterstock**

India's capital once ranked among the 10 most polluted cities in the world, with measured amounts five times as high as international benchmarks. Public transport contributed 70 per cent of the pollution, and buses were identified as one of the major culprits.

This situation brought the non-governmental Centre for Science and Environment to launch a protracted campaign in favour of controls on bus emissions, which culminated in much-publicized public interest proceedings before the Supreme Court of India. In 1998, the Supreme Court directed the Delhi Government to convert all public transport and para-transit vehicles from diesel or petrol engines to compressed natural gas (CNG). In the process, the Court also paved the way for stricter environmental norms and ordered the phasing out of old, highly polluting commercial vehicles.

Subsequent conversion to gas and introduction of low-sulphur fuel demonstrated that major change could occur on a large scale, as long as appropriate policies were deployed and enforced (although, in the case of Delhi, the judiciary had to step in and tell public authorities what to do).

Natural gas has made Delhi cleaner and more environment-friendly (Narain & Krupnick, 2007). The use of low-sulphur diesel has also led to significant reductions in sulphur dioxide and suspended particulate matter. However, the benefits arising from the introduction of compressed natural gas are diminishing due to the rapidly increasing numbers of private vehicles that run on petrol. More recently (October 2008), 'eco-friendly' hybrid rickshaws have been introduced in the Indian capital. Known as *'solekshaws',* these vehicles are fuelled by solar-generated electric power which is produced and distributed by a dedicated facility located in central Delhi (GoI, 2008).

*Sources: CNG Busses in Delhi http://www.cleanairnet.org/infopool/1411/propertyvalue-19513.html*

act as major resource centres for network development. Three cities in India and another three in Viet Nam are currently developing city-level climate change adaptation strategies with assistance from the network (Rockefeller Foundation, 2009). The new model is based on the concept of "mass collaboration" (Tapscott & Williams, 2006), which resorts to holistic and collaborative approaches to address complex business, social and environmental problems.

Admittedly, integrating global issues such as climate change into urban management remains a challenge for most developing cities in the region (Bai, 2007a; World Bank, 2008). In many cases, required action will be expensive – relocating millions of people, or deploying protective structures to prevent or reduce inundation (McGranahan et al., 2007).

### *Mitigation*

Asian countries can already begin mitigating the longer-term impacts of climate change in a variety of ways. This is of particular importance for the larger polluting countries like China, India, Japan and the Republic of Korea. These and others are beginning to reduce greenhouse gas emissions by switching to cleaner fuels and alternative sources as far as electric power generation is concerned; they have also taken to reduce industrial, domestic and public transport demand for fossil fuels, but the pace of change is not fast enough.

In the transportation sector, the conversion of private (cars, motorized tricycles) and public vehicles to natural gas in several Asian cities has brought significant reductions in greenhouse gas emissions (see Box 5.7). Other measures are in the course of investigation or introduction in many Asian cities, including solar panels, improved housing and building insulation, bio-gas, industrial ecology and methane capture from solid waste dumping sites.

Research has shown that large reductions in greenhouse gases would be achieved by a shift from large numbers of small, private vehicles for personal transportation to fewer, larger-capacity vehicles (World Bank, 2006). Table 5.5 displays greenhouse gas emissions for various transportation modes. It would seem that diesel-powered articulated buses (i.e., double-length, with a walk-through trailer) produce the least greenhouse gas emissions per passenger-kilometre (due to exceptional capacity) on top of being cost-effective public transport options.[7]

With regard to buildings, according to the above-mentioned International Energy Agency report (Laustsen, 2008, also cited in ESCAP, 2009), energy-efficiency standards in buildings across the world would reduce energy use by about 11 per cent by 2030 compared with a business-as-usual scenario. In China, the city of Rizhao (see Box 5.9) has demonstrated that overall energy demand and greenhouse gas emissions can be reduced through sustainable building design and energy use.

Sustainable construction can be supported in a variety of ways in Asia, especially through improved and well-enforced building codes and planning regulations. Voluntary methods such as energy-rating schemes and standards and labelling

TABLE 5.5: **GREENHOUSE GAS EMISSIONS, SELECTED TRANSPORT SYSTEMS**

| **Mode of Transport** | **Maximum Capacity** (Passengers/Vehicle) | **Average Capacity** (Passengers/Vehicle) | **GHG Emissions** (Grams) **Per Vehicle-Kilometre** | **GHG Emissions** (Grams) **Per Average Passenger-Kilometre** |
|---|---|---|---|---|
| Gasoline scooter (two-stroke) | 2 | 1.2 | 118 | 98 |
| Gasoline scooter (four stroke) | 2 | 1.2 | 70 | 64 |
| Gasoline car | 5 | 1.2 | 293 | 244 |
| Diesel car | 5 | 1.5 | 172 | 143 |
| Diesel minibus | 20 | 15 | 750 | 50 |
| Diesel bus | 80 | 65 | 963 | 15 |
| Compressed Natural Gas bus | 80 | 65 | 1 000 | 16 |
| Diesel articulated bus | 80 | 65 | 1 000 | 7 |

*Source: Hook & Lloyd (2002); World-Bank (2006:5)*

can also be effective (ESCAP, 2009). However, these must be supplemented for best effect, such as through innovative construction methods (to lengthen the life and reduce the energy requirements of buildings), which can reduce the use of natural resources and therefore the ecological footprint of buildings, in the process supplementing broader climate-change mitigation efforts.

Linkages between environmental problems and climate change are increasingly apparent in Asia, but mitigation or adaptation strategies can be found in only a small number of cities (World Bank, 2008). Integrating climate change into urban management remains a major challenge in the region (Bai, 2007b). Asian countries together stretch over a vast area and are highly diverse in respect of population, size, altitude, climate and economic development. Consequently, the effects of and responses to climate change – both in cities and in countries at large – will vary widely. Mitigating, and adapting to, climate change will require greater collaboration and cooperation among communities, businesses and governments. To date, most Asian countries have focused on the process of ratifying the United Nations Framework Convention on Climate Change (UNFCCC). Now is the time to take practical steps.

However, it must be recognised, that existing models are not accurate enough to predict the precise effects of climate change on any particular conurbation. In this situation and for the time being, the best that developing countries can do is to address a number of factors which currently put their respective environments under stress. These factors include urban poverty (food security, water availability), combating land degradation and reducing the potential loss of biological diversity and 'ecosystem services'[8]. A major concern of many urban authorities in Asia is global warming, arising from the increase in greenhouse gas emissions due to urban services and amenities such as transportation, electricity generation, solid waste disposal and food production, among others. Some urban authorities have found that the most effective way to mitigate global warming is to launch integrated, multi-pronged strategies involving infrastructures and services (see Box 5.10).

When it comes to climate change mitigation, authors like Bai (2007b) and Bulkely (2003) find significant capacities and potential in Asian cities, with reductions in energy use (including both supply and demand) standing out as an apt starting point. Urban energy consumption can be reduced through the transformation of infrastructure, particularly transportation and energy production systems, as well as changes to the population's behaviour and consumption patterns. Some of the larger economies such as China and

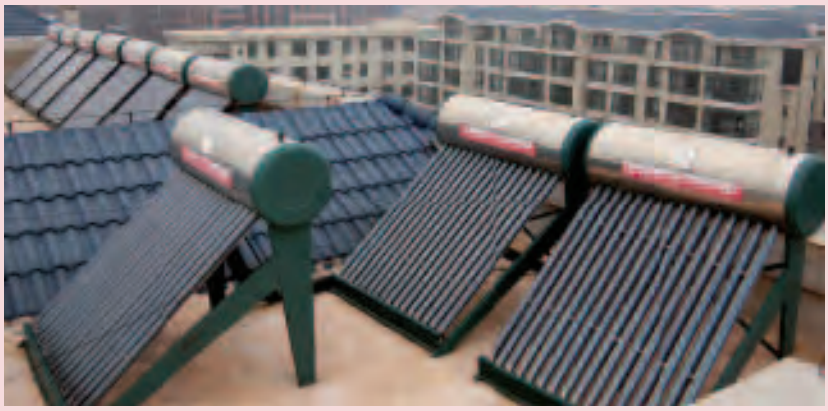
## BOX 5.8: UN-HABITAT'S INNOVATIVE URBAN NETWORK

Climate change is a vast and complex phenomenon and if cities are to become more sustainable all tiers of government must benefit from a wide range of knowledge and experience. This is the rationale behind the Sustainable Urban Development Network ('SUD-Net'), a worldwide interdisciplinary link supported by UN-HABITAT.

SUD-Net assists cities in a variety of ways: mobilizing partners and networks, building partnerships, implementing innovative, pro-poor projects, stimulating the acquisition and sharing of knowledge, and disseminating good practice. The network provides access to up-to-date information (tools and guidelines, resource packages, documents) as well as feedback on ongoing debates, initiatives and activities at the global, regional, national and local levels. SUD-Net also supports institutional capacity-building through improved governance and leadership against a background of decentralized public authorities. Over the past year or so, links have been established with local urban knowledge networks, city councils and universities, as well as the World Bank.

*Source: UN-HABITAT (2010a:14)*

## BOX 5.9: **RENEWABLE ENERGY USE: GOOD PRACTICE FROM RIZHAO, CHINA**



▲
Rizhao, China. **©CSIRO**

In most cities in China, use of coal for industrial and municipal purposes is one of the primary sources of air pollution. Therefore, enhancing energy efficiency and increasing the share of renewables in the overall energy supply have become strategic targets for the Chinese government. The city of Rizhao (with an estimated population of 816,000 in 2010) on the Shandong Peninsula is one of the country's leaders for renewable energy use and improved air quality. In the 1990s, the city began to popularize solar-powered street lighting, hot water, cooking and greenhouse farming. After 10 years' efforts, up to 99 per cent of all households in Rizhao's central districts are now equipped with solar water-heaters and more than 6,000 solar cooking devices are in use in the suburbs.

With financial and other incentives from the city, provincial and national authorities, manufacturers have managed to make the costs of solar water-heaters level with those of standard electric devices. However, since solar heaters come with longer life-spans and zero operating costs, over a period of 15 years they bring total savings equivalent to US $2,050 to users, a significant amount for an ordinary local household (Bai, 2007b, 2007c).

The Rizhao municipality has combined these technical innovations with environment-friendly policies, regulations, incentives and public awareness programmes (Bai, 2007c). Solar water-heaters have become mandatory in all new housing units, as part of a scheme that was pioneered by civil servants and which is supported by advertising and educational campaigns on local television.

The city's drive in favour of renewable energies extends to other areas, including electricity generation which now uses methane gas from wastewater treatment, livestock dung and straw. This programme alone substitutes for more than 39,000 tons of coal annually (WCEA, 2007). In 2007, Rizhao received the first World Clean Energy Award for its innovative policies. This success might trigger a change in urban energy and environment policies elsewhere in China. The capital city of Shandong Province, Jinan, has already decided to make solar water-heaters mandatory in all new housing. According to a senior official at China's National Development and Reform Commission, the government has decided to disseminate Rizhao's innovative policies to all other cities in the country.

*Source: Bai (2007c)*

India will likely find themselves in better positions to adapt to climate change thanks to recent economic, managerial, technological and infrastructure improvements. It is the poorer countries, such as Bangladesh, and the smaller Pacific and Indian Ocean island states, which will struggle to adapt due to very limited resources and options.

It is important to understand that mitigation of greenhouse gas emissions in Asian cities must be addressed across all segments of society, from the large-size polluters to individuals. Just as important is sharing lessons learnt from effective strategies to address both the mitigation of, and adaptation to, climate change impacts between cities, which requires networks and partnerships between countries and cities in the region (see Boxes 5.8 and 5.11).

### 5.4.4 Financing climate change policies

Although difficult to predict, the economic costs of unmitigated climate change in Asia are likely to be very high. According to research by Oxfam (2008), climate change was to reduce India's gross domestic product by 9 to 13 per cent in 2010. According to an OECD report (2008), however, the costs of limiting climate change are manageable (although higher in China and India than in OECD countries).

In a speech to the United Nations Climate Change Conference in Bali, Indonesia in 2007, OECD Secretary-General Angel Gurría said that if greenhouse gas emissions were to be cut to reach the more ambitious 2050 international targets under discussion at the time, this would shave 0.1 per cent off the world's combined production of goods and services every year until mid-century. As far as OECD countries were concerned, he added, a harmonized worldwide carbon tax would reduce the world's output by only 0.2 per cent in 2030 and 1.1 per cent in 2050. However, outside the OECD, gross domestic product would experience more pronounced declines in China and India: 5.5 per cent of total output in 2030 and 1.4 per cent in 2050 (Gurría, 2007).

In Asia as elsewhere in the world, a major question when addressing the issue of climate change is, who will bear the costs? Adaptation will be expensive and will require significant national and international borrowing and the raising of revenue through a variety of user-pay means. Most costs will

## BOX 5.10: **THE CLIMATE CHANGE MITIGATION INITIATIVE IN BANGKOK**

▲
'BTS SkyTrain' has transformed public transportation in Bangkok, Thailand. **©1000 Words/Shutterstock**

With its Action Plan on Global Warming Mitigation, the Bangkok Metropolitan Administration seeks to reduce greenhouse gas emissions by 15 per cent between 2007 and 2012. As shown in Table 5.6, the Action Plan has identified the urban functions that contribute most to global warming, and taken a number of steps to curb greenhouse gas emissions.

In the transportation sector, the Metropolitan Administration proposed expanding Bangkok's rapid transit system with additional bus routes to outlying areas, a more affordable option rail-based transit. The Metropolitan Administration also encourages walking and non-motorized transport modes, while at the same time planning to increase the number of buses that will act as feeders to the rapid transit systems. The Metropolitan Administration has also launched a campaign urging people to turn off vehicles while parked.

Electricity generation in Bangkok produces just under 15 million tons of greenhouse gases per year. In a bid to reduce these, the Metropolitan Administration has launched a campaign to encourage people to shift from ordinary to compact fluorescent electric bulbs. In May 2007, the city also asked all residents to turn off all electric lights for 15 minutes every day to help reduce greenhouse gas emissions. On top of this and as an integral part of the Action Plan, the BMA urged the Bangkok population to adopt 'recover, re-use and recycle' routines in order to reduce solid waste, and to favour reusable cloth bags over plastic bags. Instead of relying mainly on landfills and open dumps, the Metropolitan Administration proposed capturing methane gas from waste and to use it as an energy source. Finally, the Administration has also promoted the planting of three million trees and the expansion of parks and open spaces in the whole Bangkok metropolis.

In 2009, the UN Environment Programme (UNEP) provided technical support to the Bangkok Metropolitan Administration to assess the impacts of climate change and vulnerability of Bangkok and area. The Bangkok Assessment Report on Climate Change (BARCC) identified "energy efficiency and emissions reduction" as one of its long term initiatives to mitigate climate change impacts. The assessment identified two priority mitigation responses: (i) adopt and encourage energy efficiency and conservation among the population; and (ii) increase the use of renewable energy, both in terms of passive design and power generation, in individual homes, other buildings and the local grid (Bangkok Metropolitan Administration *et al.,* 2009).

For implementation, the Metropolitan Administration is collaborating with the Ministry of Energy and various non-governmental organisations to support local business, using audits to establish energy efficiency standards and building codes and encouraging stakeholder involvement in the Action Plan in order to build strong community support.

TABLE 5.6: **GHG EMISSIONS IN BANGKOK METROPOLITAN AREA (2007 - 2012*)**

| | $CO_2$ Equivalent, Million Tons | | |
|---|---|---|---|
| **Sector** | **GHG Emissions 2007** | **GHG Emissions 2012*, Business as Usual** | **GHG Emissions 2012*, Under BMA Action Plan** |
| Transportation | 21.18 | 25.30 | 19.77 |
| Electricity generation | 14.86 | 16.00 | 13.75 |
| Waste production | 1.13 | 1.13 | 0.95 |
| Others, methane from rice production, etc. | 5.58 | 6.36 | 6.36 |
| Reduction of GHG emissions from bio-fuel energy | | | (0.61) |
| Reduction of GHG emissions from improved waste disposal | | | (0.28) |
| Reduction of GHG emissions from expanded parks and green areas | | | (1.00) |
| **TOTAL** | **42.65** | **48.69** | **38.94** |

** Projections*
*Source: Bangkok Metropolitan Administration (2008)*

*Source: Bangkok Metropolitan Administration et al. (2009); Bangkok Metropolitan Administration (2008)*


Beijing, China . The China International Energy Saving and Environmental Protection Exhibition (EnerChina 2010). **©Testing/Shutterstock**

have to be borne by urban dwellers, since cities contribute most to greenhouse gas emissions. Reducing these will call for a variety of strategies. Some – such as the introduction of cleaner fuels and engine conversions for public transport, which is already occurring in many South Asian cities – will become widespread across the region. Because of the diversity in climatic, geographic and economic conditions, however, individual cities will also need specific strategies to suit their own circumstances.

As far as the financial dimension of climate change adaptation/mitigation is concerned, some Asian countries have adopted, or are considering schemes based on, emissions trading, carbon taxes and the Clean Development Mechanism (CDM), a legacy of the Kyoto Protocol that is particularly favoured by developing countries. The UNFCCC-run mechanism provides a basis for developed-country investors to launch energy-efficient projects in developing countries, in the process earning pollution credits in the form of 'certified emission reductions' (CERs). Three types of 'Clean Development' projects'[9] are available: stand-alone, bundled, and programmatic (Hinostroza *et al.*, 2007).

The Clean Development Mechanism is particularly efficient because reductions take place where they can be made most cheaply, and it also offers developing countries an incentive to address their own environmental problems. Asian countries currently account for more that 75 per cent of the total certified emission reduction credits issued by the UNFCCC through the mechanism, with China and India among the more extensive issuers, accounting for more than 70 per cent together with the Republic of Korea.

Under the mechanism, a large majority (over 90 per cent) of the formal credits have been issued to supply-side energy reduction projects involving cleaner, large-scale power generation, a sector responsible for over 35 per cent of total fossil energy use. Demand-side reduction projects could include improved efficiency of public transport systems as well as manufacturing and agriculture, together with domestic heating and cooking. Since most of non-renewable energy consumption in cities is demand-driven, significant additional opportunities are available to use the Clean Development Mechanism to reduce greenhouse gas emissions in Asian cities.

Several papers from the OECD (Ellis, 2006; Ellis & Kamel, 2007; Ellis & Levina, 2005) suggest that the current interpretation and focus of 'programmatic' clean development mechanism projects may be constraining the potential of the initiative. Ellis (2006) suggests that consideration should be given to broadening the interpretation and scope of 'Clean Development' projects to include funding of public transport systems, as well as urban development and infrastructure projects which focus on reducing both the demand-side requirement for energy and greenhouse gas emissions. Such broadening could provide significant opportunities for Asian cities. Evidence shows that improvements to building and urban form, density and infrastructure, transport and urban logistics systems can lower greenhouse gas emissions (Droege, 2008). Authors like Hinostroza *et al.* (2007) suggest that it should be possible to expand the scope of 'programmatic' projects into this area.

# 5.5
# Towards improved environmental planning and management in Asian cities

Phnom Penh, Cambodia. ©Wdeon/Shutterstock

Asian cities are facing serious environmental problems which, if not addressed, will have serious local, regional and worldwide consequences. Clearly, if urban development in the Asia-Pacific region is to become more sustainable, governments and communities must give priority to actions in three major areas: (i) better urban planning and management of development, (ii) improved environmental management, and (iii) better environmental governance and compliance. These points are detailed below.

## 5.5.1 Better urban planning and management of development

Sustainable urban development in Asian cities will make more efficient use of urban resources through better spatial planning of development and improved logistics systems, and by paying greater attention to the mitigation of, and adaptation to, the effects of climate change.

### *Improved urban planning and development practices*

Urban development in Asian cities is increasingly driven by consumption, which in turn is highly dependent on the use of non-renewable resources. This pattern is unsustainable, as supplies of non-renewable resources are bound to dwindle in the future. In peri-urban areas, relatively low-density residential development is accompanied by broad-acre industrial estates (ADB, 2008). In city centres, high-rise commercial, retail and residential structures are replacing old urban fabrics, with the loss of heritage buildings and marginalization of lower-income families and communities. The poor are forced to the edges of cities by a combination of rising rents and decentralization of employment. This pattern of urban development will increase the unit/per head costs of transportation, infrastructure and communal and other public services, resulting in increased demand for energy.

To address such problems, local and national governments should give more attention to stabilizing urban demographic densities, ensuring mixed-use development with balanced localized employment, developing integrated transportation systems, and enforcing those environmental and planning regulations and laws that support sustainable development.

### *Institutional capacity for urban environmental planning and management*

Better planning and capacity-building for the purposes of improved urban environments and climate change mitigation and adaptation will be essential in all cities across Asia and the Pacific. Making developing-country cities more sustainable is a daunting technical, economic and political challenge at all levels of government and decision-making. Local authorities and the various stakeholders need improved institutional capacities for urban environment planning and management if the goal of sustainable urban development is to be reached. Under the joint UN-HABITAT – UNEP Sustainable Cities Programme, technical support has been provided to more than 60 cities in the Asia-Pacific region (see Box 5.11). With effective technology transfers, developing countries can take advantage of the scientific advances achieved by those more developed. Prosperity puts Asian cities collectively in a better position to fund sustainable development once donor support is terminated (Staniskis, 2005). Apart from technology and funding, a vital component in this effort is none other than political will, in order to mobilise the public as well as all tiers of government. In short, the transition to sustainability demands technical, economic and political commitment from all stakeholders.

### *Decentralized urbanization*

Unless better managed, high urban growth rates will continue to damage the environment in Asia's mega-cities. Therefore, decentralized urban expansion through development of secondary and tertiary cities is a major task for governments. Such a strategy will not solve the environmental problems

associated with urbanization; rather, it will draw activities away from mega-cities, alleviating the pressure those cities are under, and provide them with 'breathing space' to improve planning processes and urban services. Gurgaon in the Delhi National Capital Region, and Cyber Jaya to the south of Kuala Lumpur, are examples of successful decentralization within a large metropolitan region. Sprawling, poorly planned cities come with large ecological footprints, generate large quantities of waste and pollution, and have a significant impact on rural hinterlands and coastlines. Decentralization will require improved urban management, especially with regard to spatial planning.

***Congestion and logistics management***

Asian cities are among the most congested in the world, undermining business competitiveness and making major contributions to environmental problems, including greenhouse gas emissions.

Adequate public transport is critical to the operational efficiency of Asian cities. Most of these need mass-transit systems but rising personal wealth and lack of efficient urban transportation have combined to increase the proportion of the population now using private cars. Nevertheless, cities such as Beijing, Shanghai, Singapore, Tokyo and Hong Kong, China, have begun to develop public transportation and logistics systems that will serve them well in the future. Many Asian countries are trying to discourage the public from using private vehicles and instead to develop public-private partnerships for mass transit. Many successful examples can be found across the region, including Jakarta's mass rapid bus project and the Singapore congestion charge.

***Improvements to environmental health***

Asian-Pacific cities must combine technical, political and economic initiatives in order to control air pollution and manage hazards and vulnerabilities. Air pollution is one of the easiest types of pollution for cities to address, because the costs can be distributed across the population and businesses through carbon and other taxes on fossil fuels at source. This is not the case with water or solid waste pollution, where taxing and policing become more difficult. Technology can certainly help control motor vehicle carbon dioxide emissions, but this must be supplemented with government action in favour of better public transportation and incentive policies, for instance. Detailed assessment of public policies is essential to ensure that the urban poor are not unduly affected. Urban managers and planners must be fully informed about local air quality and engage actively with local populations to address the problems. Effective air monitoring and modelling systems should be put in place. Problem-solving calls for coordination between all tiers of government and communities.

In view of the above-mentioned lack of accurate figures regarding individual cities, more information on and research into the health effects of indoor and outdoor air pollution in Asian-Pacific cities is badly needed. Ambient concentrations of pollutants could be assessed, as well as the characteristics and main sources of urban air pollution, and the size and distribution of particulate emissions.

Securing the funds needed for air pollution control schemes (for instance, eradication of two-stroke engines, introducing cleaner fuels for domestic cooking and heating and for public and goods transport as well as industry) remains a major challenge for cities in the region. It is important for Asian-Pacific cities to take advantage of economic growth to provide the resources required for urban air pollution control.

***Eco-efficient infrastructure and industrial production***

Eco-efficiency is the major prerequisite for more sustainable urban development and improved quality of life in Asian-Pacific cities, and therefore must be brought to bear on buildings, infrastructure and industrial production systems. Few cities or industries in the Asia-Pacific region actively recycle water or waste materials, or work in favour of more efficient power generation, distribution and use. The case studies of Rizhao (Box 5.9) and Kitakyushu (Box 5.12) show how two Asian cities are adopting more eco-efficient infrastructure and industrial production systems. Industrial ecology offers a way of turning wastes and energy losses into commercial use, or, in other words, great opportunities to make industrial production systems more sustainable in Asia (Chiu & Yong, 2004).

## 5.5.2 Improvements to environmental management

Environmental management is concerned with more efficient use of natural resources and handling of any related waste.

***Adopting an integrated '3R' approach to waste management***

As its name suggests, the 'reduce, re-use and recycle' (3R) approach handles urban solid waste in an integrated way. Solid waste can be considered as a resource – what is waste to some people is a valuable resource to others, and a considerable proportion of the waste generated in cities can be used for other purposes. The 3R approach provides economic and environmental benefits as it reduces (i) the amounts of waste dumped in landfills, (ii) reliance on virgin materials, and (iii) pollution, while also saving energy (Visvanathan & Norbu, 2006). Prompted by its own solid waste management problems, the Government of Japan is spearheading the implementation of 3R in Asia (GoJ, 2005). The Government of China has adopted the concept of a 'circular economy' and sees the 3R approach as one of its essential components (Guomei, 2006).

The 3R approach in general features a number of issues that must be overcome. First, recycling in practice is market-driven and underestimates environmental externalities. For instance, plastic shopping bags are generally not recycled because they are so cheap to produce from virgin material – but then their environmental costs are often much higher than their market prices (they are not bio-degradable).

The 3R approach involves other practical issues. On the one hand, environmental externalities should be internalized, where possible, into market prices to reduce consumption and encourage substitute products. On the other hand, 3R

## BOX 5.11: **THE 'SUSTAINABLE CITIES PROGRAMME', 20-PLUS YEARS ON**

Chennai, India. **©Jaimaa/Shutterstock**

Even before the landmark 1992 'Earth Summit' in Rio de Janeiro, UN-HABITAT (UNCHS) and the UN Environment Programme (UNEP) had undertaken to help urban authorities across the world to reconcile economic development and environmental preservation as advocated by the UN-sponsored World Commission on Environment and Development. The joint effort launched in 1988 took the form of the Sustainable Cities Programme (SCP), now in its fourth stage in 66 Asian cities.

The basic rationale was that sustainable cities are more productive engines of growth, and therefore degradation of the urban environment must be tackled through a proactive approach that addresses the complex interactions between development and the environment (UNCHS & UNEP, 1998a). More specifically, cities (including the public, private and community sectors) must build the capacities and strengthen the institutions needed to deploy the well-balanced environmental planning and management approaches that can meet local development challenges while implementing global environmental agreements and conventions. Chennai, India, was the designated pilot city in the Asia-Pacific region.

The Programme helps stakeholders to place environmental concerns at the forefront of urban development decision-making through a gradual, cross-sector, participatory Environmental Planning and Management (EPM) process. Stakeholders are brought together in order better to understand the complex urban development and environmental interactions, discuss strategies and seek solutions to priority issues of common concern, in the process improving urban management methods, partnerships and capacities. To support these efforts, the Programme looks to build a stakeholders' coalition at national level in order to mainstream environmental concerns into urban development policies and relevant legislation. Further support is provided by region-wide sharing of information and technical cooperation between cities through networks and regional conferences. The Programme benefits from the worldwide expertise of the two UN agencies with regard to best practice, awareness-raising, capacity-building, policy development and local-national-regional replication.

The end result is a well-proven cross-sector and participatory Environmental Planning and Management process that addresses priority environmental issues in a city with a focus on "action" and results. Capacity-building aims at strengthening four core areas: (i) environmental information and technical expertise, (ii) broad-based stakeholder participation, (iii) environmental planning and decision making, and (iv) cross-sector and inter-institutional coordination (UNCHS & UNEP, 1998b).

The initial phase (1988-1995) of the Programme focused on integrating environmental concerns into urban decision making. Participating cities learned how to prepare their own environmental profiles, and to elicit broad-based stakeholder participation through consultations and issue-specific working groups in order to develop strategies and test them through demonstration projects to be documented with the aim of influencing national policies.

Having identified local needs and implemented pilot projects, participating cities (by then more than 15 in the Asia-Pacific region) deployed 'sustainability' strategies on a broader, "citywide" scale between 1995 and the year 2000 (2nd phase). For instance, cities in India, the Philippines and Sri Lanka introduced household composting and neighbourhood recycling centres as well as biogas for market waste in a bid to reduce costs and pollution. In China, Shenyang and Wuhan addressed pressing environmental concerns such us air pollution, river water quality and solid waste management.

This citywide upscaling was supported by Programme staff with the development of three new 'global' instruments: one on air quality management, an "Environmental Management Information System" and another one aimed at "integrating gender responsiveness in environmental planning and management."

By the year 2000, the Programme had matured and it was time to establish a sustained response structure, especially as by then the Millennium Development Goals were coming on top of Agenda 21 and Habitat Agenda principles and objectives. The regional arm of SCP became the Asian-Pacific Regional Environmental Support Programme, with UN-HABITAT, through its regional office in Fukuoka, Japan providing capacity-building and institutional strengthening support to some 66 demonstration cities and their national partners in 10 countries. This 3rd phase was characterized by extensive efforts to build a region-wide capacity-building support structure through partnerships with regional and national universities and local government training institutions, making use of their specialised expertise and mainstreaming SCP lessons learned into curricula. Further efforts focused on improved national-regional up-scaling and replication capacities through professional networking, expert group meetings, websites and publications.

Since 2008, the Sustainable Cities Programme has been supporting participants' efforts to 'localize the global agenda', i.e., to implement a number of international agreements and conventions on the environment (global warming, land-based pollution, urban biodiversity and ecological management). This makes it easier for urban authorities to asses and prioritize local environmental concerns and to have a voice in national and global environmental negotiations.

The Asian-Pacific arm of the Programme has reviewed its own country-support operations, listing the 'Factors of Success' from more than 10 years' experience. The objective is to put cities in the region in a better position to address climate change, with support from UN-HABITAT's global Sustainable Urban Development Network (SUD-Net) and its "Cities in Climate Change Initiative" (see Boxes 5.5 and 5.8).

*Source: Chris Radford and Angela Pinzon, UN-HABITAT*

implementation sometimes relies on strong government intervention. For example, in 2008, the Government of China banned the provision by vendors of free plastic shopping bags to customers in an effort to reduce 'white pollution' (*China Daily*, 2008; *National Geographic*, 2008). In support of 3R policies, environment-friendly products should be promoted through subsidies or awards.

Second, public awareness of local recycling schemes and waste issues is, in general, still low (Scott, 1999). Environmental education is needed if this is to change. Enforcement of and compliance with recycling obligations should be strengthened.

Third, lack of financial resources is another obvious constraint on the 3R approach. Unlike developed countries, most 3R activities in the Asia-Pacific region involve a more or less informal sector of waste-pickers – either employees or scavengers – whose work methods are labour-intensive and unsafe. This informal workforce plays a significant role in the recycling of up to 30 per cent of the waste generated in Asian-Pacific cities (Visvanathan & Norbu, 2006).

***Water management***

Water faces Asian-Pacific cities with three major challenges: (i) halting the depletion of available water resources; (ii) reversing the degradation of water quality; and (iii) the reticulation and treatment of wastewater. Cities in the region are rapidly running out of potable water to service expanding populations. For the many cities located along rivers, one's wastewater becomes another's water supply problem. Heavy metals and other industrial pollution, together with water-borne diseases from urban wastewater discharge, remain major health problems. Increasing contamination of surface and groundwater systems is leading Asian-Pacific cities towards mounting water crises. Moreover, disputes over access to water are festering within and among countries. Improving water management, and especially recycling, must become a high priority for Asian-Pacific urban authorities.

***Improving air quality***

Air pollution, primarily from fossil fuel combustion, is having a major impact on the health of Asia-Pacific's urban populations. This not only affects public health and well-being, but also reduces productivity and performance through sickness and infirmity, not to mention the social problems deriving from cancer and respiratory diseases. Reducing the demand for fossil fuel-based energy is a challenge for all Asian-Pacific cities. Dhaka and Delhi (see Box 5.7) have demonstrated how cities can develop non-polluting, efficient public transport systems and introduce cleaner vehicle fuels (Singh & Pannu, 2005; Narain & Krupnick, 2007).

***Solid waste management***

Most waterways and river systems in the Asia-Pacific region are heavily polluted by the dumping of urban domestic and industrial solid waste. Groundwater aquifers in low-lying cities are also becoming increasingly contaminated with domestic and industrial waste, heavy metals and other industrial pollutants.

Most solid waste in Asian-Pacific cities is disposed of locally, leading to soil contamination and the spread of disease in overcrowded urban areas. One of the challenges for governments is to improve solid and hazardous waste management and to promote opportunities for recycling and the reprocessing of waste into commercial and other usable products.

### 5.5.3 Better environmental governance and compliance

***Good governance***

Continued urban governance reforms are in order if Asian cities are to address the mounting environmental problems facing them. Local authorities lack some of the resources and powers required for environmental management plans and law enforcement. Legislation on decentralized environmental management has failed clearly to apportion distinct powers and responsibilities to national and sub-national tiers of government, leading to ineffective environmental governance.

In many Asian-Pacific cities, one of the most challenging dimensions of urban governance is industry compliance with standards and policy guidelines. To many governments, economic growth for the sake of development and poverty alleviation must be the first priority. Compliance with environmental regulations and norms is often overlooked or open to corrupt practices.

A conference on environmental law in Asia (Bangkok, January 2008) found that only a few countries and cities were enforcing national environmental laws (Casey, 2008). As a result, widespread passive corporate attitudes to pollution have little incentives to change. One of the most effective ways of enforcing environmental regulations is to delegate responsibilities and power to local governments and in particular to their environmental protection agencies. Environmental compliance strategies must be considered in their specific circumstances and take into account governments' enforcement capacities.

***Environmental education***

Short of improved environmental stewardship, the quality of life of many urban residents can only decline (Richman, 1994). Building environmental awareness is a priority for any urban climate change mitigation strategy (Gokhale, 2001).

Awareness of the local environment and its problems must feature as one of the main planks of environmental and development agendas. The rationale is a triple one: (i) increasing knowledge about the biophysical environment and its problems; (ii) enhancing awareness of any strategies dealing with those problems; and (iii) securing practical engagement in favour of a resolution of those problems (Stapp *et al.*, 1969), cited in (Fisman, 2005:39).

In the Asia-Pacific region, environmental education is embedded in all forms of tuition (including social and physical sciences at higher education level) and many examples of environmental innovation and eco-businesses can be found (Bhandari & Abe, 2000). Nevertheless, such efforts do not seem to have led to significant society-wide changes in environmental behaviour. In this respect, four major issues must be addressed, as follows:

## BOX 5.12: FROM HEAVY INDUSTRY TO ECO-TOWN: GOOD PRACTICE FROM KITAKYUSHU, JAPAN

Kitakyushu is a city on the Japanese island of Kyushu with a population of about one million. The city is famous for its ground-breaking introduction of air pollution standards in the mid-1960s, and more recently for building an environmental model city, the lessons from which are now shared with 60 other cities in the world. Being home to coal-burning heavy industries such as steel, cement, chemicals and coke up to the 1960s, Kitakyushu suffered from large volumes of air-borne soot and dust. In 1965, for example, one of the city's districts experienced the worst dust fall ever recorded in Japan (Bai, 2003). The phenomenon abated when local industries switched from coal to heavy oil, which instead caused high concentrations of sulphur dioxide in the atmosphere. These in turn abated in the latter half of the 1970s after the industries changed from high- to low-sulphur oil and to natural gas. Today, the quality of air in Kitakyushu is so high that the city features on the United Nations' 'Global 500 Laureate Roll of Honour' which recognizes the environmental achievements of individuals and organisations around the world.

There is much more to Kitakyushu's success than its transition from one kind of industrial fuel to another. The transformation process is all the more remarkable as it was triggered by grassroots movements united behind the slogan "We want our blue sky back!" These groups conducted their own surveys and confronted local authorities and industries with the results. Public authorities responded with a series of measures, including a local voluntary agreement with industrialists, stricter regulations on emissions and enhanced monitoring capacity, which were complemented by a participatory air pollution control liaison conference that brought all stakeholders together. Local industries complied with the agreement even before the national government set out an air pollution prevention law.

Kitakyushu was also one of the first cities in Japan to adopt the 'eco-town' concept. In the early 1990s, the city's reclaimed bay area became host to a comprehensive eco-town project with three major functional goals: (i) encouraging the growth of environment-friendly industries; (ii) promoting research into and development of environmentally sound technologies; and (iii) becoming a centre for environmental information, training and education. The eco-town project is expected to contribute to the city's goal of "zero emissions" through industrial symbiosis.

Kitakyushu's overcoming of air pollution and recent endeavour to create a more sustainable city has set an example for many other conurbations experiencing similar environmental problems and provides much for others to draw on. In 2000, the United Nations Economic and Social Commission for Asia and the Pacific adopted a 'Kitakyushu Initiative for a Clean Environment', which involves exchange of best practices, experiences and lessons learnt as well as information on demonstration projects, together with developing models for innovative policies and programmes, and collaborative mechanisms among cities. Today, the network brings together 60 cities in 18 Asian countries, enabling them to discuss a variety of topics including water treatment, water-use efficiency, waste management and energy audits for office buildings.

*Source: Van Berkel et al. (2009)*

1. Environmental education should be recognized as a policy priority for the sake of more effective sustainability. In coordination with non-governmental organisations, government agencies should promote environmental education, with relevant issues and solutions added to formal and non-formal curriculums and programmes.

2. Poverty and demographic factors shape the outcome of environmental education programmes, if in an underhand sort of way. Therefore, any educational programmes should acknowledge the interests and incentives of the various socio-economic segments of society.

3. Greater gender equity is important to the management of environmental assets. Women play the main role in shaping household behaviour related to hygiene, energy consumption and waste disposal (Schaefer-Preuss, 2008). The need for greater gender equity relates especially to land rights and ownership, which are often denied to women under traditional (including inheritance) systems. Consequently, any environmental education programmes should be accessible to women.

4. Being aimed at an audience with a variety of perspectives, backgrounds, politics and cultures, environmental education programmes should be participatory, practical, and capable of dealing with complexity. If it is to be successful, "environmental education needs to vary from region to region and be realized in different ways" (Barraza *et al.*, 2003:349).

### 5.5.4 Environmental issues call for more regional responses

By their very nature and scope, environmental issues, including climate change, are complex and varied, involving multiple spatial scales from local to global (UN-HABITAT, 2010b). This is why the measures described above cannot be met by national governments or urban authorities acting independently. Cities can certainly begin to improve their own environments; however, issues such as climate change, cross-border pollution (air, waterways, and relocation of industries) and the containment of disease and epidemics call for new, broader forms of governance, management mechanisms and technical and financial responses among many stakeholders.

Clearly, environmental improvements in Asian-Pacific cities will require greatly increased regional cooperation, collaboration and commitment. This calls for close coordination of environmental policies, standards and practices to a degree that is unprecedented in the region. Changes to customs, traditions and governance practices that date back hundreds of years are also in order. Changing attitudes and practices to improve the environment in Asian-Pacific cities may prove to be the greatest challenge of all for governments and populations alike. Environmental education, greater openness and trust-building are the foundations of success in this regard.

# 5.6
# Urban Asia and the environment: Diagnosis and policies

As far as Asia is concerned, the prognosis for many cities is that environmental conditions are to worsen for some time to come. However, improvements can be expected once better urban environmental planning and management practices are adopted and the economic benefits of growth become more widespread.

Cities have the potential to influence both the causes and consequences of climate change. They can also contribute to national and international strategies to prevent unacceptable climate change impacts. It is for cities to provide leadership and direction and implement practical initiatives for the benefit of their and national populations (UN-HABITAT, n.d.a).

A particularly difficult issue will be dealing with climate change-refugees inside and across borders. This will be a very significant problem in Bangladesh, China, India and the Pacific island-states. At the same time, governments must also address poverty and the issues of food and water security, and create sustainable economic development opportunities. Most Asian cities and governments face a difficult balancing act in this regard.

The age-old, inefficient physical and economic infrastructure that is underpinning the rapid expansion of Asian-Pacific cities is likely to remain in place for the next 50 to 100 years. Instead of overturning it overnight, the priority is to adjust it in order to make transport, industrial and energy production systems more sustainable. This is likely to be an incremental process, although rapid change will be necessary in some cases to address more serious environmental problems. The sheer number and sizes of Asian-Pacific cities and the resources needed to service them pose great challenges to sustainable-minded governments and urban managers. Few cities in Asia have the massive resources required to reinvent themselves. They lack the capacity to inject the vast amounts of capital that could radically transform development, production and consumption practices.

However, the business-as-usual approach to development and environmental management is no longer an option. The way Asian-Pacific countries handle urban development and management in the future must change if further environmental deterioration is to be avoided. In order to remain competitive, viable, healthy and liveable places, Asian-Pacific cities must embark upon more sustainable development pathways. Working towards 'green growth', Asian-Pacific economies should make efforts to improve eco-efficiency of their economic growth, which will help in meeting "the most important challenge to sustainable development in this region reducing the pressure on the natural resource base while continuing to meet human needs" (ESCAP, 2008a:8).

We should not, however, be apocalyptic or overly pessimistic about the future of Asian-Pacific cities. Undoubtedly, they face massive problems of congestion, pollution, inadequate infrastructure, weak governance and poverty. But they are also very dynamic and vibrant places that have demonstrated remarkable resilience and the capacity to recover from past catastrophes. As noted in Chapter 3, this was especially the case in the aftermath of the 1997-98 Asian financial crisis.

Nevertheless, given the unprecedented scale and pace of urbanization, it is clear that fresh approaches must shape the way Asian-Pacific cities are planned, managed and governed. Urgent action is required from all tiers of government to address pressing matters related to climate change – both mitigation and adaptation, and with a special focus on water security, wastewater and solid waste. These requirements are such that cooperation among countries, public authorities, business and communities will be required on a scale never seen before in the region. Admittedly, differences in language, politics, culture, history and the extent of economic development will stand in the way of such cooperation, but they must be overcome if Asian-Pacific cities are to become more sustainable and better places to live.

## ENDNOTES

[1] The prefix 'eco' designates a fully sustainable town or city, i.e., one that can feed itself with minimal reliance on the surrounding countryside, and power itself with renewable sources of energy. An eco-city/town has the smallest possible ecological footprint and produces the lowest possible amounts of pollution, thanks to efficient land use, composting/recycling/conversion of used materials, etc.

[2] The ecological footprint is a measure of human demand on the Earth's ecosystems. It compares human demand with planet Earth's ecological capacity to regenerate. The 'footprint' represents the amount of biologically productive land and sea area that are needed (i) to regenerate the resources a human population consumes and (ii) to absorb and render harmless the corresponding waste. This measurement makes it possible to estimate how much of the Earth (or how many planets Earth) it would take to support humankind if everyone lived the same lifestyle.

[3] Urban form or 'morphology' refers to the physical fabric and street-patterns of a city, and the people and processes that shape these patterns.

[4] Eutrophication is a process where water bodies receive overabundant amounts of nutrients (e.g., phosphorus, nitrogen) that stimulate excessive plant growth and cause water degradation.

[5] An urban heat island is a conurbation with significantly higher temperatures than surrounding rural areas. The phenomenon is caused by the changes brought to the land surface by urban development which uses materials that effectively retain heat. Spatial urban expansion increases the effect.

[6] Gordon McGranahan 2010 (November), personal communication.

[7] Articulated buses have been operating in some major Western cities for some time. Recent experience led London's mayor in late 2008 to pronounce the phasing-out of 'bendy' buses after only five years. According to figures from *Transport for London,* articulated buses (18m in length) cause 5.6 pedestrian injuries per million miles operated, compared with 0.97 per million for all other buses, are involved in 2.62 collisions with cyclists per million miles, compared with 0.97 for other buses, and have 153 accidents per million miles, compared with 87 per million on routes operated by standard buses. 'Bendy' buses are also more prone to fare evasion. (Source: 'Johnson ditches London's bendy buses', *The Independent,* London, 6 December 2008). http://www.independent.co.uk/news/uk/home-news/johnson-ditches-londons-bendy-buses-1054433.html (accessed 22 August 2010)

[8] 'Ecosystem' is a term formalised and popularised by the United Nations 2004 Millennium Ecosystem Assessment, which refers to the wide variety of resources and processes that are supplied by natural ecosystems and notionally benefit all humankind (e.g., clean drinking water or waste decomposition). According to the UN, ecosystems fall into four broad categories: *provisioning,* such as the production of food and water; *regulating,* such as the control of climate and disease; *supporting,* such as nutrient cycles and crop pollination; and *cultural,* such as spiritual and recreational benefits.

[9] *See Glossary of CDM Terms,* UNFCCC website: http://cdm.unfccc.int/Reference/Guidclarif/glos_CDM.pdf

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