CHAPTER 2:
Environmental sustainability under threat

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The robust display of economic strength in Asia and the Pacific belies the stark reality that economic growth has been achieved at a very high cost to the environment. The pressures exerted on the region’s ecosystems and natural resources have been tremendous and continue to mount as the drive for growth intensifies. The decline in environmental sustainability is the result of unsustainable patterns of production and consumption linked to four major trends: the growth of pollution and resource-intensive industry; the intensification of agriculture; urbanization and globalizing consumption patterns; and a heightening demand for raw materials, energy and water. While, in general, governments have strengthened legislation and institutions, resulting in significantly improved environmental performance, particularly with respect to pollution control, the rising environmental pressures exerted by expanded consumption and production and resource-extraction processes threaten to overwhelm the progress achieved so far. High future environmental, economic and social infrastructure costs, a growing tendency to generate waste and the continuing decline of the region’s natural capital are the unmistakable signs of an unsustainable growth pattern.

The continuing focus on improving environmental performance distracts attention from the critical need to improve the environmental sustainability of economic growth patterns. Without doubt, economic growth is a prerequisite for achieving significant reductions in poverty and addressing key sustainable development issues. However, declining environmental sustainability represents a critical political, institutional, social and economic threat for many countries in the region. Despite the overall negative picture, there are many bright spots across the region. Several governments have taken significant steps to improve the environmental sustainability of their growth patterns, and many stakeholders are taking individual initiatives which need to be supported further and mainstreamed into public policy, economic development planning and infrastructure development.
2.1 Sustainable development: focusing on sustainability

Thirteen years after Rio: the dominance of the economic dimension

Since the 1992 Rio Summit, Asian and Pacific countries have embarked on numerous initiatives aimed at translating the principles of sustainable development into tangible outcomes. Achievements have been mixed, dictated by economic status, institutional capacity and political leadership, among other factors. New legislation that applies market-based instruments, stronger environmental regulation enforcement and other improvements in environmental governance are just some of the major breakthroughs observed.

However, a major precept of sustainable development, i.e. integration of environmental objectives in strategic, long-term and day-to-day decision-making, has yet to be achieved. Developing countries are not averse to pursuing structural and policy reforms in theory; but in reality, a long-term planning perspective is needed to make the shift to a sustainable development paradigm. The high degree of political and economic risk that this entails, means that a short- and medium-term decision-making time frames tend to predominate.

Emphasis is thus placed on economic growth and advancing social progress rather than on environmental protection, a prioritization that is perhaps justified given the high levels of poverty that still exist in the region. Theoretically, economic growth is required to make resources available that can be used to reverse environmental degradation and improve environmental quality in the long term. However, even in the best-performing economies in the region, consistently high rates of economic growth and relative affluence have not resulted in lasting improvements in environmental sustainability.

Why improvements in environmental performance are not enough

Mounting environmental pressures in the Asian and Pacific region are the result of unsustainable patterns of production and consumption reflected in four major trends: resource-intensive and polluting industrialization; the intensification of agriculture; urbanization and changing consumption patterns; and a heightening demand for raw materials, energy and water. While, in general, governments have strengthened legislation and institutions to improve their environmental performance, particularly with respect to pollution control, rising environmental pressures due to expanded consumption and production activities and resource-extraction processes threaten to overwhelm the progress achieved so far.

The premise that sustainable development can be achieved by improving environmental performance may be creating a false sense of security and is distracting attention from the critical need to improve the environmental sustainability of economic growth patterns. While the concepts of environmental sustainability and environmental performance are closely linked, there are significant differences.

Action to improve environmental sustainability explicitly seeks to maintain environmental pressures within environmental carrying capacity and refers to the capacity of economic growth and social change processes to ensure that natural resources are not depleted faster than they can be regenerated, and that ecological systems remain viable. For economic growth to be environmentally sustainable, the demand for ecological products and services should not exceed the ecological products and services that can be provided sustainably in a particular area. An ‘overshoot’ reduces the ability of the natural environment to provide ecological goods and services to support human activity in the long term.

An affluent country can be expected to attain specific environmental targets and alleviate specific sources of environmental pressure (for example relating to air pollution control) in the short term. However, where there is a high population density, growing environmental pressure due to changing consumption patterns and an environmental influence that extends beyond any country’s borders, mean that these measures are only likely to be effective in the short to medium term, i.e. that environmental sustainability is low. A less affluent
country with a lower population density and larger endowment of natural resources is likely to exhibit lower levels of environmental performance, but still be inherently more environmentally sustainable. Therefore, high levels of environmental performance and low environmental sustainability (and vice versa) can characterize the same country and are not strictly linked at a given point in time.

Environmental sustainability is therefore determined, in large part, by the patterns of production and consumption, i.e. the way in which human needs are met. Pollution control efforts that do not go beyond end-of-pipe approaches (such as wastewater treatment), contribute little to reducing the long-term environmental impacts of the production processes which extend beyond the limits of the factory site. On the other hand, pollution control efforts which adopt life-cycle analysis to reduce pollution from the sourcing of raw materials, throughout the processing and manufacturing processes, and during the consumption and disposal of the manufactured goods, contribute both to a more environmentally sustainable production process and to better short-term environmental performance. Therefore, while action to improve environmental sustainability leads to improved environmental performance, the reverse is not necessarily true in the long term (see table 2.1).

The following subsections will explore these issues and identify the environmental impacts of unsustainable growth. The conclusion is that continued economic growth is imperative in light of the continuing and substantial need for poverty reduction. However, improving the environmental sustainability of Asian and Pacific economic growth patterns is becoming increasingly urgent.

2.2 Industrialization: pollution from export-led economic growth

The shift from a reliance on income from agricultural activity to a reliance on industrial and service-based activity is a tenet of economic growth theory. Several East-Asian economies have gone from being largely agriculture-based to relying heavily on income from

<table>
<thead>
<tr>
<th>Table 2.1 Environmental performance vis-à-vis environmental sustainability</th>
</tr>
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<tbody>
<tr>
<td><strong>Environmental performance approaches</strong></td>
</tr>
<tr>
<td><strong>Planning and policy perspectives</strong></td>
</tr>
<tr>
<td><strong>Intervention in systems that impact on the natural environment</strong></td>
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<td><strong>Scope of responsibility</strong></td>
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<td><strong>Measures and indicators</strong></td>
</tr>
</tbody>
</table>
industrialization in just one to two decades. In at least 30 Asian and Pacific countries, more than 20 per cent of the total GDP is earned by industrial activity. Despite the rapid growth of the services sector in almost all countries, export-led industrialization remains a defining feature of the Asian and Pacific region’s economic development, particularly in its developing countries.

Industrialization is a double-edged sword. It increases employment, prosperity and the opportunity to invest in a better future; at the same time, it generates pollution, intensifies competition for the use of natural resources and changes lifestyles and consumption patterns. Patterns of industrialization are therefore major determinants of environmental sustainability.

The environmental impacts of industrial production depend on three factors: the scale of industrial activity; the types of industries making up the industrial sector (for example, whether they are more or less energy-, pollution- or water-intensive); and the eco-efficiencies of individual companies. This section explores all three aspects of regional industrial production.

2.2.1 Increasing pollution and toxicity-intensive industrial production

Figure 2.1 compares industrial production growth in the world, in the ESCAP region overall, and in ESCAP developing countries. In overall industrial production, manufacturing and mining, the economies of Asian and Pacific developing countries are racing ahead. In 1990, these countries accounted for only 8 per cent of global manufacturing value added. They now account for almost 18 per cent of global manufacturing value added, and over 70 per cent of global developing country manufacturing value added. This is the result of an almost 70 per cent increase in manufacturing value added in less than 10 years, from 1995 to 2003. The manufacturing sector’s share of value added in the GDP of Asian and Pacific countries (excluding Japan, Australia and New Zealand) is estimated to have grown from 23 per cent in 1990 to almost 29 per cent in 2003.

Since 1995, the fastest-growing manufacturing activities in Asia and the Pacific overall have included the production of food and beverages (beer, fresh pork, cigarettes and refined sugar); office, computing, radio, television and other electrical equipment; cement; crude steel and ingots; and textiles (cotton yarn). From 1995 to 2001, production in these sectors expanded in a range of between 20 and 45 per cent.

**Figure 2.1 Industrial production indices**

<table>
<thead>
<tr>
<th>INDUSTRIAL PRODUCTION</th>
<th>INDEX (1995=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World</strong></td>
<td>120</td>
</tr>
<tr>
<td><strong>ESCAP countries</strong></td>
<td>113</td>
</tr>
<tr>
<td><strong>Developing ESCAP countries</strong></td>
<td>110</td>
</tr>
</tbody>
</table>

However, taking a closer look at the developing countries in the region, industrial production growth is concentrated in slightly different sectors. Office, computing, radio, television and other electrical equipment, crude steel and ingots, transport equipment, chemicals, petroleum, rubber and plastic products and cement take prominence as the fastest-growing areas of production. In addition to these sectors, the production of basic metals, fabricated metals, non-metallic mineral products and food is growing much faster in developing countries than developed, signaling a concentration of production in these subsectors in developing countries (Figure 2.2).

While a significant proportion of manufactured goods are exported, most of the pollution load associated with their production stays within the producing country. Among the industries with high rates of growth in developing countries in the region between 1995 and 2001 were those which, in the absence of stringent environmental regulations and high levels of company environmental performance, are likely to have been relatively pollution-intensive, including metals, chemicals (including fertilizers), petroleum, rubber and plastic products, as well as the food and beverages industries.

Several studies have found that a growing proportion of global pollution was attributable to Asian developing countries during the 1970s and 1980s. The growth in regional industrial activity has, logically, increased pollution loads. In one study, the World Bank shows that the quantity of heavy metals accumulating per year in Indonesia increased by a factor of almost 10, with similar increases in the Philippines and Thailand and far exceeding the rate of growth in GDP from 1978 to the late 1980s. The increases in other pollutants (organic water pollution, suspended solids, SO\textsubscript{x}, particulates and toxic chemicals) varied from two to more than eleven-fold. These increases are indicative of the scale of pollution loading that is likely to have taken place from the early 1990s to the present, years which were marked by a rapid increase in industrial activity supported by FDI infusions.

In terms of the toxic content of pollution loads, the World Bank shows in another study that the toxicity intensity or unit volume of toxic releases per unit of output value increased in 11 Asian countries during the 1970s and 1980s; the fastest increases in toxicity intensity were estimated to have occurred in Indonesia, Pakistan and Malaysia. Looking again at the increase in production of each of the sectors shown in figure 2.2, and comparing it with the subsectoral toxicity indices produced by the World Bank in the early 1990s (Figure 2.3), it may be concluded that the toxicity of Asian and the Pacific production is continuing to increase, along with the tendency to pollute. Production in highly toxicity-intensive sectors (such as the chemicals sector) is expanding rapidly. Other
toxicity-intensive industries growing rapidly in Asian and Pacific developing countries are those of crude steel and ingot production, transport equipment, petroleum, rubber and plastic basic metals and fabricated metal products.

Facilities for the safe disposal, recycling or recovery of toxic or hazardous waste are not widely available in Asian and Pacific developing countries. Table 2.2 shows the trends in hazardous waste production in Japan, the Republic of Korea and the Russian Federation. These figures include, in addition to hazardous waste from industrial production, other categories of waste including biomedical waste and domestic hazardous waste, such as batteries. China reportedly produces some 10 million metric tons of hazardous waste, including 115,300 metric tons of radioactive waste, per year. However, less than 25 per cent of this total is disposed of (mostly by landfill or burning), while one third is stored in makeshift storage areas. The role played by small waste processors which are ill-equipped to deal with such wastes exacerbates the problem. China mandated the licensing of businesses engaged in the collection and processing of hazardous wastes in July 2004.6

Export-processing zones and industrial parks in the region have been a source of concentrated pollution emissions. While the availability of water, energy and pollution treatment and waste-management infrastructure is one reason why companies choose to locate to these centres, pollution treatment and waste-management services are not always fully operational. In one country, a survey of industrial parks showed that few had invested in wastewater treatment facilities. In other cases, industrial parks are known to operate pollution control equipment only when inspectors are due to arrive. Others operate without any provision for hazardous waste management, and in at least one industrial park waste-treatment facilities were not utilized by resident companies because charges for their use were viewed as being unfairly applied.

In countries in which there is limited capacity for proper treatment and disposal, regulations that prohibit hazardous waste disposal and trade can foster the illegal hazardous waste trade. Reports of illegally traded hazardous industrial waste have surfaced. E-waste is one category of waste described

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Table 2.2 Hazardous waste production (thousand metric tons)

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<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>-</td>
<td>-</td>
<td>2,297</td>
<td>2,883</td>
<td>3,158</td>
<td>2,994</td>
<td>2,653</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>7,804</td>
<td>-</td>
<td>-</td>
<td>1,622</td>
<td>1,912</td>
<td>2,217</td>
<td>1,922</td>
<td>2,733</td>
<td>2,779</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>-</td>
<td>67,520</td>
<td>-</td>
<td>-</td>
<td>82,590</td>
<td>89,390</td>
<td>107,060</td>
<td>108,707</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2.3 Transboundary movements of hazardous and other wastes (2000; metric tons)

<table>
<thead>
<tr>
<th></th>
<th>Imports</th>
<th>Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3 346.0</td>
<td>-</td>
</tr>
<tr>
<td>Japan</td>
<td>3 924.0</td>
<td>1 539.0</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>17 380.4</td>
<td>60.4</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>8 082.5</td>
<td>96 988.0</td>
</tr>
<tr>
<td>Georgia</td>
<td>935 632.0</td>
<td>273 409.0</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>152.0</td>
<td>930.0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>61 068.8</td>
<td>240.0</td>
</tr>
<tr>
<td>Malaysia</td>
<td>125 875.2</td>
<td>4 947.4</td>
</tr>
<tr>
<td>Singapore</td>
<td>-</td>
<td>19 548.5</td>
</tr>
<tr>
<td>Thailand</td>
<td>-</td>
<td>193.04</td>
</tr>
<tr>
<td>Turkey</td>
<td>-</td>
<td>888.0</td>
</tr>
<tr>
<td>Australia</td>
<td>302.2</td>
<td>24 918.3</td>
</tr>
<tr>
<td>New Zealand</td>
<td>11 100.0</td>
<td>1 465.7</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>-</td>
<td>2.89</td>
</tr>
</tbody>
</table>


Accelerated production by polluting subsectors, together with only marginal reductions in the pollution emitted per unit of GDP in most cases (see box 2.1), and a still-limited capacity to deal with the waste generated, indicate that a much more serious effort needs to be made to change industrial profiles and production patterns.

The prominent role of small- to medium-sized enterprises (SMEs) in the regional industrial production sector is a significant barrier to improving its environmental performance. Small industrial plants have been found to have much higher marginal pollution abatement costs than large plants; per unit of output, small plants pollute more than large plants. Small plants are less likely to invest in pollution-abatement technology or in environmental management expertise. However, as hazardous, and will be discussed in section 2.5. Substantial volumes of waste are traded legally (Table 2.3).

Changes in the pollution emitted per unit of GDP, or pollution intensity, are an indicator of the polluting impact of economic growth patterns. Pollution intensities focus attention on the composition of the industrial sector as well as on the environmental performance of firms in the industrial sector. High pollution intensities which have not improved significantly with time, are indicative of economies which are locked into industrialization patterns that are inherently polluting. One indicator of air pollution is total \( \text{SO}_2 \) emissions. Industrial processes which involve coal and oil combustion, petroleum refineries, cement manufacturing and metal processing facilities, as well as locomotives, large ships, and some non-road diesel combustion processes, are major sources of \( \text{SO}_2 \). This chemical is responsible for acid rain and impacts on respiratory health.

Over the period 1990-2000, most countries reduced the \( \text{SO}_2 \) intensity of their economies. Each unit of GDP earned resulted in the emission of lower amounts of \( \text{SO}_2 \) by the end of the 1990s (Figure 2.4). However, a far lower proportion of countries managed to reduce total emissions of \( \text{SO}_2 \) (Figure 2.5), even where there have been significant reductions in \( \text{SO}_2 \) intensities. For example, China, with a \( \text{SO}_2 \) intensity reduction of more than 20 per cent in 10 years, still increased its total emissions in the same time period. Some countries are producing more \( \text{SO}_2 \) per unit GDP than they were 10 years ago, such as Indonesia, Pakistan, Singapore, Sri Lanka and Thailand. While the industrial sectors of Azerbaijan and the Russian Federation contribute roughly the same proportion to overall GDP, the \( \text{SO}_2 \) produced by Azerbaijan for every unit of GDP is almost four times that of the Russian Federation. This is largely a reflection of the composition of the industrial sectors in the two countries, as well as of fuel quality, process differences and levels of technological advancement.

One water pollutant is organic water pollution, which is responsible for nuisance odours, fish kills and other radical ecosystem changes, particularly in standing water bodies. Industrial organic water pollution intensities declined in most countries (Figure 2.6) between 1990 and 2000, but industrial emissions of organic water pollution declined in far fewer countries during this period (Figure 2.7). The production patterns of China, India and Nepal have become much cleaner with respect to organic water pollution. Despite Cambodia’s dramatic reduction in industrial organic water pollution intensity, total organic water pollution discharges increased between 1990 and 2000 (Figure 2.6). Notable exceptions to the pattern of declining pollution intensities are Armenia, Mongolia and Kyrgyzstan, where industrial organic water pollution intensity has increased. The food processing industry is one of the most important sources of organic water pollution, but the production of pulp and paper, chemicals, textiles and primary metals is also an important source of this type of pollution.
Environmental sustainability under threat

Figure 2.4 Air pollution intensity, anthropogenic SO$_2$

Figure 2.5 Change in anthropogenic SO$_2$ emissions, 1990-2000

Figure 2.6 Industrial organic water pollution (BOD) intensity

Figure 2.7 Change in industrial organic water pollution (BOD) discharge, 1990-2000

large plants, because of their size, are likely to have greater impacts on health and other pollution statistics.7

The aggregate environmental impacts of small plants, particularly in clustered, highly polluting industries, have also been found to be substantial. One study of industrial pollution in Tiruppur, India, where over 7,000 small textile producing firms are located, estimates that the pollution load of total dissolved solids from 1980 to 2000 was 2.35 million metric tons; of chloride 1.31 million metric tons; of sulphate 0.12 million metric tons; of organic water pollution (COD) 0.09 million metric tons; and of oil and grease 1,000 metric tons. The accumulation of this pollution in and around Tiruppur has left the water unsuitable for domestic or irrigation purposes and resulted in economic losses estimated at the values shown in table 2.4.

Dealing with the pollution from industry requires targeted interventions within sectors. Figure 2.8 shows the relative subsectoral contributions to organic water pollution by country.
2.2.2 Resource use – energy, raw materials and minerals

Pollution loading and production of hazardous wastes are downstream impacts of the expanding Asian and Pacific industrial base; the upstream impact on resource use is also important to consider. Taking energy as one important resource, the subsectors most often identified as being energy-intensive are those of transport equipment, crude steel, chemicals, petroleum, rubber and plastic products, cement and non-ferrous metals, fabricated metal products and food and beverages. Again, many of these are among the fastest-growing in the region, and include sectors in which production is being concentrated in developing countries.

Higher global energy prices and pressures to reduce greenhouse gas emissions to meet implementation commitments of the Kyoto Protocol may promote the flight of energy-intensive industry to developing countries. Coupled with the (albeit declining) tendency of governments to subsidize energy supplies to industry as an investment incentive, growth in these industries is likely to represent a growing financial burden and to impact negatively on overall pollution loads.

Growth in energy demand is closely linked to the growth in demand for minerals, as mineral-related industry tends to be energy-intensive. The expanding demand for metals is being driven by the growth in the construction sector and metal-based production (e.g. electronic equipment, crude steel, transport equipment, basic metals and fabricated metal products) that has become concentrated in Asian and Pacific developing countries.

Water is another important input to industrial processes which is in short supply in some countries. Section 2.4 discusses how various industries impact on water resources. Two of the fastest-growing sectors of production – transportation equipment and food and beverages – have high water consumption rates. At the same time, while having a relatively low water consumption rate, the chemical industry requires higher flows of water throughout its processes. When this fact is considered along with the water pollution generated, the growth of the chemical industry regionally is likely to have an important impact on the sustainability of the water supply. It is not only a major source of water pollution, but also of increasing pressure on water resources.

The productivity of the use of such a valuable resource as water by the industrial sector varies widely by country. Paradoxically, the economic value added of industrial water use is the lowest in countries where water is already in short supply, such as Central Asia and the Caucasus, China and India, as discussed in section 2.4. In response to pricing or scarcity, significant improvements in the efficiency of water use have been achieved, notably in the pulp and paper and textile industries.

2.2.3 Promoting more environmentally-sustainable investment

The policy divide that separates those government institutions responsible for economic planning and industry from those responsible for environmental protection is reflected in the limited attention that has been paid to the impact of the national industrial production profile on the environmental outlook. This impact can be considerable: while the United States of America’s industrial output increased by 25 per cent between 1990 and 2003, there was only a 2 per cent increase in energy use, due to energy-efficiency technologies and slow growth in energy-intensive industries. In Canada, aggregate energy intensity remained relatively constant between 1990 and 1997; energy-efficiency improvements were found to have been partly offset by a growth in energy-intensive industry.

Strategic Environmental Assessment (SEA) is an assessment methodology designed for application at the planning stage of any development activity. SEA integrates environmental issues into the formulation of plans and programmes. An effective SEA process informs planners, decision-makers and the affected public about the environmental sustainability of strategic or policy decisions, facilitates the search for the best alternative and ensures a participatory decision-making process. SEA is attracting increasing interest from countries such as the Republic of Korea, and can be applied to reduce the overall impact of industrial development.
Planning that takes into account the pollution- and resource-intensities of various industrial subsectors must be supported by appropriate investment policy. East Asia and the Pacific have higher savings and investment rates as a percentage of GDP (at approximately 30 per cent) than the world savings and investment rate of just above 20 per cent of GDP. These resources are invested in various ways to influence industrial development patterns, such as through portfolio equity investment, transnational company investment (FDI), or debt finance (or loans). FDI-supported manufacturing for export has been responsible for a dramatic increase in exports and FDI also represents a growing share of GDP in many Asian countries (Table 2.5). While labour costs remain one of the primary factors influencing the location of industry, the differences between pollution abatement costs in higher- and lower-income countries, as well as the increasingly important role of intraregional FDI, are also likely to feature among the factors encouraging the growth of these industries in developing countries.

FDI infusions have directly supported growth in manufacturing subsectors such as mining, chemicals, information and communication technologies and transport equipment, among others. While “protectionist countries tend to shelter pollution-intensive heavy industry,” high levels of FDI are said to promote cleaner manufacturing practices and may be one of the reasons for the reductions in SO₂ and organic water pollution intensities observed in many countries (Figures 2.4 and 2.6).

However, by expanding the scale of industrial production, the regional impact of FDI has been, overall, negative in environmental terms, not taking into account any avoided environmental damage due to pressure on environmental resources related to poverty. The assessment of FDI impact on the environmental outlook is complicated by the implications of FDI in economic activity known to cause significant environmental damage, such as logging and mining.

FDI is increasingly concentrated in just a few countries, intensifying competition for investment, and thereby possibly lowering environmental standards in competing countries in what has been termed a “race to the bottom.” There are four mitigating FDI-related developments that may be leveraged to reduce the environmental impact of FDI-supported activity.

The first is that investments in the primary sector are expected to increase because of growing demand for natural resources. The steel industry has become a major target of FDI flows among developing countries. FDI inflows to Central Asia rose by 88 per cent in 2001, with resource-based activities, particularly in copper and zinc making up the largest share of inflows. With a view to extracting greater benefits from inward FDI, and in particular from investments targeting natural resources, several Latin American and African countries have tightened their regulatory frameworks. In contrast, some countries, such as India, allow automatic approval of 100 per cent foreign equity investment in prospecting, mining, processing and metallurgy (with some restrictions on precious metals).

The growing demand for natural resources means that the bargaining position (in terms of the

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Table 2.5 Foreign direct investment stock as a percentage of GDP

<table>
<thead>
<tr>
<th>Region</th>
<th>1980</th>
<th>1990</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>South-East Asia</td>
<td>23.4</td>
<td>18.4</td>
<td>34.4</td>
</tr>
<tr>
<td>Asia and the Pacific</td>
<td>2.9</td>
<td>15.5</td>
<td>30.2</td>
</tr>
<tr>
<td>Developing countries</td>
<td>4.3</td>
<td>13.4</td>
<td>28.0</td>
</tr>
<tr>
<td>World</td>
<td>6.0</td>
<td>9.2</td>
<td>17.3</td>
</tr>
<tr>
<td>China</td>
<td>3.1</td>
<td>7.0</td>
<td>30.9</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>487.0</td>
<td>217.5</td>
<td>255.6</td>
</tr>
<tr>
<td>India</td>
<td>0.7</td>
<td>0.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Indonesia</td>
<td>14.2</td>
<td>34.0</td>
<td>46.2</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>1.8</td>
<td>2.0</td>
<td>7.9</td>
</tr>
<tr>
<td>Malaysia</td>
<td>21.1</td>
<td>24.1</td>
<td>65.3</td>
</tr>
<tr>
<td>Philippines</td>
<td>3.9</td>
<td>7.4</td>
<td>14.9</td>
</tr>
<tr>
<td>Singapore</td>
<td>52.9</td>
<td>76.3</td>
<td>97.5</td>
</tr>
<tr>
<td>Taiwan Province of China</td>
<td>5.8</td>
<td>6.1</td>
<td>8.0</td>
</tr>
<tr>
<td>Thailand</td>
<td>3.0</td>
<td>9.6</td>
<td>17.5</td>
</tr>
</tbody>
</table>

ability to influence environmental outcomes) of countries with a rich natural resource base may be improving.

The second opportunity for improving the environmental outlook of FDI-driven growth is that incentives for investment are also shifting. The perception of Asian and Pacific countries is changing – from that of a region offering low-cost labour and a rich natural resource endowment to one of a region of consumers and investors in their own right. This sea change in perception is supported by two important regional economic trends: trade liberalization and the rise of consumerism. The power of consumers may be harnessed creatively to promote higher levels of corporate environmental responsibility by innovations such as through ecolabelling schemes and corporate ratings and disclosure schemes (see section 2.2.5). In the Republic of Korea, companies appearing in a monthly listing of companies in violation of environmental regulations suffered a reduction in market value of their publicly traded equities. The average reduction in market value was found to be of a similar order of magnitude as that in other developing countries where similar listings were published.15

The third trend is that FDI-originating countries are demonstrating a willingness to assist developing countries in avoiding the environmental impacts of FDI. An example has been set by Denmark, which used official development assistance (ODA) funding to install a palm-oil waste processing plant in Malaysia to support a palm-oil processing factory investment by a Danish company. Similarly, Canada provided nearly US$8.5 million to Peru to improve environmental regulation in the context of cross-border investment agreement negotiations. Canada was also expected to include clauses asking Peru not to lower its environmental standards in order to attract investment and to enforce the law already in place.16 While FDI arrangements between countries are governed primarily by bilateral investment treaties,17 cooperation through regional economic cooperation secretariats such as ASEAN, SAARC and ECO could be developed to help countries to avoid a “race to the bottom.”

Fourthly, multinational companies are increasingly setting a level playing field for all of their suppliers across the global supply chain. In response to consumer demand for higher levels of corporate governance and accountability for environmental impacts, environmental performance standards which apply to suppliers in a developed country like Germany are more and more likely to apply equally to suppliers in developing countries like China.

With respect to debt finance, some finance institutions are beginning to apply environment-related criteria in assessing the risk related to loans. Portfolio equity investments are also influenced by environmental criteria; investor perception of the greater overall sustainability, higher corporate governance standards and lower risk associated with green investing has supported the success of green funds in Japan, for example, as described in ESCAP’s State of the Environment in Asia and the Pacific 2000 report.

2.2.4 Driving firm-level eco-efficiency

A comprehensive review of OECD implementation of sustainable development policy during the period 2000-2004 concludes that “the strengthening of the environmental pillar of sustainable development has come at a cost to the economic pillar, as a direct consequence of choosing relatively inefficient policies.”18 These findings confirm that environmental regulations that result in high pollution-abatement costs can have a negative economic impact. Does a developing country therefore have to forego economic growth based on industrial development in order to protect its natural resources and the health of its citizens, or does it have no choice but to weaken environmental regulations in order to seek opportunities to reduce poverty?

Identifying low-cost and effective policies to minimize the impact of industrialization is critical to both the economic and environmental outlooks of the region. Environmental impact assessments (EIAs) are an important government policy tool for enhancing environmental performance. Cambodia, among other countries, is in the process of developing EIA guidelines, while many others still do not have legislation relating to EIAs. However, even the most
comprehensive EIA system requires high levels of corporate environmental responsibility to be effective. The ADB, in its *Asian Environment Outlook 2005*,19 concludes that “the business community’s actions hold the key to whether further rapid economic growth in this region can be achieved without undermining the basis for health and prosperity.” A fully engaged private sector is a critical missing element in regional sustainable development efforts; the *State of the Environment in Asia and the Pacific 2000* notes that Asian and Pacific firms are more reactive than proactive when it comes to environmental issues.

By promoting more eco-efficient production practices, cleaner production contributes to decoupling industrial production and environmental degradation. Eco-efficiency concepts emphasize that actions aimed at reducing environmental impacts across the entire product or service life cycle can have simultaneous economic and environmental benefits (Box 2.2).

Eco-efficient production requires a more supportive policy framework. Appropriate environmental standards and regulations exist in most countries to support traditional pollution control efforts, but enforcement remains a problem and there is less policy and institutional support for cleaner production efforts that upgrade the environmental performance of the entire life cycle of a product or service, or that reward sustained pollution control efforts. Ineffective and unsustainable end-of-pipe approaches and waste are often encouraged by policy. For example, pollution treatment technology is subsidized, but technologies that improve water and energy efficiency, or process improvements that reduce waste and pollution, are not. Subsidies are provided to offset wastewater treatment-plant capital costs but not for their operating costs, with the result that equipment is often turned off to save money. Resource wastage (and by consequence pollution) is also encouraged when the inputs provided to industrial estates, such

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**Box 2.2 Cleaner production as a path to firm-level eco-efficiency**

The term eco-efficiency was brought into popular usage by the World Business Council for Sustainable Development (WBCSD) in its 1992 report *Changing Course*. The WBCSD describes eco-efficiency, in the corporate context, as a management philosophy of “environmental improvement that yields parallel economic benefit,” achievable by “the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth’s estimated carrying capacity.” A two-year WBCSD project to develop a framework for assessing and reporting eco-efficiency that is applicable across industries resulted in the publication of a guide to reporting company performance in relation to its eco-efficiency. It proposes that, at the firm level, eco-efficiency is measurable by the ratio of product or service value to the related environmental influence. Environmental influence can be interpreted as pollution or waste, resource use or other environmental impact(s) associated with the unit of production or service value. The WBCSD has identified seven success factors for eco-efficiency at the firm level:

- reduced material intensity of goods and services
- reduced energy intensity of goods and services
- reduced toxic dispersion
- enhanced material recyclability
- maximized use of renewable resources
- increased material durability
- increased service intensity of goods and services.

Cleaner production can encompass all of the above aims and therefore contributes to more eco-efficient production processes. Cleaner production is defined by UNEP as the “continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment.” A central pillar of cleaner production is the life-cycle assessment, or analysis of the entire life cycle of a product or service to identify opportunities to minimize pollution, waste and resource use and other environmental impacts. Life-cycle assessment begins with resource extraction and ends with the waste generated when a product is used.

as electricity, are subsidized as part of investment promotion policy. In addition, where pollution abatement costs are perceived to increase production costs unnecessarily and so reduce industrial competitiveness, environmental regulations are often relaxed.

Rather than taking advantage of the existing opportunities to prevent pollution and waste from the product design stage to product disposal, companies therefore tend to opt for end-of-pipe technology. Asia has the dubious distinction of being the fastest-growing market for the end-of-pipe technology that makes up a major part of a global environmental technology market valued at US$477 billion in 2003. At the same time, the limited capacity for monitoring of pollution and waste and the sometimes weak enforcement of environmental regulations provide little impetus for improvement in corporate environmental performance in many countries. Although there is evidence of rising judicial activism on environmental issues, policies generally do not encourage the use of new technologies, or cleaner production and eco-efficiency initiatives.

More recently developed innovative policies and programmes have shown that incentive-based measures can have dramatic impacts and represent a more efficient way of reducing pollution – the carrot and the stick together are far more powerful than the stick alone. Innovative approaches that have been applied in the region to promote cleaner production and eco-efficiency are described below.

National cleaner production programmes and policy

National cleaner production programmes seek to support industry in making technological and process changes that reduce pollution and other forms of waste generation, as well as resource use. National cleaner production centres have been established with the assistance of UNIDO and UNEP in China, Indonesia, the Republic of Korea, Sri Lanka, the Russian Federation and Viet Nam. UNEP notes that there has been more progress on cleaner production in countries in which national cleaner production centres have been established than in others. Developed countries, in particular Japan and Australia, are leading the way in promoting cleaner production, but several initiatives in developing countries have also clearly demonstrated startling and perhaps unexpected economic benefits, as reported by UNEP. National policies on cleaner production have been adopted in China and Indonesia, with China adopting a comprehensive Cleaner Production Promotion Law in 2002.

The Samut Prakarn Cleaner Production for Industrial Efficiency (CPIE) Project implemented in Thailand involved more than 423 manufacturing industry members. The UNEP Production and Consumption branch reports that by the time the project ended in April 2003, the project had achieved impressive results. The total estimated after-tax savings for programme participants from water, wastewater and electricity reductions over the period of 2003 to 2007 alone is estimated at a net present value of approximately US$10 million – as compared with an investment (project budget) of US$6.5 million. The following direct benefits for project participants and the environment were reported:

- 1.24 million m$^3$ in reduced water/waste water per year;
- 9.4 million kWh in reduced electricity use per year;
- 7 million litres in reduced diesel oil use per year; and
- Cost savings to participants of over US$3.2 million per year.

The project is also reported to have generated significant benefits for the Government of Thailand and for Thai society. The reported estimated value of these benefits are as follows:

- over US$1 million per year in increased tax revenue;
- US$198,000 per year in industrial productivity gains;
- US$67,000 per year in savings from reduced greenhouse gas emissions; and
- US$190,500 per year in savings from reduced land subsidence.

The Viet Nam Cleaner Production Centre also reports significant cost and resource savings from its technical assistance services (Table 2.6).
Industrial ecology and industrial waste exchange

Industrial ecology matches waste streams and production processes across multiple industries to turn what is pollution and waste for one industry into a resource for another. There are industrial ecology initiatives in at least 11 countries of the region.23 Japan’s eco-towns (see chapter 7, box 7.2) are industrial zones in which zero-emission concepts are promoted through industrial symbiosis and recycling. In one low-tech example, the eco-cement plant in Chiba Prefecture uses ash, the by-product of incineration processes, to make cement by adding natural limestone. Waste is reduced, along with the costs of disposal of and expenditure on the purchase of virgin aggregate. In another promising initiative, the Eco-Industrial Estate Development in the Jababeka Industrial Estate of West Java has been established to promote waste exchange on the industrial estate and the production of organic fertilizers from liquid and solid palm-oil industry

Table 2.6 Cleaner production in Viet Nam

<table>
<thead>
<tr>
<th>Products (no. of companies)</th>
<th>Location</th>
<th>Project started in</th>
<th>Investment (US$)</th>
<th>Benefits in demonstration year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jelly (1)</td>
<td>Viet Tri</td>
<td>2003</td>
<td>0</td>
<td>Savings of US$5,717; 10% reduction in modified starch use, 0.1% reduction in electricity consumption</td>
</tr>
<tr>
<td>Sugar (1)</td>
<td>Can Tho</td>
<td>2001</td>
<td>0</td>
<td>Savings of US$88,000</td>
</tr>
<tr>
<td>Noodles (1)</td>
<td>Ho Chi Minh City</td>
<td>2000</td>
<td>5,000</td>
<td>Savings of US$363,000; reduction of up to 10% in greenhouse gases (GHG)</td>
</tr>
<tr>
<td>Agar-agar, seafood (3)</td>
<td>Hai Phong, Ninh Binh, Da Nang, Ho Chi Minh City</td>
<td>1999</td>
<td>13,230</td>
<td>Savings of US$55,000; reduction of up to 13% in air pollution, 78% in GHG, 34% in solid waste, 40% in chemical use, 78% in electricity consumption, 13% in coal consumption</td>
</tr>
<tr>
<td>Printing paper, tissues, carton (2)</td>
<td>Phu Tho, Nha Trang</td>
<td>2003</td>
<td>45,266</td>
<td>Savings of US$1,681,243; reduction of up to 22% in electricity consumption, 13% in fuel consumption</td>
</tr>
<tr>
<td>Printing paper, tissues, carton (6)</td>
<td>Phu Tho, Hoa Binh, Nghe An, Dong Nai, Khanh Hoa, Ho Chi Minh City</td>
<td>2001</td>
<td>346,000</td>
<td>Savings of US$500,000; reduction of up to 42% in wastewater, 70% in COD loadings</td>
</tr>
<tr>
<td>Printing paper, tissues, carton (3)</td>
<td>Phu Tho, Ho Chi Minh City</td>
<td>1999</td>
<td>74,000</td>
<td>Savings of US$344,000; reduction of up to 35% in air pollution, 15% in GHG, 20% in fibre loss, 30% in wastewater, 24% in electricity consumption, 16% in fuel oil consumption, 20% in coal consumption</td>
</tr>
<tr>
<td>Dyed fabric, thread (8)</td>
<td>Nam Dinh, Hanoi, Ho Chi Minh City</td>
<td>2002</td>
<td>73,950</td>
<td>Savings of US$477,000; reduction of up to 30% in chemical and dye stuff use, 28% in fuel consumption, 35% in water consumption, 4% in reprocessing, 14% in low-quality products</td>
</tr>
<tr>
<td>Dyed fabric, zippers, thread (4)</td>
<td>Nam Dinh, Hanoi, Ho Chi Minh City</td>
<td>1999</td>
<td>8,900</td>
<td>Savings of US$115,000; reduction of up to 14% in air pollution, 14% in GHG, 20% in chemical use, 14% in fuel oil consumption</td>
</tr>
<tr>
<td>Wire and nets, steel pipes (2)</td>
<td>Nam Dinh, Hai Phong</td>
<td>1999</td>
<td>36,500</td>
<td>Savings of US$357,000; reduction of up to 15% in air pollution, 20% in solid waste, 5% in electricity consumption, 15% in coal consumption</td>
</tr>
<tr>
<td>Beer (1)</td>
<td>Ninh Binh</td>
<td>1999</td>
<td>2,900</td>
<td>Savings of US$23,400; increase in production capacity of 13.4%; reduction in consumption of raw materials (7.0%), water (14.0%), electricity (11.3%), coal (13.3%) and filter media (6.6%)</td>
</tr>
</tbody>
</table>

wastes. The Philippine Business for the Environment is a non-profit organization that has developed an industrial waste exchange network which matches industrial waste generators with buyers and recyclers. Buyers benefit from low-cost or free material; sellers garner savings on disposal costs.

**Certification schemes as economic incentives**

Reliable ecolabelling schemes are poised to contribute towards making important long-term changes to production (and consumption) behaviour. Growing environmental awareness, heightening consumer power and increasing investment in Asia and the Pacific as a consumer base, all serve as opportunities to utilize this tool proactively, providing incentives for improved corporate environmental performance. Ecolabelling schemes have been established in Indonesia, Japan, the Republic of Korea and Thailand among other countries. Green procurement, which encourages the procurement of environmentally friendly products, stimulates and supports cleaner production initiatives by building on the establishment of reliable ecolabelling schemes. In Japan, more than 95 per cent of government procurement in 2002 met eco-friendly procurement requirements; among the products procured, the highest increases in green procurement activity were recorded in uniforms and air-conditioners. The Republic of Korea’s 2004 green purchasing law was projected to result in an expansion of the domestic “green market” from US$2 billion to US$5 billion between 2004 and 2006.

The ISO 14000 standard remains the key reference point in discussing certification schemes aimed at improving organizational environmental performance. It has a much larger influence on business-to-business transactions than ecolabelling schemes aimed at the general public consumer. The Government of the Republic of Korea has established its own certification scheme, the “Environment-Friendly Company Certification System”, which provides for voluntary action to improve performance against a company-specific environment-related target. Only 28 businesses were certified by this system in 1995; by 2004, this number grew to 157.

**Levying of pollution charges**

Pollution charges are just one in a suite of economic instruments that can be applied to improve environmental performance, and have been identified by the World Bank as one of the three approaches that work to “clean up” corporate behaviour without sacrificing growth. At least three examples can be offered to support this distinction. In China, each one per cent increase in water pollution charges reduced industrial organic water pollution by about 0.8 per cent and each one per cent increase in the air-pollution levy reduced air pollution by about 0.4 per cent. In the Philippines, an environmental user fee for the discharge of organic water pollution into the Laguna Lake reduced organic water pollution (BOD) discharges from pilot plants by some 88 per cent. This charge system was based on fixed fees with stepped increases linked to increasing volumes of discharge, as well as a variable fee determined by the concentration of pollutants in discharge water. In Malaysia, taxes on pollution from oil palms in the late 1980s were credited with substantial reductions in polluted effluent.

The difficulties of setting charges at a level high enough to penalize polluting behaviour without over-charging (i.e. the level at which the marginal cost of abatement is equal to the marginal benefit) have been noted. The charges applied by Chinese authorities for wastewater treatment and for SO$_2$ emissions, for example, have been noted as being substantially below the abatement cost. In the Republic of Korea, the 1993 Waste Production Charges System was established to cover the costs of waste treatment and the disposal of items and waste less amenable to recycling. The system reduced the amount of waste produced, but did not generate enough revenue to cover the costs of disposal and treatment. It was also noted that the amount of waste produced declined immediately after the charge was introduced, but rose again soon afterwards. In addition, as the declines in waste production occurred in tandem with fluctuations in GDP, it was difficult to separate the effects of changes in economic activity from the impacts of the charge system and other waste minimization policies in force at the time. The
Republic of Korea’s waste production charges system was being revised at the time of writing this report.

Other types of charges which have been considered include tradeable pollution permits and life-cycle assessment taxes. Both have been identified as having potential positive impacts, but the capacity of developing countries to implement them is questioned.

2.2.5 Improving access to environmental information and justice

One of the most powerful tools for reducing the environmental impact of industrial activity is access to information. Access to environmental information is a tenet of sustainable development, enshrined in Principle 10 of the Rio Convention, and indirectly improves polluting behaviour in a number of ways. Access to environmental information:

- promotes accountability for pollution;
- promotes awareness of environmental issues;
- promotes public participation in policy formulation and decision-making;
- supports access to environmental justice; and
- supports investment decisions that take into account environmental risks, as assessed based on environmental information.

Increased access to information in support of the enforcement of constitutionally enshrined environmental protection state obligations is being supported by the enactment of freedom of information acts in the Republic of Korea, Thailand and the Philippines; legislation is pending in Bangladesh, India, Indonesia, Pakistan and Sri Lanka. In a related development, the Indian Supreme Court’s Monitoring Committee on Hazardous Wastes has promised to ensure online public access to effluent and emissions data from large industrial units.

The Access Initiative is a global coalition that works to stimulate progress at the national level on legal frameworks for access, dissemination of information, participation and access to justice and decision-making processes. At the request of civil society and governments, the Access Initiative undertakes assessments of access to environmental information in which governments participate. Assessments have taken place in Indonesia and Thailand.

The Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters

The Aarhus Convention has been hailed by United Nations Secretary-General, Kofi Annan, as “the most impressive elaboration of Principle 10 of the Rio Declaration.” Entering into force on 30 October 2001, it had been ratified by 37 of its 40 European and Central Asian signatories by November 2005. The convention links environmental with human rights. It broadly provides for access to environmental information (including public information disclosure), public participation and access to justice. The convention has assisted regulatory and monitoring agencies to obtain financial and political support for improving monitoring and compliance, as well as for making changes in national legislation consistent with Principle 10.

Ratifying parties must ensure that they respond to requests for environmental information from the public. The convention identifies the time frame and conditions under which a request should be responded to, or refused. It also identifies the basic

Principle 10 of the Rio Declaration on Environment and Development*

“Environmental issues are best handled with the participation of all concerned citizens at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.”

institutional provisions to be put in place and the types of information to be provided, as well as the formats in which this information should be provided, and requires regular state-of-the-environment reporting. With respect to public participation, it focuses on the processes and information to be provided to facilitate public consultation on development activities and requires parties to the convention to make provisions for public participation, without specifying the form of participation. A person who considers that a request for information has been ignored or wrongfully refused, or that national environmental law has been contravened, must have access to judicial review (in the latter case, this must meet the criteria of national law).

The implementation of the Aarhus Convention by the Central Asian states has been supported by ECE and UNEP activity. Implementation challenges faced by many ratifying countries, in particular Central Asian and Caucasian countries, have been discussed in various forums (Box 2.3).

Access to environmental information is improved by public information disclosure, an activity that covers a range of structured communications in various media to the public. These include state-of-the-environment and corporate sustainability reporting, pollutant release and transfer registers, ecolabelling, certification and corporate rating disclosure programmes, among others.

**Corporate rating disclosure programmes**

Cleaner production initiatives have had extremely positive impacts on improving polluting behaviour. However, corporate rating disclosure programmes, a relatively new type of intervention, have the potential to increase the involvement of a wide cross-section of society in determining environmental outcomes. Corporate rating disclosure programmes have had dramatic and short-term impacts in diverse countries and have resulted in significant and measurable reductions in pollution levels. Corporate rating disclosure programmes, also referred to as public disclosure programmes, were

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**Box 2.3 Aarhus Convention – challenges for economies in transition**

**Access to environmental information**
- Lack of officials with experience in collecting, providing and properly disseminating information
- Need for compatible methodologies across government offices
- Lack of information exchange between government authorities and of coordinated cooperation among agencies to ensure the flow of information
- Need for attitudinal changes on the part of government officials and NGOs
- Lack of public requests for information - the majority of the public does not know about and does not believe in the possibility of receiving information publicly (wider governance issues are important)
- Lack of trust in official information
- Difficulty of local-level information dissemination, particularly in rural areas

**Public participation**
- Lack of clear requirements and procedural norms for public participation

**Access to justice**
- Conflict between economic and environmental interests
- Low levels of legal knowledge, corruption of legal systems, lack of trust in the justice system, financial barriers, non-enforcement of court decisions and lack of professional environmental lawyers. The interpretation of constitutional provisions relating to environmental rights has been found to be extremely subjective
- To be effective, the convention requires strong environmental legislation, particularly in the area of environmental impact assessment

developed by Vietnamese and Indonesian environmental agencies in the 1990s as a low-cost response to rising pollution loads. Viet Nam published “Black” and “Green Books” listing worst-performing and best-performing companies, while staff of the Indonesian national pollution control agency (BAPEDAL) are credited with conceiving a corporate rating disclosure model that has been successfully replicated, with slight modifications, in China, the Philippines, Viet Nam and India, as well as other countries outside the region. The World Bank’s New Ideas in Pollution Reduction (NIPR) programme has supported many of these country initiatives, which have made dramatic and well-documented changes to corporate polluting behaviour (see box 2.4).

Typically, corporate rating disclosure programmes develop colour-coded systems to rate corporate environmental performance. The results of a preliminary assessment are usually shared with companies; in some cases, the high-performing companies are publicly congratulated. Companies are then given time (usually around one year) to improve their ratings; in some cases, they are also given the chance to appeal and discuss their ratings. A second assessment then takes place, followed by a ceremony in which the corporate ratings are revealed to the public in the presence of the news media and high government officials and other stakeholders. A significant number of companies improve their environmental performance during the grace period, as shown in box 2.4. One study compares the changes in the organic water pollution (COD) discharges of companies that were assessed under the BAPEDAL Program for Pollution Control, Evaluation and Rating (PROPER) programme and of companies that were not, and concludes that there was an immediate response to the programme. The organic water pollution (BOD and COD) discharges were reduced by approximately 32 per cent.32

A comprehensive review of China’s pilot corporate rating disclosure programme, Green Watch, identifies the following reasons for the effectiveness of these programmes: 33

- disclosure provides an incentive for improved performance because of the value
- the ratings systems provide a management tool that can be used by companies for self-assessment;
- the systems provide an incentive for improving the quality of monitoring and reporting by regulatory authorities;
- they encourage public participation in environmental regulation – access to easily understood information allows greater pressure to be placed on polluting industry; and
- corporate resistance to environmental monitoring is transformed into active self-assessment and the solicitation of inspections as a means of improving ratings.

China’s GreenWatch programme is the most comprehensive, large-scale public information disclosure programme. The ratings system is based on polluting emissions, environmental management, records of public complaints, regulatory actions and penalties and surveys that record other relevant firm characteristics. The pilot programmes in Zhenjiang, a relatively well-off city in Jiangsu province, and Hohot, the relatively impoverished provincial capital of Inner Mongolia, were tailored to fit the local conditions, information availability and monitoring capacity. Their success, despite the differences in the relative power that the public was perceived to wield in each location, “suggests that public disclosure should be feasible in most of China.”34 By June 2002, some 2,500 firms were included in the expanded GreenWatch programme.35

A corporate rating disclosure pilot project in Uttar Pradesh, India is notable in that it seems to have been the only programme in which assessments were based on self-reported data (which was subsequently checked).

These programmes are beneficial to both the wider public and to the companies involved. A survey in Viet Nam showed that publicly-disclosed negative ratings were seen by companies as an opportunity to request support from the government for pollution reduction. Positive ratings were used by more than half of the companies in various interactions with their clients. In one case, a
Box 2.4 Public information disclosure

- Rising public complaints and increasing industrial pollution moved the municipal authorities of Ho Chi Minh City, Viet Nam to launch a survey of 600 enterprises in 1993. A “Black Book” listing the 43 worst polluters was published in 1994. 13 firms subsequently installed waste treatment plants, 21 firms prepared Environmental Impact Assessment reports and one firm moved to the outskirts of the city. Eight of the 43 firms did not take any action. The exercise was repeated in 1997. A follow-up survey indicated that the Black Books induced investment in pollution control in 98 per cent of polluting companies.

- Under the Indonesia public disclosure programme (PROPER) launched in 1995, five plants, of the 187 assessed, which were rated as “very good” were publicly congratulated. Other lower-rated firms were privately notified of their ratings and given six months to clean up before full disclosure. One year later, the number of compliant plants had expanded from one third to over half. Five of the six plants in the worst category graduated to higher categories. COD emissions are estimated to have been reduced by 30 per cent by the programme. Relaunched in 2003, the new Indonesia PROPER reduced the number of facilities with the worst rating from 40 per cent of the companies assessed to 4 per cent in two years.

- The Philippines EcoWatch programme’s initial assessment in 1997 showed that 48 plants (92 per cent of the total number of companies assessed) were ranked in the “non-compliant” and “very poor” categories. One and a half years later, the number of companies rated as “compliant” had risen from 8 per cent to 58 per cent.

- In Zhenjiang, Jiangsu Province of China, a pilot ratings scheme, starting in June 1999, was applied to 91 firms. One year after public disclosure of the ratings, the numbers of firms rated as “superior performers” had doubled from 31 per cent to 62 per cent. The province then took the decision to promote province-wide implementation of the programme. In Hohhot, Inner Mongolia, China, the scheme was applied to 107 enterprises. Enterprises rated “good” or better increased from 24 per cent to 62 per cent. Enterprises in the worst category decreased from 11 per cent to 5 per cent.

- A 2001 Vietnamese programme assessed 50 food and textile plants in Hanoi. Five were rated as “compliant”, 29 were rated as “non-compliant”, and 16 as “very poor.” After public recognition of the five compliant companies and the threat of public disclosure of all ratings four months later, the number of compliant companies doubled. The number of non-compliant companies was reduced to 23 and the number of “very poor” companies was reduced to 15.

- A voluntary pilot ratings and disclosure programme in Uttar Pradesh, India, initiated in May 2001 used self-reported company data for 34 companies representing a mix of sizes and activities and a ratings scheme in which companies participated in developing. After a grace period, the numbers of companies in the worst-performing segments decreased from 17 to 11, while the number of companies which were basically compliant increased from 12 to 16. The number in the highest-performing categories increased from four to six.

- The Republic of Korea’s Monthly Violation Report was issued between 1992 and 2002 and was based on monthly government inspections of about 10,000 air and water-polluting facilities. The report was published through the Korea Press Foundation’s online news database service. Based on the positive impacts of this programme, a large-scale public disclosure programme has been developed.

positive rating was used to obtain better conditions on a loan agreement.\(^3^6\)

In Asia and the Pacific, as in other parts of the world, governments are perceived to have resented moves to strengthen the link between trade, corporate governance and environmentally unsustainable economic growth, and have been accused of harbouring companies which have done extensive environmental damage.\(^3^7\) In *Greening Industry*,\(^3^8\) the World Bank noted that under corporate rating disclosure programmes, multinational companies seemed the most motivated to make improvements, while locally based export-oriented companies seemed the least motivated. Corporate ratings and public disclosure programmes may be a politically acceptable way of addressing the environmental performance of multinationals, where this is less than satisfactory.

**Corporate environmental governance and judicial activism**

While governments are often viewed as the main purveyors of environmental information, corporations are increasingly called upon to disclose the environmental impacts of their operations. Corporate environmental reporting is one of a suite of overall corporate governance tools. Good corporate governance has been strongly linked to low environmental risk; conversely, environmentally risky behaviour is associated with flawed corporate governance.\(^3^9\) Good corporate governance, as advocated by several international initiatives such as the UNCTAD Intergovernmental Working Group of Experts on International Standards of Accounting and Reporting,\(^4^0\) stresses the accountability and transparency of corporate operations and promotes the positive link between profitability and good governance.

Corporate environmental responsibility and accountability thrives where governance processes and institutions relating to environment-related constitutional provisions and national legislation is effective. The enforcement of environmental justice seems to be improving in some countries. The “green courts” of Bangladesh are seeking to ensure that justice in environmental matters is served, while India’s Supreme Court and High Courts in Chennai, Kolkata, Gujarat and Mumbai have established “green benches” to adjudicate on environmental cases. However, in some countries conflict between local communities and industrial interests around environmental issues has not been resolved despite constitutional and other legislative provisions.

A combination of corporate rating and disclosure programmes with a sound legislative framework and appropriate environmental standards, support for firms (in particular SMEs and the very worst performers) to make improvements, as well as support for institutional capacity-building for monitoring, is perhaps the most effective approach to “greening” industry in Asian and Pacific developing countries.\(^4^1\)

### 2.3 Increasing demand for raw materials and energy

There is a strong relationship between environmental sustainability and the demand for raw materials and energy supplied by nature. The extraction of raw materials and their processing as inputs for manufacturing, buildings and infrastructure, as well as to support services provision is one of the main sources of environmental pressure.

However the extraction and processing of raw materials remain necessary to support human activity. Iron and steel demand reflects government investment in steel-intensive infrastructure such as natural gas projects. It also is an indicator of the production of consumer durables such as cars and household appliances, as well as for paper, plastics and paint. Copper is used extensively in specialized equipment production and electricity infrastructure development, including for electricity generation, electrified railways and telephone networks.

The markets for certain commodities also strongly influence the markets for others. High demand for stainless steel precipitates price increases in nickel, since this mineral is a key input to stainless steel production. Rising energy prices boost the demand for products such as wood and natural rubber that can substitute for petroleum-based products such as plastics and synthetic rubber.
Environmental, social and economic impacts

Ensuring that the supply of renewable resources such as wood, other forms of biomass and water can continue indefinitely into the future to support fast-growing economies as well as meet the future needs of other countries, requires that these resources be used at a slower rate than the rate at which they are regenerated in nature. Shrinking forests, increasing land degradation and declining fisheries (see section 2.4) are evidence that the current rate of use of renewable resources is already higher than the rate at which they are being replenished by natural processes, diminishing the flow of life-supporting ecosystem goods and services.

However, diminishing natural capital is not the only way in which environmental pressures linked to resource use is manifested. Rising demand for raw materials is inextricably linked to growth in demand for water and energy, as the processing of raw materials (including fuels) requires both water and energy. In addition, raw materials that are not directly transformed into goods, services or infrastructure, or consumed or recycled, are disposed of, or emitted, as pollution and waste.

Environmental sustainability requires that the volumes and types of waste produced be kept within the environment’s absorptive capacity. However, a World Resources Institute study has concluded that half to three quarters of the annual raw material inputs in five study countries are returned to the environment as waste material within one year.42 Solid waste is becoming a problem even in the most remote Pacific islands. Acid rain in East Asia persists, despite the slowed emission of \( \text{SO}_2 \). Wastes from mineral extraction are accumulating in Central Asia and climate change processes are becoming more evident as the amount of \( \text{CO}_2 \) emissions (characterized as “humankind’s most weighty waste product”)43 rise faster than can be absorbed by growing biomass or other natural processes.

China and Japan are the two main markets for processed minerals in the region. Japan is the largest consumer of minerals overall, while China has shown the greatest growth rate in mineral consumption. India, the Republic of Korea, Indonesia, Malaysia, Singapore, Thailand and Viet Nam are other significant importers of ferrous and non-ferrous metals and industrial minerals, cement in particular. China has become the largest aluminum and copper-consuming country in the world.

The growth in demand for raw materials is supported by the rapid increases in mineral production, particularly from Asia. Global iron ore production, constituting the majority of world mineral flows, increased by some 30 per cent between 1995 and 2004. In the same period, Asia’s iron ore production increased by some 40 per cent.44 Australia, China and India are among the top five global producers of minerals such as bauxite, copper, gold, lead and zinc; there has also been significant mining activity in Indonesia, the Philippines and Papua New Guinea.45 The countries where mineral production is growing fastest include Thailand, which increased its iron ore production almost twofold. In Viet Nam and Malaysia iron ore production tripled, and in Australia, production increased by 70 per cent between 1995 and 2002.46 Since 1995, at least 120 major mines have opened in China alone. Silver, copper, platinum, aluminium, nickel and gold constituted the fastest-growing regional mineral production streams between 1990 and 2001.47 The growth in mineral production is reflected in export growth (Figure 2.9).

Changes in the exports and production of forest products are shown in figures 2.10 to 2.12. The value of global imports of forest products increased by almost one third in the ten years from 1991 to 2001. Imports grew at twice the global rate in South-East Asia, and at more than three times the global rate in Central Asia and the Caucasus in this time period. Together, China, Japan and the Republic of Korea account for some 80 per cent of all regional imports. China imported nearly 26 million m\(^3\) of industrial roundwood in 2002, almost equalling the imports of roundwood in all other countries of the region put together.48 China’s booming furniture and construction industries are the main users of timber.

Patterns of international trade in minerals and biomass (food and timber) are changing as the demand for raw materials grows (Figure 2.13). Asian
Environmental sustainability under threat

Figure 2.9 Change in ores and metals export, 1990-2002


Figure 2.10 Change in forestry products exports value, 1991-2001


Figure 2.11 Change in roundwood production, 1992-2000


Figure 2.12 Change in woodpulp production, 1992-2002

Figure 2.13 Global trade flows – main resources, 1983 and 1998

UNIT: Thousand metric tons

1983

1998

countries (other than Japan) increasingly import minerals, and export biomass; some traditional mineral exporters such as Australia import growing amounts of minerals. Western Asia (including Central Asian and Caucasus countries) accounts for growing proportions of global fossil fuel exports.49

Private sector investment firms have recently targeted minerals and other commodities with good investment prospects in light of the expected growth in global demand, and greater proportions of FDI are expected to target this sector.50 Countries which produce minerals and other raw materials are therefore benefitting from rising commodity prices, but these economic gains can be compromised by heightened environmental and social risk.

Environmental management practices and the accountability of mining operations for disturbed surfaces, increased soil erosion and leaching of toxic metals and acid, and the production of large volumes of waste material, leave much to be desired in developing countries. The long-term containment of mining wastes in tailing dams has proven risky and the long-term rehabilitation of mining sites is rarely undertaken; submarine tailing disposal is also subject to pipe failure and its safety has not been proven.

Rural communities and coastal communities where tailings are dumped directly into watercourses have paid a high price. The failure of the Ok Tedi mine’s tailing dam and the consequent loss of freshwater fisheries in Papua New Guinea is one example of the disastrous impact of industrial mining practices on local communities. In another case, the Indonesian government obtained an out-of-court settlement over alleged mining waste pollution in North Sulawesi which was linked to skin diseases and neurological diseases. Mining activity has also been linked to high levels of cadmium in agricultural crops such as rice. As the experience of Central Asia shows (see chapter 6), the impacts of mining activity continue to manifest themselves far into the future.

The demand for another important commodity, wood, is changing global and regional landscapes. Plantation forests constitute almost 10 per cent of the total regional forest area, twice the global figure and equivalent to some five times the area of New Zealand. Plantation forests in the ESCAP region make up more than 72 per cent of the global planted forests; plantations in five Asian and Pacific countries (China, India, Japan, Indonesia and Thailand) rank among the world’s largest. While plantation forests grow vigourously, natural forests are in decline (Figure 2.14). The losses of natural forest indicated in countries like Cambodia, Papua New Guinea, the Russian Federation and Viet Nam were relatively modest in the period 1990 to 2000, but the FAO’s most recent Global Forest Resources Assessment indicates that substantial losses occurred in those countries between 2000 and 2005.

<table>
<thead>
<tr>
<th>Figure 2.14 Change in natural and plantation forest, 1990-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanuatu</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Percentage</td>
</tr>
<tr>
<td>-40</td>
</tr>
</tbody>
</table>

Natural forest losses in Sri Lanka and Indonesia continue to occur at high rates. As fossil fuel prices continue to rise, there has been increasing pressure on natural forests as people turn away from increasingly pricey fossil fuels, to wood.

The social impacts of natural resource extraction are also manifested in several countries. For example, the economic benefits of mining have been found to have been offset by “poor governance, corruption, [and inadequate attention to] conflict resolution, disclosure policy, revenue management and human rights and the environment ...” Similar issues arise around both illegal mining and the illegal production of and trade in forest products. The potential for illegal activity related to resource extraction is high because resources are extracted mainly in rural areas and extraction directly impacts on people with low incomes, and by extension low levels of influence, access to information and to justice.

The FAO State of the Forests 2005 report makes the link between deforestation, the illegal trade in timber and social conflict. The losses of natural forest in countries such as Myanmar, Sri Lanka and Nepal seem to support this conclusion. The illegal timber trade is highly lucrative for those who engage in it, but reportedly accumulates environmental, social and direct economic costs of some US$15 billion annually to the wider economy. Illegal timber extraction also acts as a disincentive to investment in improving the sustainability of forest resource management and keeps commodity prices artificially low.

While official Russian Federation estimates put illegal felling at no more than 5 per cent of overall production, estimates as high as 20 per cent have been made. Estimates of illegal production of both hardwood and softwood in China are as high as 30 per cent. Illegal timber felling is estimated at up to 60 per cent of production in Indonesia, and 5 per cent of production in Malaysia. Illegal timber fellings supply local markets but also find their way across country borders. Due to the difficulty of verifying the origin of timber, several countries are significant importers of timber of illegal and suspicious origin. As wood is processed (into plywood or pulp, for example), the difficulty of verifying the origin of the constituent timber increases. Up to 35 per cent of imports of timber into China are estimated as being of illegal origin and, in Japan, 20 per cent of hardwood logs, 30 per cent of hardwood timber and 40 per cent of plywood are thought to have illegal origins. Similarly, as much as 70 per cent of Malaysian log imports may be of illegal origin.

The increasing demand for raw materials also has a very real impact on poverty reduction efforts. Sixty per cent of people in the region, or some 1.6 billion people, live in rural areas and are directly or indirectly dependent on forest ecosystem services. These services range from hydrological system regulation, which is critical to agricultural activity, to the provision of fuel and other non-wood forest products. Many people live in mixed cash-subsistence economic systems, with the total proportion of such persons highest in some of the Pacific island countries.

While noting that between 1992 and 2002, the import values of 55 non-wood forest products (NWFPs), such as honey, essential oils and plants used for pharmaceutical products, increased by 50 per cent from US$5.5 billion to US$8.3 billion, the FAO makes the point that “local uses of NWFPs and their trade within countries have more impact on poverty alleviation and sustainable forest management than international trade.” The 2005 FAO Global Forest Resources Assessment shows that the value of wood removals is decreasing, while the value of non-wood forest products is both increasing and underestimated. The loss of natural forest due to inadequate protection therefore entrenches poverty in rural areas. At the other end of the scale, forest management regimes which completely exclude communities from access to valuable forest resources threaten livelihoods and can create conditions for illegal activity.

2.3.2 Rising raw material prices and resource-use efficiency

Meeting the demand for raw materials and other commodities therefore has significant environmental, and social implications. However, none of these
issues have focused attention on the demand for raw materials like the skyrocketing commodity prices (see table 2.7 and figure 2.15) that have sparked fears of global economic slowdown.

Not only have rising energy and minerals prices increased the costs of production, but they have also influenced the prices of other resources. The current increases in energy prices are strong determinants of the prices of other commodities which are important inputs to economic activity, because of the direct and indirect energy use in their extraction, refining and production processes. These commodities include minerals, nitrogenous fertilizers and agricultural commodities that can substitute for petroleum-based products such as wood and natural rubber, as well as ethanol and other inputs for making biofuels such as molasses.

Continuing highs in oil prices and an increased demand for commodities as a result of rapid economic growth may influence long-term trends in commodity prices and prove not only to be an increasingly heavy environmental burden, but an economic one as well. Resource-use efficiency is therefore becoming a matter of economic success.

Resource-use efficiency (an important element of eco-efficiency, discussed in chapter 3) reduces the consumption of raw materials and therefore, the environmental pressures associated with extraction, processing and waste. Recent increases in energy and raw material prices, as well as the rising costs of waste disposal, highlight resource-use efficiency as a key indicator of both the environmental and economic sustainability of growth patterns. Both Japan and China have shown a strong interest in improving resource-use efficiency; Japan’s motivation lies mainly in its mounting waste problem, while China’s recent policy realignment to focus on building a resource-efficient economy is based on the sheer scale of its demand for resources and evidence that it is relatively resource poor (see chapter 3).

Measures to support an increasing efficiency of resource use include waste minimization, increased recycling and dematerialization (shown in table 2.8). There is considerable overlap between these measures.

Table 2.7 Commodity prices

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Unit</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal, Australia</td>
<td>$/metric ton</td>
<td>27.84</td>
<td>54.70</td>
<td>50.38</td>
</tr>
<tr>
<td>Natural gas, Europe</td>
<td>$/mmbtu</td>
<td>3.91</td>
<td>4.28</td>
<td>6.22</td>
</tr>
<tr>
<td>Logs, Malaysia</td>
<td>$/m³</td>
<td>187.20</td>
<td>197.30</td>
<td>202.40</td>
</tr>
<tr>
<td>Plywood</td>
<td>c/sheet</td>
<td>431.90</td>
<td>464.80</td>
<td>508.50</td>
</tr>
<tr>
<td>Sawnwood, Cameroon</td>
<td>$/m³</td>
<td>551.60</td>
<td>587.00</td>
<td>562.00</td>
</tr>
<tr>
<td>Sawnwood, Malaysia</td>
<td>$/m³</td>
<td>551.00</td>
<td>581.30</td>
<td>656.40</td>
</tr>
<tr>
<td>Woodpulp</td>
<td>$/metric ton</td>
<td>525.70</td>
<td>640.80</td>
<td>637.70</td>
</tr>
<tr>
<td>Di-ammonium phosphate fertilizer</td>
<td>$/metric ton</td>
<td>179.40</td>
<td>221.20</td>
<td>245.70</td>
</tr>
<tr>
<td>Phosphate rock</td>
<td>$/metric ton</td>
<td>38.00</td>
<td>41.00</td>
<td>42.00</td>
</tr>
<tr>
<td>Aluminium</td>
<td>$/metric ton</td>
<td>1 431.00</td>
<td>1 716.00</td>
<td>1 867.00</td>
</tr>
<tr>
<td>Copper</td>
<td>$/metric ton</td>
<td>1 779.00</td>
<td>2 866.00</td>
<td>3 597.00</td>
</tr>
<tr>
<td>Iron ore</td>
<td>cents/dry metric ton units</td>
<td>31.950</td>
<td>37.90</td>
<td>65.00</td>
</tr>
<tr>
<td>Nickel</td>
<td>$/metric ton</td>
<td>9 629.00</td>
<td>13 823.00</td>
<td>14 863.00</td>
</tr>
<tr>
<td>Steel products [B] [price] index</td>
<td>1990=100</td>
<td>78.80</td>
<td>121.50</td>
<td>137.80</td>
</tr>
<tr>
<td>Tin</td>
<td>cents/kg</td>
<td>489.50</td>
<td>851.30</td>
<td>744.00</td>
</tr>
<tr>
<td>Zinc</td>
<td>cents/kg</td>
<td>82.80</td>
<td>104.80</td>
<td>134.10</td>
</tr>
</tbody>
</table>

Figure 2.15 Base metals and petroleum – price changes and consumption

Aluminium

Monthly prices ($/metric ton)

Copper

Monthly prices ($/metric ton)

Nickel

Monthly prices ($/metric ton)

Petroleum

Monthly prices ($/metric ton)

Policies, legislation and programmes to support recycling remain the first-line response of most countries to the need to improve resource-efficiency and reduce pollution and waste, but several countries are moving towards programmes that also promote voluntary action to minimize waste.

The recycling of certain types of material, such as paper, steel, aluminium cans and corrugated cardboard, is well underway. In advanced recycling societies, community kerbside recycling initiatives have given way to legislation providing for the application of economic instruments in the context of mandatory take-back programmes, deposit-refund programmes and waste disposal charges, with varying success and levels of complexity relating to the administration and funding of recycling systems. In Japan in 2000, some 1.6 million metric tons of recyclables were collected, with more than 95 per cent of this amount re-manufactured; in Taiwan Province of China, an 80 per cent recycling rate of polyethylene terephthalate (PET) bottles was achieved, but recycling funds soon went into deficit

| Table 2.8 Action to promote waste minimization, recycling and dematerialization |
|-----------------------------|--------------------------------------------------|--------------------------------------------------|---------------------------------|
| Waste minimization          | Waste treatment/disposal charges                 | • Non-refundable fees on non-recyclable or difficult to recycle products – Republic of Korea | • ‘Pay-per-bag’ household waste disposal charges – Philippines, Republic of Korea |
| Waste minimization and recycling | Voluntary ecolabelling                           | • China, India, Japan, Republic of Korea, the Philippines, Singapore, Taiwan Province of China, Thailand. | |
|                             | Voluntary agreements and programmes              | • Packaging Accord & Zero Waste campaign – New Zealand |
|                             | Eco-industrial development                       | • Eco-town projects – Japan |
|                             | Cleaner production policy                        | • Indonesia |
|                             | Waste recovery/conversion                        | • Municipal solid waste conversion to agricultural grade compost – Sri Lanka |
|                             |                                                  | • Municipal waste biogas capture – Bangladesh |
| Recycling                   | Mandatory product take-back                      | • Specific household appliances; consumers pay processing fees – Japan |
|                             |                                                  | • Non-PET containers, used tires, cars, motorcycles, lubricant oils, household appliances and office electronics (expansion to audio devices and cellphones planned); producers pay processing fees into a fund based on sales data – Taiwan Province of China |
|                             | Deposit-refund systems                           | • Producers and importers pay deposits into a special account, and are required to collect and treat wastes; refunds to producers and importers are paid based on recovery rates – Republic of Korea |
|                             |                                                  | • Producers and importers pay into a fund; consumers are refunded based on returns – Taiwan Province of China |
|                             | Compulsory ecolabelling/certification            | • All containers covered by recycling legislation to carry an official recycling symbol – Taiwan Province of China |
|                             | Special recycling programmes                     | • Batteries, cars – Taiwan Province of China |
|                             |                                                  | • Batteries – Hong Kong, China |
| Waste minimization and dematerialization | Disposable goods restrictions                   | • Food service sector items – Republic of Korea |
|                             |                                                  | • Plastic bags less than 20 microns thick – India |
|                             |                                                  | • Foamed polystyrene (styrofoam) – China |
|                             |                                                  | • Plastic bags and bottles, plastic bags – Nepal |
|                             |                                                  | • Disposable packaging – Philippines |
|                             | Packaging design requirements                    | • Restrictions on layers and empty space for consumer goods packaging – Republic of Korea |
|                             |                                                  | • Food, alcohol and CDs – Taiwan Province of China |
because of non-payment and underpayment by firms. In the Republic of Korea, financial incentives that were insufficient to cover recycling costs dampened recycling rates. In Asian and Pacific developing countries, informal recycling activities are an income-earning activity for some of the poorest segments of society, but expose already vulnerable populations to potentially hazardous substances. There has been some success with formalizing informal programmes in Bangladesh.

The rising demand for, and prices of, raw materials have supported the development of an international trade in recyclable materials (minerals and paper in particular), reducing the need for “virgin” raw material (material extracted directly from nature). Exports and imports of recyclable material are shown in tables 2.9 and 2.10. China imports growing volumes of all types of recyclable material. Growth in other countries is much less or declining, partly as a result of the huge pull exerted by Chinese demand, but also in response to tightening restrictions on trade in waste and higher local recycling rates.

The barriers to reducing both the demand for raw materials and raw material intensity (the content of raw material embodied in processed materials and manufactured goods) include “red tape” that hampers international trade in recycled material and a low capacity to process and regulate the trade in potentially hazardous waste. They also include governance weaknesses that facilitate illegal resource extraction and reduce incentives for environmentally and socially sustainable resource extraction activity, as well as the challenge of achieving economies of scale in recycling. Technological development has also focused too long on how to extract more resources, rather than on the efficient use of these resources in production and consumption processes. The authors of Natural Capitalism advocate for improving resource-use efficiency through holistic design approaches and document cost-saving reductions in resource use by firms.60

Perhaps a more important barrier is that economic planning does not yet take into account the impacts of economic development plans on future consumption patterns, resource intensities and waste production. A World Resources Institute study on material outflows61 noted that Austria and Germany’s economic growth patterns resulted in the creation of about the same amount of durable goods and physical infrastructure as the amount of waste produced per person (see chapter 4). This situation was compared with that of the United States of America, where the amount of waste generated per person was three times higher than the amount of durable goods and physical infrastructure created. Austria and Germany’s production and consumption patterns could be described as contributing to investments in long-term wealth, while in the United States of America a much higher proportion of consumption and production can be described as being channelled into producing waste.

For developing countries with significant poverty reduction needs and limited resource bases, the question of whether financial flows are ending up in producing waste or being used to create lasting wealth is clearly one that needs to be answered by policymakers.

2.3.3 Energy demand and sustainable solutions

The consumption of energy in Asia and the Pacific increased by more than 40 per cent between 1990 and 2002, which was twice the global increase in consumption in the same period. Much of this increase fed China’s economic growth spurt over that period. However, there is still a substantial projected unmet energy demand. In 2002, the average per capita energy consumption in the ESCAP region was only about 60 per cent of the global figure. An estimated 270 million people in East Asia and the Pacific and 500 million people in South Asia lack access to electricity services.62 In 2002, 11 per cent of rural households were connected to an electricity supply in Bangladesh, with 17 to 18 per cent connected in Cambodia.63 There is a great disparity in energy supply across the region: developed countries have access to amounts of energy that are approximately four times the overall regional per capita figure.

The expansion of energy supply and infrastructure is a critical requirement of future
Table 2.9 Gross exports of recyclable wastes, 2003

<table>
<thead>
<tr>
<th></th>
<th>Japan</th>
<th>Republic of Korea</th>
<th>China</th>
<th>Taiwan Province of China</th>
<th>Philippines</th>
<th>Thailand</th>
<th>Malaysia</th>
<th>Indonesia</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics</td>
<td>681</td>
<td>82</td>
<td>30</td>
<td>137</td>
<td>25</td>
<td>59</td>
<td>60</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Paper</td>
<td>1970</td>
<td>158</td>
<td>1</td>
<td>15</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>17</td>
<td>0.7</td>
</tr>
<tr>
<td>Iron</td>
<td>5719</td>
<td>307</td>
<td>3</td>
<td>118</td>
<td>494</td>
<td>117</td>
<td>294</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>Copper</td>
<td>307</td>
<td>94</td>
<td>7</td>
<td>75</td>
<td>20</td>
<td>54</td>
<td>471</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Aluminium</td>
<td>69</td>
<td>1</td>
<td>11</td>
<td>59</td>
<td>20</td>
<td>17</td>
<td>31</td>
<td>13</td>
<td>0.5</td>
</tr>
<tr>
<td>Lead</td>
<td>12</td>
<td>0</td>
<td>0.1</td>
<td>0.5</td>
<td>0.6</td>
<td>0.3</td>
<td>19</td>
<td>0.0</td>
<td>0.3</td>
</tr>
</tbody>
</table>


Table 2.10 Imports of recyclable wastes, 1990 and 2003

<table>
<thead>
<tr>
<th></th>
<th>Japan</th>
<th>Republic of Korea</th>
<th>China</th>
<th>Taiwan Province of China</th>
<th>Philippines</th>
<th>Thailand</th>
<th>Malaysia</th>
<th>Indonesia</th>
<th>India*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
<td>23</td>
</tr>
<tr>
<td>2003</td>
<td>15</td>
<td>1</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>1990</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
<td>23</td>
</tr>
<tr>
<td>2003</td>
<td>15</td>
<td>1</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>1990</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
<td>23</td>
</tr>
<tr>
<td>2003</td>
<td>15</td>
<td>1</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
<td>23</td>
<td>8</td>
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<tr>
<td>1990</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>6</td>
<td>24</td>
<td>3024</td>
<td>0</td>
<td>63</td>
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<tr>
<td>2003</td>
<td>15</td>
<td>1</td>
<td>6</td>
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<td>0</td>
<td>63</td>
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<td>8</td>
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<tr>
<td>1990</td>
<td>3</td>
<td>2</td>
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<tr>
<td>1990</td>
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<td>0</td>
<td>63</td>
<td>23</td>
<td>8</td>
</tr>
</tbody>
</table>


Note: * - Data for 1990 based on the figures for April 1990 through March 1991.
economic competitiveness, economic growth and poverty reduction. The UNDP World Energy Assessment Overview (2004 Update) shows that a Human Development Index (HDI) value of 0.8 (about the HDI value of Malaysia) or higher requires a minimum energy use of about 1 tonne of oil equivalent (toe) per year per capita (or 42 gigajoules per capita). Despite the current concern regarding the energy use of rapidly growing developing economies such as China and India, energy use has not yet passed this threshold in either country (Figure 2.16). As a result of political and economic instability following independence from the former Union of Soviet Socialist Republics, economies in transition have all recorded a decline in energy use per capita, a situation that is impacting on both quality of life and prospects for future development.

Energy intensity, or energy used economy-wide per unit of GDP, is a key indicator of patterns of energy use. This indicator, in general, is not a good indicator of efficiency of energy use, unless economies with very similar sectoral and subsectoral compositions are compared or the energy intensities of individual subsectors are calculated. It tends to reflect economic dependence on energy-intensive activity, such as heavy industry. While a country like Japan, with a high contribution to GDP from the services sector, has one of the highest per capita energy use levels in the region, it manages to obtain an average of almost US$6 of GDP from every kg of oil equivalent of energy, while some countries only obtain US$1 of GDP from the same amount of energy. Energy intensities are high in many countries in the region (see chapter 5 and figure 5.4) and increased in Indonesia, the Islamic Republic of Iran, Malaysia, the Philippines, the Republic of Korea and Thailand between 1990 and 2002. Energy demand in countries with high energy intensities, such as Central Asian countries (with the exception of Kyrgyzstan) and the Russian Federation can be expected to increase much more rapidly than in other countries as their economies grow.

Energy consumption by sector

Despite increases in electricity use per capita in the range of 120 (Myanmar) to 472 per cent (Viet Nam) between 1980 and 1990, access to electricity by the general population is still very limited in these and other countries. Electricity makes up only 9 per cent of final energy consumption in the residential sector of the ESCAP region. Combustible renewables (biomass) and waste are the source of 59 per cent of the energy consumed by the residential sector in the developing countries of the region, compared to 4 per cent in the developed countries. Indoor air pollution from burning biomass fuels is responsible for the deaths of an estimated 1.6 million persons globally per year; 59 per cent are women or girls, 56 per cent are children under five, and some 26 per cent (420,000 people per year) die in India alone. The lack of access to clean fuels and energy technology means that those who do not
die from indoor air pollution still pay a high price in terms of lost opportunities for education and income generation; the time and money spent to acquire fuel used in relatively inefficient cooking technologies; and limited opportunities for overall improvements in quality of life. Given the traditional differentiation of the role of men and women in the home in most regional societies, the cost to women is generally higher than to men.

Total energy use in the industrial sector in Asia and the Pacific increased by some 18 per cent between 1996 and 2003.67 Fossil fuels (coal, gas, oil and petroleum products) make up the majority of industrial energy sources (Table 2.11). Section 2.2 showed that industrial production in some of the most energy-intensive sectors (including the production of iron and steel) is growing faster in developing countries than developed countries. Section 2.2 also discussed the fact that, as energy prices increase, energy-intensive production may become more concentrated in countries with lower energy costs (often responding to high energy subsidies or low fuel taxes), accelerating growth in energy demand in these countries.

As incomes increase, developing countries are also facing growth in energy demand from the transport sector. Energy use in this sector increased by some 14 per cent between 1996 and 2003.68 The transport sector is heavily dependent on fossil fuels; it is no surprise that, after electricity generation, the transport sector is the second fastest-growing source of CO₂ emissions and accounts for a growing proportion of fossil-fuel use. Section 2.5 illustrates how changes in consumer preferences and lifestyles have changed energy demand in the transportation sector.

### Meeting the demand for electricity – energy efficiency as a first-line response

Electricity is used by all economic sectors and its generation is the fastest-growing source of CO₂ emissions globally and regionally. Electricity use

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### Table 2.11 Industrial energy consumption – share by type of energy, 2001

<table>
<thead>
<tr>
<th>Source</th>
<th>Total final consumption (million tonnes oil equivalent)</th>
<th>Coal</th>
<th>Crude oil</th>
<th>Petroleum products</th>
<th>Gas</th>
<th>Combustible renewables and waste</th>
<th>Electricity</th>
<th>Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESCAP region</td>
<td>938 951</td>
<td>28</td>
<td>1</td>
<td>26</td>
<td>14</td>
<td>4</td>
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<td>8</td>
</tr>
<tr>
<td>ESCAP developing countries</td>
<td>78 434</td>
<td>30</td>
<td>1</td>
<td>23</td>
<td>15</td>
<td>4</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>ESCAP developed countries</td>
<td>154 517</td>
<td>16</td>
<td>1</td>
<td>41</td>
<td>12</td>
<td>4</td>
<td>26</td>
<td>-</td>
</tr>
<tr>
<td>North-East Asiaa</td>
<td>496 911</td>
<td>39</td>
<td>1</td>
<td>30</td>
<td>5</td>
<td>-</td>
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</tr>
<tr>
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<td>17</td>
<td>3</td>
<td>37</td>
<td>16</td>
<td>10</td>
<td>17</td>
<td>-</td>
</tr>
<tr>
<td>South and South-West Asia</td>
<td>165 350</td>
<td>21</td>
<td>-</td>
<td>27</td>
<td>21</td>
<td>16</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Central Asia and the Caucasus, Russian Federation</td>
<td>171 031</td>
<td>10</td>
<td>-</td>
<td>11</td>
<td>31</td>
<td>-</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>Pacificb</td>
<td>31 613</td>
<td>14</td>
<td>-</td>
<td>14</td>
<td>34</td>
<td>11</td>
<td>27</td>
<td>-</td>
</tr>
</tbody>
</table>


Note:

- a Not including the Russian Federation
- b Geothermal energy accounted for 2 per cent of energy consumption in the residential sector in Pacific countries.
production in Asia and the Pacific grew by 5.6 per cent per annum between 1990 and 2002, with growth slowing slightly during the second half of the 1990s.\textsuperscript{69} In May 2005, it was reported that China’s annual increase in installed capacity reached 50 million kW in 2004, accounting for some 50 per cent of world capacity growth that year.\textsuperscript{70} Despite this growth, continuing shortages in electrical energy are reported in China, with severe outages in 2004 reminiscent of the 1980s. In some cases, shortages are compensated for by off-grid diesel power generators, but they are also increasingly supplemented by biogas, solar photovoltaic (PV) and wind power.

The choice of fuels for electricity generation depends on the application, availability and cost of infrastructure and the cost of the fuel, as well as on the structure of the electricity production sector. Where electrical power generation is highly centralized, fossil fuels continue to be the fuel of choice. After the energy crisis in the 1970s and the rise in the price of oil price, many countries diversified their power sector to other fuel sources.

The growth in demand for electricity is fuelling cross-border trade in energy based on mega-projects within South-East Asia. Hydroelectricity-rich Kyrgyzstan and Tajikistan are earmarked as possible sources of cheap electricity to meet demand in the neighbouring countries of Afghanistan, China, India, Pakistan and the Russian Federation. Meeting the demand for energy via large electricity generation projects, natural gas and oil transportation via pipeline, large hydroelectricity dams, lignite and coal power plants or wind farms has been a source of social conflict in China, India and Thailand.

There are a number of options for increasing both the sustainability of energy supply and access to energy in order to satisfy the demands of growing economies and the aspirations of their populations. Demand-side management describes a range of measures to reduce energy demand, including energy pricing and taxation measures. Energy efficiency is in general the most immediately cost-effective, first-line response to slowing the growth in demand.

A review of key data, opportunities, policy issues and case studies in end-use energy efficiency is provided by ESCAP.\textsuperscript{71} Based on various studies of estimated energy savings and audits, and taking an average potential saving of 20 per cent from average consumption between 1990 and 2000, energy cost savings from energy efficiency measures alone, estimated in 2004, could range from US$5 million (Brunei Darussalam) to US$18 billion (China) per year.\textsuperscript{72} Energy efficiency can be improved at each stage of energy flow through an economy, and energy efficiency measures are generally described as being implemented at the stages of generation, distribution and end-use. Energy efficiency in generation and distribution is generally low, and power theft can also contribute significantly to energy losses. Distribution losses were as high as 30 per cent in Bangladesh in 1992.

Key sectors targeted by end-use energy efficiency initiatives include the industry, transport, construction and buildings and residential sectors. Cleaner production initiatives, described in Section 2.2, show the impressive savings that can result from a minimum investment in energy efficiency in industry. Unstable policy environments or the lack of a clear long-term policy, energy subsidies and a lack of access to financing all serve as disincentives to investment by firms in cleaner energy sources or energy efficiency measures. Small and medium-sized enterprises (SMEs), which have lower access to financing, are less able to make substantial changes. End-use energy efficiency initiatives can also take the form of energy-efficient infrastructure development.

In the context of rapid urbanization and growing urban populations, ensuring that energy efficiency and conservation are explicit objectives in urban development and planning is critical to reducing energy demand on an ongoing basis, since urban infrastructure – as represented by buildings – fixes the energy consumption patterns of large numbers of energy users in all sectors. Energy efficiency in the building sector has significant potential for reducing energy needs (for heating, cooling and lighting, for example) – reductions in energy use of more than 50 per cent, resulting from relatively cost-
effective design provisions, have been reported. However, in terms of energy efficiency options, and as a result of the focus on western-style construction, building energy efficiency is perhaps the least exploited.

A lack of coherence in the building industry, in which architects work separately from climate control specialists, for example, as well as limited incentives for building contractors to ensure lower building operation costs, are also important contributing factors. Construction tendering processes usually focus on building costs on delivery, without taking into account building operation costs such as energy usage. Action in Asian and Pacific countries is also restricted by a scarcity of energy-saving materials for construction and by a lack of awareness. However, the success of the Shinawatra University and other entrants to the ASEAN Energy Award for Energy Efficient Buildings competition that have been successful in reducing energy use through building design show that improvements in the energy efficiency of the construction sector are feasible, even in regional developing countries.

Transportation infrastructure development, as discussed in section 2.4, will be a critical determinant of future energy consumption patterns. Encouraging the use of energy saving mass transit requires both infrastructure development and policies that reduce car use and maximize urban mobility based on public transport. A greater focus on eco-efficient and people-centred mass transit and urban planning which builds cities for people and not for cars, along the lines of the famed Curitiba, Brazil, model maximizes long-term economic, social and environmental benefits. Singapore is noted for its highly efficient mass transit infrastructure and its policies to limit car use to within the capacity of the nation’s roads.

New and renewable energy, distributed energy generation and the Clean Development Mechanism (CDM)

New and renewable energy (solar, geothermal, wind power, biomass and hydropower) makes up a significant proportion of the energy used for electricity generation in some countries of the region, largely due to the contributions from large and medium hydropower plants and combustible waste. More environmentally-friendly renewables, such as solar, geothermal and wind-power, make up, in all countries, limited proportions of total electricity production (see table 2.12), but efforts to expand capacity are accelerating.

Wind energy capacity in Asian countries (mainly China, India and Japan) comprises just over 10 per cent of global wind energy capacity. Indian wind energy capacity ranks among that of the top five countries globally, and is estimated to be growing at a rate of over 30 per cent per year. Armenia has launched its first wind power plant, financed by the Government of the Islamic Republic of Iran. The Philippines launched South-East Asia’s first wind farm in Bangui in July 2005 and the Republic of Korea has made plans to construct what will be the world’s largest tidal energy plant, due for completion by 2009. The 260 MW Sihwa Lake Tidal Power Plant is designed to improve the quality of water in the lake and will benefit from financing through the Clean Development Mechanism.

Despite these efforts, the unmet demand for electricity is high. It has been estimated that only 12 per cent of the people currently without grid access will be connected by 2015. Distributed energy (DE) generation – energy/electricity generated separate from any energy/electricity grid system – not only meets energy needs quickly, but also has significant economic, environmental and social benefits (Box 2.5). After remaining fairly stable for several years, the share of DE generation in the world market, including industrial cogeneration and community-based solar PV, biogas, mini-hydro power and waste-incineration projects, increased marginally from 7 per cent to 7.2 per cent in 2002. Emerging developing country markets are seen as having greater potential than those in industrialized countries. The World Alliance for Decentralized Energy finds that solar PV DE generation growth rates have remained high, in contrast with cogeneration activity, which is susceptible to rising gas prices and persistent regulatory barriers.
Table 2.12 Electricity production capacity – new and renewable energy

<table>
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<td>6 203</td>
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<td>-</td>
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</tr>
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<td>45 325</td>
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<td>-</td>
</tr>
<tr>
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<td>-</td>
<td>5 193</td>
<td>5 260</td>
<td>509</td>
</tr>
<tr>
<td>Pakistand</td>
<td>32</td>
<td>32</td>
<td>4 902</td>
<td>4 902</td>
<td>-</td>
</tr>
<tr>
<td>Philippinesa</td>
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<td>31</td>
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<td>2 524</td>
<td>1 931</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>-</td>
<td>-</td>
<td>3 876</td>
<td>3 876</td>
<td>-</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>-</td>
<td>-</td>
<td>44 345</td>
<td>44 700</td>
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<tr>
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<td>2</td>
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<td>-</td>
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<tr>
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<td>2 886</td>
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<td>1</td>
</tr>
<tr>
<td>Turkey</td>
<td>33</td>
<td>33</td>
<td>11 657</td>
<td>12 225</td>
<td>37</td>
</tr>
</tbody>
</table>

Notes:
- a The 2002 figure for “Combustible renewables and waste” for Australia includes the installed capacity from other renewable sources.
- b Capacity under “Other” for Bhutan is small hydropower (<10 MW).
- c The installed wind energy capacity for the Islamic Republic of Iran consists of 28.4 MW operated by the Ministry of Environment and 120 MW operated by organizations external to the Ministry of Environment.
- d “Large and medium hydropower” for Pakistan includes a capacity of 184 MW and above. “Other” includes power purchased from a small hydropower project.
- e Figure for “Combustible renewables and waste” for the Philippines is in million metric barrels of fuel oil equivalent.
Independent power production (IPP) has the potential to create competitive markets for energy services based on DE generation from waste material (e.g. agricultural waste and industrial gases) and new renewables. The ADB points out that although the introduction of IPP has brought private participation to East Asian electricity markets, competitive markets for power are not generally found. IPP companies typically sell power to state-owned single (monopoly) buyers, which resell power to public consumers. Such arrangements are motivated by the quick access to private financing that they provide to state-owned electricity companies, by the control over strategic infrastructure that can be maintained and by political reasons. They also allow cross-subsidization between large (industrial) and small (residential) consumers, which is important for social and political reasons.

Access to financing for IPP and DE generation in developing countries has been boosted by the entry into force of the Kyoto Protocol and by rising oil, gas, and coal prices which have made such investments more feasible. DE generation projects can result in substantial reductions of CO₂ and other greenhouse gases and present substantial opportunities for financing and increasing internal rates of return via the sale of certified emission reductions (CERs) through the Clean Development Mechanism of the Kyoto Protocol (see section 2.7 and box 2.12). The Danish Ministry of Foreign Affairs has signed agreements with a Thai company for the purchase of CERs. Methane emissions from open wastewater ponds at two starch production plants in Nakorn Ratchasima and Chacherngsao provinces will be collected and used for producing energy within the production process; this is just one example of DE generation projects that take advantage of CDM financing.

Decaying and underdeveloped electricity infrastructure provides ideal market conditions for DE. Three of the five most important emerging global DE generation markets are in large Asian and Pacific countries which have infrastructure of this type – China, India and the Russian Federation. In India, a new electricity law is boosting DE, particularly through cogeneration in the industrial sector. Artificially low electricity tariffs pose challenges to cogeneration developers in China. However, China is set to be an important global centre of DE generation activity; DE already provides some 15 per cent of its total electricity generation and 19 per cent of its total electricity capacity. In Japan, 20 per cent of electricity is expected to be DE-generated by 2030. In the Russian Federation, around 20 to 30 per cent of electricity generation is from cogeneration. In Central Asia, mini-hydro projects have been targeted for investment.

The use of renewable sources of energy in both grid applications (primarily in Japan) and off-grid applications to increase access to electricity, in particular via biogas and solar PV technology, is gathering momentum with the support of initiatives such as the Solar Electric Light Fund, development banks such as the World Bank and national financing arrangements (see box 2.6). Private sector companies and financing agencies have played a key role in many of these initiatives, and the Clean Development Mechanism of the Kyoto Protocol provides a new

Box 2.5 Benefits of distributed energy generation based on renewable sources and cogeneration

- reduction of the “diseconomies of scale” of large plants, which include additional infrastructure, social dislocation and environmental costs;
- reduced project costs, which expands financing opportunities;
- greater speed of execution – faster access to energy;
- lower social and environmental impacts;
- lower, and more widely distributed, maintenance costs;
- increased opportunity to use renewable and lower-carbon domestic fuels, including waste heat and gases from industry;
- lower vulnerability to foreign exchange fluctuations;
- lower vulnerability to increases in oil and gas prices;
- lower vulnerability to natural disasters – higher energy infrastructure redundancy;
- improved energy security; and
- lower demands for water for the cooling of large power plants.
opportunity for financing. For example, 60,000 high quality biogas plants are planned for installation over 21 years in Nepal by the Nepal Government’s Alternative Energy Promotion Centre, with the help of the World Bank’s Community Development Carbon Fund, the Netherlands Development Agency and the Kreditanstalt für Wiederaufbau of Germany. 1.8 million metric tons of CO₂ equivalent will be generated in total emission reductions.83

The World Bank plans to support projects worldwide to provide one million households with electricity, install 1GW of renewable generating capacity and save more than 1GW in fossil fuel power generation through energy efficiency programmes in the years 2006 to 2008. Significant support is being extended to China through the World Bank’s Renewable Energy Scale-Up Project, which will provide investment support and technical assistance.84

These initiatives to develop energy infrastructure based on distributed energy generation and renewable energy are critical because infrastructure development approaches lock countries into specific consumption patterns – without such action consumers have little choice but to use the electricity provided through national infrastructure, the environmental sustainability of which depends on the energy source. Energy infrastructure development planning based on renewable energy and energy efficiency considerations can therefore be considered a form of demand-side management, and is critical to avoiding the environmental, economic and social costs of fossil-fuel based energy infrastructure that are incurred well beyond the construction period and the immediate area of infrastructure deployment, as indicated in box 2.7.

Barriers to the generation of renewable DE include electricity market conditions that discourage private sector involvement in power generation, non-cost-reflective energy pricing, inadequate policy commitment, shortages of investment finance, uncertainty in government policy, low and often subsidized prices of grid-based electricity, high cogeneration and equipment costs and the low prices paid for electricity sold back to the grid by DE projects. As well as the additional financing provided by the sale of CERs through the Clean Development Mechanism, mentioned above, public-private partnerships offer substantial opportunities to reduce poverty and increase access to energy services. In recognition of this, the Government of Indonesia has taken the decision to replicate the pro-poor public-private partnership (5P) micro-hydro project piloted by ESCAP in several other districts.85

Alternative fuels such as natural gas are becoming well-integrated into mainstream transport fuel systems in Thailand (particularly in taxis), and are also increasingly used in certain cities of India. Myanmar is reported to have converted 4,000

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**Box 2.6 Solar PV applications across the region**

- In Japan, subsidized costs for grid-connected PV systems under the 70,000 Roofs Program have been the primary driver of Japan’s PV market expansion. The number of installed residential systems had reached 144,000 by 2002.
- In Sri Lanka, as of March 2005, 66,000 solar home systems had been sold at a rate of about 2,000 per month by private firms with support from microfinance institutions, commercial banks and leasing companies, with World Bank and Global Environment Facility (GEF) support. In Bangladesh, with similar financial support, 43,000 units were sold in under 30 months.
- The Solar Electric Light Fund (SELF) has undertaken projects to install solar PV home units in villages in the Solomon Islands in 1996, and in West Java, Indonesia in 1996 (supported by the Indonesian government). It also established a company in 1997 to install solar PV home systems in Andhra Pradesh and Karnataka, India, working with rural banking groups which provide subsidized financing for solar home system purchasers.
- Under China’s Renewable Energy Development Project, more than 265,000 solar PV units had been sold as of March 2005, adding to the 25,000 units already in use in 2001.
- In Sri Lanka, the NGO Light Up the World and Stanford University have teamed solar PV systems with light-emitting diode technology to dramatically downsize and reduce total system costs to as low as US$40 per year.
- In the Philippines, the number of solar PV units in use jumped from 5,120 in 2001 to 7,786 in 2002. In Mongolia in 2001, 1,100 solar PV units were in use.
vehicles to run on compressed natural gas during 2005, with buses making up more than 75 per cent of this number.

Biofuels are another alternative being promoted as cleaner-burning, lower-carbon fuels with relatively low toxicity. Produced from renewable domestic sources, they can improve energy security by reducing dependence on fossil fuel imports and promote agribusiness growth. These fuels include biodiesel (from palm oil, soybeans, sunflower and safflower seeds, used kitchen and animal oils and coconut oil) and ethanol (from sugar cane, cassava, wood waste, rice-mill husks and other biomass sources). Gasohol (a blend of gasoline and ethanol) is commercially available in Thailand, while biodiesel is available in India. Malaysia’s capacity to produce biodiesel from palm oil is being expanded.

**Fossil fuel pricing and industrial policy support**

Appropriate fossil fuel pricing can play an important role in enhancing energy efficiency, and can make other fuels and technologies (for example natural gas, or fuel cell technology) more economically feasible; a positive relationship between energy efficiency and fuel prices has been noted in several publications. There is a vast range of fuel prices throughout the region, with Turkmenistan, at one end of the scale, having one of the lowest fuel prices of 172 countries worldwide; prices in Malaysia, Azerbaijan, China, the Philippines, the Russian Federation, Bangladesh, Tajikistan, New Zealand and Bhutan are higher; while Japan and the Republic of Korea have the highest prices in the region, these prices being within the top five highest fuel prices of 172 countries worldwide. However, it is clear that fuel pricing alone cannot influence total energy demand. There is also a need for strong state policy and support for technological change.

A comparison of the Republic of Korea and China is illustrative. In the Republic of Korea, CO2 emission growth remains coupled to economic growth, and it is one of the few countries in the region in which energy intensity (energy used per unit GDP) increased between 1990 and 2002 – this despite its having one of the highest fuel prices in the world, as well as high fuel taxes. Structural changes in the industrial sector, as well as increasing consumption, may have outweighed any improvements in energy efficiency that may have been gained through higher energy prices. By contrast, China, with a fuel price less than half that of the Republic of Korea and two thirds that of India, has managed to significantly decouple CO2 emissions (a major waste product of fossil fuel consumption) from economic growth (see chapter 3).

### 2.4 Pressure on water supplies

When it comes to its water resources, Asia seems to live beyond its means. Despite having the lowest water availability per capita of all global regions (Table 2.13), Asia uses almost twice as much water per capita as Latin America, which has the highest potential water availability in the world. This situation is partly attributable to the high dependence of Asian countries on irrigated agriculture. At the same time, water use and management are notoriously inefficient in most countries of the region, with the exception of a few countries such as Singapore and Japan.
These patterns of water use belie the reality – clean water is in fact a precious and scarce resource in many parts of the region. Almost one in five people in the region still do not have access to safe drinking water, and almost half of the regional population does not have access to sanitation facilities. Water withdrawals continue to rise, with the most rapid growth in those countries in South Asia with high population growth rates and in the rapidly industrializing economies of South-East Asia (Figure 2.17).90

To compound the problem, some of the countries with the lowest per capita water availability also have among the worst water qualities in the region. Many countries, particularly those with arid climates and those with an expanding industrial base, are finding that ensuring that long-term needs are met is an increasing challenge. In Thailand, India and China (and possibly in other countries), water shortages are reportedly limiting industrial production in localized areas to varying extents, and droughts have reduced agricultural productivity and livelihoods in every subregion. Managing water resources to meet competing demands in the agricultural, industrial, residential and increasingly the services sector (in particular tourism) is complicated by a high variation in the distribution of water resources, in both temporal and spatial terms, across the region. As a reflection of the urgency of water issues, the United Nations declared 2005 to 2015 the ‘Water for Life’ International Decade for Action.

Table 2.13 Potential water availability, 2004 (’000 m³ per year)

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<thead>
<tr>
<th></th>
<th>per km²</th>
<th>per capita</th>
</tr>
</thead>
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<td>Australia &amp; Oceania</td>
<td>268</td>
<td>83.60</td>
</tr>
</tbody>
</table>


2.4.1 Assessing the sustainability of the water supply

Many Asian and Pacific countries are already using too much of their existing water resources to be able to ensure that future water needs are met. Based on the water exploitation index (Figure 2.18),91 current water extraction rates may be placing at least 16 countries in the region in situations of water stress – in other words, intermittent or chronic water scarcity and a diminished ability of natural ecosystems to replenish themselves. Per capita water availability, another indicator of water stress92 (Figure 2.19) is declining as populations continue to grow, particularly in India and other parts of South and South-West Asia where population expansion continues unabated.

The water exploitation index of the Islamic Republic of Iran places this country in the category of countries facing “severe” water stress. Growing water scarcity in this country is expected to heighten tensions between water users, accelerate migration and exacerbate water crises, as well as cause serious environmental degradation.93 Indicators such as the water exploitation index and per capita water availability are valuable, but can only roughly describe the situation on the ground in each country. Despite falling into the category of countries facing “stress” rather than “severe stress”, China is almost chronically unable to meet all of its
Environmental sustainability under threat

Figure 2.18 Water exploitation index, 2000

Figure 2.19 Water availability per capita, 2003-2007

water needs, with a 40 billion m$^3$ shortage in a normal year, and with 400 out of 663 cities suffering water shortage (108 suffering serious water shortage) in 2000.\textsuperscript{94}

Although indicated as a 'no water stress' country based on the water exploitation index, relatively water-rich Indonesia is now facing increasing water supply problems, particularly with respect to the supply and quality of water in its major cities.\textsuperscript{95}

Population growth, growing consumption, environmental damage, harmful agricultural activities, poor management of water catchment areas, pollution, industrialization and groundwater overuse are responsible for this situation. Indonesia's situation illustrates the impact of poor water quality on the ability of even a water-rich country to meet its needs. Countries that are relatively less well-endowed with water are even more severely affected.

Figure 2.20 relates water quality and availability to identify the countries where the coincidence of poor water quality and low water availability is likely to pose the greatest challenges. It indicates that many of the countries in the region with the least available water per person also have some of the worst water quality. The water resources of Azerbaijan, China, India, the Islamic Republic of Iran, Pakistan, Thailand, Turkey and Uzbekistan are among those severely stressed.
under the most pressure in the region. In China, some 52 urban river stretches may be so contaminated that they cannot be used for irrigation. A 2001 survey of water quality in Islamabad and Rawalpindi, Pakistan, showed 94 per cent of samples unsuitable for drinking due to bacteriological contamination, 34 per cent affected by fecal contamination and 12.8 per cent of samples unsuitable for drinking due to high nitrate levels. Poor water quality also increases the costs of water treatment and distribution.

While the per capita water availabilities in Japan and the Republic of Korea are both relatively low, the much higher overall quality of water places these countries in a better position to meet their water needs. There have been some improvements in water quality in the region, particularly in Japan and the Republic of Korea but water quality continues to decline in many of its developing countries.

As indicated in State of the Environment in Asia and the Pacific 2000, the main water pollutants of concern in most countries in the region are microbial pollutants (mainly from domestic sewerage), toxic chemicals and heavy metals (from agricultural activity, waste disposal and industrial production processes) and phosphates and nitrates (from agricultural production, domestic sewage and industrial discharge). Measures to reduce pollution from point sources such as industrial processes have had some success, but reducing water pollution from non-point sources such as agricultural production and domestic sewerage (particularly where water treatment infrastructure is lacking), and from groundwater contaminating sources such as sewerage systems and landfills, is increasingly difficult to achieve. Naturally occurring contaminants, described below, pose a particular threat to groundwater quality.

While water quality and patterns of resource exploitation are reducing the ability to meet water needs in several countries, the economically accessible freshwater endowment may be decreasing as natural water infrastructure, such as river systems, freshwater lakes, floodplains, wetlands, forests and other vegetative cover in river basins and aquifers,
come under threat from development. High losses of watershed forest cover are increasing run off rates, reducing aquifer recharge and increasing the variability of water flow. Table 2.14 shows the river basins with some of the highest percentage losses of original forest cover in the region.

The increasing pressure on natural water infrastructure also threatens other critical ecosystem goods and services. River systems and other inland water bodies are important as freshwater fisheries, sometimes providing the primary source of protein for rural communities. The lower Mekong River Basin produces two million metric tons of fish and other species annually for human consumption. Two thirds of this amount comes from natural wetlands. Wetlands provide groundwater recharge, waste-treatment and detoxification services, and potentially reduce nitrate concentrations by more than 80 per cent. The Millennium Ecosystems Assessment also notes that “they have significant aesthetic, cultural and spiritual values and provide invaluable opportunities for recreation and tourism.” The declining ecological integrity of freshwater systems is signaled by the decline of freshwater biodiversity. As shown by the Living Planet index, freshwater vertebrate species have declined most rapidly, and most consistently, compared to other species groups.

Climate change has already resulted in changed precipitation patterns and will result in further disruptions of the water cycle. Evidence of decreases in snow cover and the retreat of glaciers due to global warming has been reported from various parts of the Hindu Kush-Himalayan region, and have serious implications for its hydrology. In March 2005, the International Commission for Snow and Ice reported that Himalayan glaciers were rapidly melting. The glaciers that feed the Ganges, Indus, Brahmaputra, Mekong, Thanlwin, Yangtze and Yellow rivers are experiencing reduced snowfall in winter, followed by increased melt caused by monsoonal rains. These are predicted to lead to floods and an increased frequency of glacial lake outbursts, followed by a reduction in river flows. The countries likely to be most affected are India, Bangladesh, Nepal, Bhutan and China, as well as the countries that share the greater Mekong River Basin, with significant impacts expected within a few decades. Central Asia may be facing a similar situation, given that most river systems in this area are glacier- and snow-fed.

The vulnerability of countries to the multiple threats to sustainability of low water availability, poor water quality, high water extraction rates and climate change is heightened by dependence

<table>
<thead>
<tr>
<th>Countries sharing watershed area</th>
<th>River(s)</th>
<th>Per cent forest cover</th>
<th>Per cent loss of original forest cover</th>
<th>Per cent cropland</th>
<th>Number of large cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Godavari</td>
<td>6.8</td>
<td>76.9</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Thailand</td>
<td>Chao Phraya</td>
<td>35.4</td>
<td>77.3</td>
<td>44.7</td>
<td>3</td>
</tr>
<tr>
<td>China</td>
<td>Huang He (Yellow River)</td>
<td>1.5</td>
<td>78.0</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>India</td>
<td>Mahanadi</td>
<td>8.1</td>
<td>79.4</td>
<td>59.5</td>
<td>1</td>
</tr>
<tr>
<td>China, Viet Nam</td>
<td>Hong (Red River)</td>
<td>43.2</td>
<td>80.0</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>India</td>
<td>Krishna</td>
<td>2.8</td>
<td>80.2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>Zhu Jiang (Pearl River)</td>
<td>9.8</td>
<td>80.4</td>
<td>66.5</td>
<td>4</td>
</tr>
<tr>
<td>India, Nepal, Bangladesh</td>
<td>Ganges</td>
<td>4.2</td>
<td>84.5</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>China</td>
<td>Yangtze</td>
<td>6.3</td>
<td>84.9</td>
<td>47.6</td>
<td>9</td>
</tr>
<tr>
<td>Tajikistan, Afghanistan, Uzbekistan, Turkmenistan, Kyrgyzstan</td>
<td>Amu Darya</td>
<td>0.1</td>
<td>98.6</td>
<td>22.4</td>
<td>9</td>
</tr>
</tbody>
</table>

on water resources from outside the country. Azerbaijan, Bangladesh, Cambodia, India, Kazakhstan, Lao People’s Democratic Republic, Pakistan, Thailand, Turkmenistan, Uzbekistan and Viet Nam are estimated to receive more than 30 per cent of their water from outside of the country (Figure 2.21). Where there is a situation of water stress coupled with high dependence on water originating outside the country, water-security issues are becoming more important and may prove to be a source of tension.

Meeting the needs of high concentrations of water-consuming populations on the coast has the potential to reduce the sustainability of water supply as increasingly large volumes of wastewater are discharged uselessly into the sea and coastal aquifers become more susceptible to saltwater intrusion. Some 40 per cent of the region’s population lives within 100 km of the coast, and this proportion will increase as urbanization proceeds.

**Figure 2.21 Water dependency ratio, 2000**

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage of water resources originating from outside the territory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkmenistan</td>
<td>90</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>85</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>80</td>
</tr>
<tr>
<td>Pakistan</td>
<td>75</td>
</tr>
<tr>
<td>Cambodia</td>
<td>70</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>65</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>60</td>
</tr>
<tr>
<td>Thailand</td>
<td>55</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>50</td>
</tr>
<tr>
<td>India</td>
<td>45</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>40</td>
</tr>
<tr>
<td>Tajikistan</td>
<td>35</td>
</tr>
<tr>
<td>Myanmar</td>
<td>30</td>
</tr>
<tr>
<td>Afghanistan</td>
<td>25</td>
</tr>
<tr>
<td>Armenia</td>
<td>20</td>
</tr>
<tr>
<td>DPR Korea</td>
<td>15</td>
</tr>
<tr>
<td>Georgia</td>
<td>10</td>
</tr>
<tr>
<td>Islamic Rep. of Iran</td>
<td>5</td>
</tr>
<tr>
<td>Rep. of Korea</td>
<td>5</td>
</tr>
<tr>
<td>Nepal</td>
<td>5</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>2</td>
</tr>
<tr>
<td>China</td>
<td>2</td>
</tr>
<tr>
<td>Turkey</td>
<td>2</td>
</tr>
</tbody>
</table>


2.4.2 Groundwater – at special risk

Poor surface water quality and localized, periodic or seasonal surface water scarcity mean that groundwater is increasingly being tapped. The exploitation of groundwater resources is leading to a rapid lowering of water tables across China, the Philippines, India, Pakistan, the Islamic Republic of Iran and to the growing exploitation of deeper aquifers. Sinking groundwater tables have resulted in diminished grain harvests in India and China. Groundwater depletion does not only affect agricultural harvests; poor communities that depend on shallow drinking-water wells, and urban centres that depend on groundwater, also pay the price of overly rapid extraction. In Jakarta, Indonesia, and Dhaka, Bangladesh, a large proportion of water is supplied from aquifers, and Quetta, Pakistan may run out of water by 2018, based on the rate at which its water table is falling.

Deep aquifers which are usually exploited as a last resort recharge so slowly that they are, for practical purposes, not considered renewable sources of water. Where the hydrology of a country is particularly fragile, such as in the Pacific islands, or is highly dependent on slowly recharging groundwater systems, a concentrated water demand presents a greater challenge to the sustainability of the water supply. The overexploitation of coastal aquifers, coupled with sea-level rise, has resulted in saltwater intrusion in some Pacific island countries and in Bangkok, Thailand, and Jakarta, Indonesia, among other cities.

While some rehabilitation of polluted surface water systems is possible, pollution of groundwater is, for practical purposes, cumulative and permanent. The more a groundwater source is used, the more vulnerable it is to pollution. A survey of groundwater in the late 1990s in 22 industrial zones in India found that all were unfit for drinking. A more recent survey showed that about 90 per cent of groundwater under China’s cities was polluted by heavy metals, pesticides, petroleum products and other toxic chemicals.

Groundwater pollution also comes from naturally occurring sources. Arsenic contamination
of groundwater has been confirmed in the aquifers of Afghanistan, Bangladesh, Cambodia, China, India, the Islamic Republic of Iran, Myanmar, Nepal, Pakistan, Thailand and Viet Nam. It is believed that Bangladesh, Nepal, Myanmar, the West Bengal Province of India and Viet Nam are among the most affected areas in the region (Table 2.15). In Cambodia, a groundwater quality survey covering 100 wells showed that almost one in ten may have had arsenic levels above WHO guideline threshold values. The scale of the arsenic crisis in Asia, however, is just coming to light. Conservative estimates put the total number of people drinking arsenic-contaminated water at over 60 million in the Asia. Although the actual number of Asian arsenicosis cases is not yet known, the estimates from published cases suggest that as many as 200 million people may be exposed to health risks associated with arsenic-tainted drinking water on a daily basis.

Long-term exposure to arsenic-contaminated groundwater can lead to serious health problems, collectively called arsenicosis, which include skin lesions, skin cancers, internal cancers affecting the bladder, kidney and lungs and hypertension. It is estimated that approximately 100 million people are exposed to arsenic-contaminated groundwater in various parts of world.

Other naturally occurring contaminants include fluoride. An estimated 66 million people in India drink groundwater with an excessive fluoride content, which, unless treated, leads to serious dental and skeletal deformities and other health problems. In China, the water supplies of some 63 million people are similarly affected.

### 2.4.3 Industrial water use

Industrialization puts pressure on water resources in two ways – it consumes water in its production processes (as “virtual water”), where it is either lost as steam or incorporated into a product, and then uses water as a waste sink by disposing of polluted wastewater directly or indirectly into water bodies.

The global demand for water to support industrial activity is projected to double between 2000 and 2025. Much of this growth is likely to continue to occur in the Asian and Pacific region, given its rapidly rising status as a global industrial production centre and the fast growth in subsectors with high water consumption, such as the production of transportation equipment, beverages or textiles. India’s industrial water use, for example, is expected to almost quadruple by 2050. Water shortages at the height of drought have temporarily slowed industrial activity in parts of Thailand and India. In China, water shortages have been responsible for an estimated annual loss of some US$28 billion in industrial output in recent years.

Little attention has been paid to the intensity of water use in the industrial sectors in the region. As figure 2.22 shows, the amount of water used to produce US$1 of GDP from the industrial sector varies widely. India’s industrial plants are estimated to consume 2 to 3.5 times more water per unit in production than similar plants in other countries. In addition to the efficiency of water use at the firm level, the productivity of the use of water is determined by the industrial subsectoral composition. Some countries which have adopted relatively unprofitable patterns of water use are relatively water-stressed and also use relatively high proportions of water for industry (Figure 2.23).

Poor plant safety in industries which use water courses as waste-sinks also poses the threat of industrial disaster (box 2.8).

<table>
<thead>
<tr>
<th>Country</th>
<th>Numbers affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>35 000 000</td>
</tr>
<tr>
<td>Cambodia</td>
<td>30 000</td>
</tr>
<tr>
<td>China</td>
<td>2 200 000</td>
</tr>
<tr>
<td>India</td>
<td>6 000 000</td>
</tr>
<tr>
<td>Iran (Islamic Republic of)</td>
<td>10 000</td>
</tr>
<tr>
<td>Myanmar</td>
<td>5 000 000</td>
</tr>
<tr>
<td>Nepal</td>
<td>500 000 – 12 000 000</td>
</tr>
<tr>
<td>Thailand</td>
<td>1 000</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>11 000 000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>59 741 000 – 71 241 000</strong></td>
</tr>
</tbody>
</table>

Source: Based on ESCAP data collected by survey between 2000 and 2002.
### 2.4.4 Agricultural water use

Water is already a limiting factor for agricultural production in Asia and the Pacific, with drought conditions and lowered aquifer levels depressing agricultural productivity across every subregion. Drought conditions diminished food security and affected more than 600 million people across the region between 1995 and 2004. In 2005, Afghanistan was in the sixth year of its worst drought in 30 years; in 2004, the drought had reduced cereal production by an estimated 25 per cent and lowered GDP growth for fiscal year 2004 to an estimated 7.5 per cent (from 15.7 and 28.6 per cent, respectively, in the two previous years). In 2005, Australian farmers seeking to make a living on the driest inhabited continent were in the grip of its worst drought in decades. The drought had reduced cereal production by an estimated 25 per cent and lowered GDP growth for fiscal year 2004 to an estimated 7.5 per cent (from 15.7 and 28.6 per cent, respectively, in the two previous years). In 2005, Australian farmers seeking to make a living on the driest inhabited continent were in the grip of its worst drought in decades.

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**Figure 2.22 Water intensity of industrial production, 2000**


**Figure 2.23 Industrial water use, 2000**

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**Box 2.8 Focusing on industrial pollution – a disaster of human origin**

Water pollution is a well-attested consequence of industrialization, but in the wake of the explosion of the petrochemical plant of the Jilin Petrochemical Corporation, China, on 13 November 2005, greater attention is likely to be paid to the impacts of industrial disaster on water resources. As a result of this explosion, an estimated 100 metric tons of pollutants (benzene, nitrobenzene and aniline) entered the nearby Songhua River. With peak concentrations of nitrobenzene reaching over 33 times the permissible level, the plume of polluted water reached Harbin city on 25 November 2005. The plume of pollutants made its way to the town of Khabarovsk, in the Russian Federation, necessitating the interruption of water supplies to approximately 10,000 people. China and the Russian Federation joined forces to monitor pollution levels under a joint emergency response monitoring plan. The frequency of such accidents, although on a smaller scale, is high.

drought in 20 years; high rural suicide rates were linked to this drought, a situation which was replicated in India.

In more than 29 countries in the Asian and Pacific region, more than 60 per cent of the water usage is for agriculture; in 15 countries, this figure rises to more than 90 per cent. Regional agricultural production increased by some 62 per cent between 1989-1991 and 2002, compared with a global increase of only 27 per cent in the same period. Irrigated areas as a percentage of total agricultural areas increased in the region by some 2.5 per cent in 10 years, a rate 25 times faster than that in the rest of the world, with major growth occurring in South-East and South Asia.111

Inefficient surface irrigation systems are employed in more than 90 per cent of Asian irrigated areas. Poor maintenance and the misuse of surface irrigation systems have been linked to land degradation, increased soil erosion rates and salinization, all of which degrade water quality. Water-use efficiency in Indian surface-water irrigation systems is estimated to be in the range of 35 to 40 per cent.112 Although agricultural water use returns much of the water to the water cycle, either through evaporation or run-off, high intensities of pesticide and fertilizer use contaminate run-off. In China, inadequate attention to maintenance is manifested in the 60 per cent of systems operating below capacity and the 30 per cent of canals in a precarious state;113 the situation is similar in Central Asia. Improperly maintained surface irrigation systems also create the conditions for outbreaks of Japanese Encephalitis and other mosquito-related diseases. In India, the human death toll from Japanese Encephalitis exceeded 1,000 in 2005, mainly in the state of Uttar Pradesh. In southern Nepal, the human death toll from this disease approached 300 in a three-month period.114

Less than one per cent of Asian and Pacific irrigated areas benefit from micro/drip irrigation systems, in which drip lines bring water directly to the plant root zone. In addition to reducing water use by some 95 per cent, these systems facilitate efficient fertilization and avoid the nitrification of water sources associated with excessive surface application of mineral fertilizers.115 The willingness of farmers to invest in more efficient irrigation systems can be limited by plot size, water subsidies and insecure land tenure. However, new, more affordable irrigation technologies make these systems an increasingly feasible option in some cases.

As discussed in section 2.5, the growing demand for water in this sector is also attributable to changing consumer preferences, the export focus of production and increased buying power. Producing one kilogram of beef requires some 15 m$^3$ of water per kilogram, while producing one kilogram of poultry requires less than half that amount (Table 2.16). The production of crops with a high water content for export (for example, citrus fruit) results in losses of virtual water, as in the industrial sector. Thailand, identified by its water exploitation index as a water-stressed country, is also ranked as the fourth largest net exporter of virtual water, having exported some 233.3 billion m$^3$ of water along with its world-famous fruits and other agricultural produce in the five years between 1995 and 1999. Two other fairly water-scarce countries, India and Australia, are not far behind. Sri Lanka leads Japan, the Netherlands, the Republic of Korea, China and India as the top net virtual water importer in the world (see box 2.11).116

While biofuels are being touted as a solution to rising energy prices, air pollution and CO$_2$ emissions from the transport sector in particular, their environmental impact and, in particular, their

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**Table 2.16 Water requirement of main food products**

<table>
<thead>
<tr>
<th>Product</th>
<th>Unit</th>
<th>Water required, m$^3$ per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>Head</td>
<td>4 000</td>
</tr>
<tr>
<td>Sheep and goats</td>
<td>Head</td>
<td>500</td>
</tr>
<tr>
<td>Fresh beef</td>
<td>kg</td>
<td>15</td>
</tr>
<tr>
<td>Fresh lamb</td>
<td>kg</td>
<td>10</td>
</tr>
<tr>
<td>Fresh poultry</td>
<td>kg</td>
<td>6</td>
</tr>
<tr>
<td>Cereals</td>
<td>kg</td>
<td>1.5</td>
</tr>
<tr>
<td>Citrus fruits</td>
<td>kg</td>
<td>1</td>
</tr>
<tr>
<td>Palm oil</td>
<td>kg</td>
<td>2</td>
</tr>
<tr>
<td>Pulses, roots and tubers</td>
<td>kg</td>
<td>1</td>
</tr>
</tbody>
</table>

impact on water demand should be taken fully into account when assessing both the positive and the negative impacts of their use.

Despite the critical role played by the agricultural sector in ensuring food security and as a basis for rural livelihoods, the agricultural sector is not given priority in times of water shortage; socio-political biases regarding the allocation of water can work against a long-term planning perspective. During ongoing droughts, while irrigation water is denied to farmers who suffer severe economic hardship and loss of productivity, these droughts rarely affect the lifestyles of city-dwellers, who usually continue with former patterns of water use except in the most dire of scarcity situations.

2.4.5 Unmet domestic water needs

Millennium Development Goal 7, Target 10 seeks to halve the proportion of people without sustainable access to safe drinking water and improved sanitation by 2015. For the purposes of monitoring, progress against the goal of “improved sanitation” refers to the installation of facilities that hygienically separate human excreta from human, animal and insect contact. Facilities such as sewers or septic tanks, poor-flush latrines and simple pit or ventilated improved pit latrines are assumed to be adequate, provided that they are not public. “Improved” or “safe” water refers to piped water, or to water from public taps, boreholes or pumps, protected wells, protected springs or to rainwater and, for statistical purposes, does not include vendor-provided water, bottled water, or water from tanker trucks or unprotected wells and springs\textsuperscript{117}.

In Asia and the Pacific, an estimated 665 million people (almost one in five people) were without access to improved water and some 1.9 billion (almost one in two people) were without access to improved sanitation in 2002 (Table 2.17).\textsuperscript{118} In absolute terms, the investment needed for Asia to meet Millennium Development Goal 7, Target 10 outstrips that required for Africa, Latin America and the Caribbean combined.\textsuperscript{119}

Between 1990 and 2002 the number of people without access to sanitation increased in some countries, such as Indonesia, the Islamic Republic of Iran, Nepal, Papua New Guinea, Turkey and Uzbekistan. During the same period, infrastructure development to provide safe drinking water did not keep pace with population increases in Bangladesh, Papua New Guinea, the Philippines, Uzbekistan and Viet Nam.\textsuperscript{120}

The ADB estimates that the investment required to halve the proportion of people without sustainable access to improved water and sanitation would be US$8 billion annually until 2015, and around twice as much to provide access to all the unserved people of the region.\textsuperscript{121} A lack of finance is a chronic problem for the water and sanitation sector, and it is most difficult to attract finance from the private sector for sanitation infrastructure.

Besides placing a strain on national treasuries, meeting water and sanitation needs based on current water use and management models would drain water reserves throughout the region. A person with access to a piped water supply and underground sewerage system uses about three times the amount of water as someone in a rural area with only limited access to a piped supply and no underground sewerage. Housing improvements and the increased use of washing machines and water heaters in China increased per capita daily household water consumption from less than 100 litres in 1980 to 244 litres in 2000.\textsuperscript{122} Domestic water demand is also expected to triple in India by 2050.

Progress towards meeting this demand will be hampered by high levels of distribution losses. In India, some 50 per cent of total water flow is lost.\textsuperscript{123} In Armenia, 60 per cent of pipelines are more than 20 years old. There are other hurdles to be overcome. In those countries with the highest numbers of people without access to improved sanitation and water, such as Indonesia, Bangladesh, Pakistan and Viet Nam water services provision is characterized by high levels of unaccounted-for water and low local government capacity to shoulder the burden of water and sanitation services provision. Tariff structures that do not reflect the true cost of providing water, a lack of metering, outdated and malfunctioning or non-functional meters and/or unauthorized connections to a water supply also play their part by limiting incentives for private and public sector investment in infrastructure upgrades.
Even where relatively efficient water administration exists, the poor – particularly migrant workers, female-headed households and those in slum areas – find it difficult or impossible to meet the preconditions for obtaining a water connection from the water utility. In some countries for which the data indicates good access to improved drinking water, many people receive limited hours of service and water of questionable quality. Some South Asian country utilities provide intermittent supplies to their service areas, while some South-East Asian country utilities provide limited service coverage.124

Those who do not have access to improved drinking water are particularly exposed to risks from contaminants, but even those with piped water sources are at risk. Health impacts can range from gastrointestinal disease and infectious diseases such as cholera, chronic illnesses and organ damage to cancers associated with toxic contaminants. Some 300 million people living in China’s countryside drink unsafe water.125 Waterborne disease fatalities and the number of persons affected show how poor water quality, a lack of access to improved water and water scarcity place a strain on health care systems (Box 2.9).

### 2.4.6 Meeting future water demand

Assuring equitable and adequate access to water to meet human needs, support economic activity and to ensure the continued provision of water-related ecosystem goods and services will depend on the

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Table 2.17 Access to improved sanitation and improved drinking water (2002)

<table>
<thead>
<tr>
<th></th>
<th>Without access to improved sanitation</th>
<th></th>
<th>Without access to improved drinking water</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rural %</td>
<td>Urban %</td>
<td>Total No. ('000)</td>
<td>%</td>
</tr>
<tr>
<td>North-East Asia, total (1)</td>
<td>67</td>
<td>23</td>
<td>759 081</td>
<td>47</td>
</tr>
<tr>
<td>China</td>
<td>71</td>
<td>31</td>
<td>711 321</td>
<td>55</td>
</tr>
<tr>
<td>North-East Asia (1) excluding China</td>
<td>29</td>
<td>9</td>
<td>47 760</td>
<td>14</td>
</tr>
<tr>
<td>Central Asia and the Caucasus</td>
<td>51</td>
<td>20</td>
<td>27 302</td>
<td>37</td>
</tr>
<tr>
<td>Pacific islands (2)</td>
<td>53</td>
<td>19</td>
<td>3 603</td>
<td>45</td>
</tr>
<tr>
<td>South and South-West Asia, total</td>
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<td>100 281</td>
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<tr>
<td>South-East Asia (3) excluding Indonesia</td>
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<td>13</td>
<td>198 243</td>
<td>33</td>
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</table>

**Asia-Pacific (4)** 68 25 1 930 517 51 25 6 664 634 171


Notes:
(1) Excluding Hong Kong, China and Macao, China
(2) Excluding Australia, American Samoa, Nauru, New Caledonia and New Zealand
(3) Excluding Brunei Darussalam. Data for Malaysia not available for urban and total access to sanitation
(4) Excluding above-mentioned countries
region’s ability to bring or maintain water withdrawal within the limits of sustainability, prevent water pollution, maintain the integrity of the water cycle and develop equitable and efficient water allocation policies.

**Developing equitable and efficient water-allocation and sharing policies**

The current practice of water allocation, in which water is unceremoniously expropriated from one use to another in times of scarcity, results in social conflict and fewer incentives to create long-term policies for water efficiency or management. In countries affected by drought, or countries where water extraction is unsustainably high in relation to existing resources, long-term and equitable water allocation policies are needed. Such policies should span the environmental, economic and social sectors and address long-term water stress or scarcity, as well as seasonal water scarcity such as drought. Not least, such policies should provide incentives for increased water efficiency and investment in the provision of water resources management and ensure the continued functioning of ecosystems to protect the integrity of the water cycle and to support biodiversity and rural livelihoods.

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**Box 2.9 Reports of disease linked to water scarcity and poor water quality, selected countries, 2004-2005**

- In Eastern China, during September and October 2004, over 180 cholera cases were reported;
- Cholera claimed upwards of 1500 lives in the Islamic Republic of Iran during mid-2005;
- Almost 2 in 10 people in Uzbekistan suffer from diarrhoea every month;
- In the Philippines, diarrhoea outbreaks in October-December 2005 caused by dirty water in deep wells in Samar and Catanduanes killed at least six and affected at least 370 people. In San Andres and Virac water contaminated by *Escherichia Coli* resulted in the deaths of 14 people in September 2005;
- In one city in Bangladesh, over 18,000 people were treated for diarrhoea between January and March 2004. The wave of illness was attributed to the scarcity of safe drinking water and the intake of stale or rotten food;
- In India, most of the 1,500 patients admitted to hospital in Kolkatta in a 12-day period during April 2004 were found to be suffering from cholera following consumption of contaminated piped water. In Karnataka state during December 2005, 70 people in one village fell ill from gastro-enteritis, claimed by villagers to be a result of groundwater contamination by effluents from a nearby distillery. In October 2005 in Madras, more than 100 people fell ill from waterborne diseases linked to unsanitary conditions and contaminated water;
- In Malaysia, the deaths of four children of an indigenous tribe in April 2004 were linked to water contamination. Salmonella infection was implicated in the death of at least one of the children, while other waterborne diseases were suspected in the cases of the others; and
- In Nepal in the village of Rautahat, over 100 people were affected by an outbreak of diarrhoea, blamed on contaminated food and water as well as on rising temperatures.

Vulnerability to waterborne disease increases after a natural disaster. In the Philippines and Bangladesh, deaths from waterborne diseases are often a consequence of the frequent floods. In the Philippines between August and September 2005, diarrhoea killed 30 people and affected 450 others, while cholera affected over 180 people and killed five. In Bangladesh between July and August 2004, more than 176,000 people were affected by diarrhoea in the post-flood period.

Meinzen-Dick and Appasamy\textsuperscript{126} propose that negotiated transfers can avoid the problems of the expropriation of water. They provide an innovative example of negotiated transfer, in which cities pay for investments in rural irrigation water conservation (such as through the upgrade of irrigation infrastructure), and then use the “saved” water to meet their needs – a national scheme for reduced water use analogous to the Clean Development Mechanism for greenhouse gas emissions, and that may be scaled up to apply to cross-border water transfers. Box 2.10 highlights a practical approach to transboundary water sharing.

**Supply-side approaches**

Supply-side approaches – watershed management, water storage (including dams) and diversions between basins – are currently considered important water resources management approaches by many countries, and have benefits relating to hydroelectric power generation, flood control and water diversion which can contribute to offsetting their often negative social and environmental impacts. In November 2002, the Government of China approved the largest-ever water infrastructure project with the objective of transferring water from the Yangtze River to the Yellow River Basin. This is a historically significant engineering feat, with the potential to help meet China's energy and water demand and to control the fatal seasonal floods. However, the resulting social impacts have already been covered by the media and the environmental impacts are beginning to emerge.

Around 20,000 large dams have been constructed in China. Japan has already dammed all but 10 per cent of its rivers.\textsuperscript{127} In Australia, a new dam is no longer considered part of the supply-side suite of options, as it has been noted that new dams either commandeer resources from an existing use (for example agricultural, or other forms of rural livelihood support) or from freshwater ecosystem- and water-cycle support.\textsuperscript{128} Mini- and micro-hydroelectricity plants are increasingly the focus of supply-side approaches in Central Asia.

Newer supply-side approaches being explored include artificial groundwater recharge and the action taken by water utilities to reduce the costs of treating polluted water, prevent groundwater contamination and encourage rainwater harvesting. The use of agrochemicals is being reduced in China and Indonesia, partly through new research into integrated pest management. The example set by Germany, where the water utility pays farmers to switch to organic operations and so reduce nitrate pollution to freshwater bodies, and at the same time reduce the additional costs of treating nitrate-polluted water, could be an effective incentive for reducing the pressure on water resources in the region.\textsuperscript{129}

**Water efficiency and demand-side management**

Greater water efficiency can go a long way towards meeting the rapidly growing water demand in a cost-effective manner, but the benefits do not stop there. The often unrecognized benefits include long-term gains in national eco-efficiency, which is reflected in

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**Box 2.10 Cross-border investment in water infrastructure: water-sharing on the Chu-Talas Rivers as a model for more effective negotiations on water resources management.**

The sharing of water resources, and upstream-downstream country relations in particular, has long been fraught with tension and insecurity. Kyrgyzstan and Kazakhstan have found a solution which institutionalizes cross-border investment in maintaining water infrastructure, rather than undertaking difficult negotiations around direct payments for water. Under a 2000 agreement, Kazakhstan has agreed to pay part of the operation and maintenance expenses for a number of Kyrgyz dams and reservoirs which supply water to Kazakhstan, taking a huge step forward towards addressing a contentious issue in a way that benefits both parties.

With the support of ECE and ESCAP, and the financing of the Governments of Sweden, the United Kingdom and Estonia under the auspices of the Organization for Security and Cooperation in Europe, the proposed Chu-Talas Rivers Commission will oversee the agreement. This model could be extended further to cross-border investments in domestic water efficiency measures or irrigation infrastructure upgrades in upstream countries. If it were applied to the sharing of resources in other transboundary river basins, significant progress and greater overall capacity to meet water needs could be achieved.
simultaneous reductions in energy consumption (for water treatment and distribution) and in wastewater treatment costs, and increases in the economic benefit gained from each unit of water used. There have been a number of successful water efficiency initiatives, including Sydney, Australia’s “Every Drop Counts” business programme. The programme resulted in a saving of 7,000 m$^3$ of water per day by the end of 2003, a return on investments by companies totalling some A$3.5 million (US$2.6 million). Between 1999 and 2003, Sydney’s investments in demand-side management totalling US$30 million also enabled the city to stabilize its 2003 water demand at 1983 levels, despite a population increase of almost one million people, and yielded 60,000 m$^3$ per day in savings. In Thailand’s south Chao Phraya area, charges levied for pumping led to an 80 to 90 per cent increase in efficiency. Under ESCAP’s Kitakyushu Initiative for a Clean Environment, a model project of water-use efficiency in an urban area of Tehran has been documented and tested. The results to date are encouraging. The project is estimated to have resulted in a saving of about 15 per cent on Nassim residents’ monthly household water bills and if applied across Tehran as a whole, could save about 135 million m$^3$ of water per year or US$6.5 million. This is a significant result for a city which already experiences water shortages even during mild droughts.

**Infrastructure design for a sustainable water supply**

Very few countries have developed comprehensive approaches to water-resource efficiency, although China’s April 2005 Water Conservation Technology Policy outlines several areas for technological development in support of greater water efficiency across all sectors. However, in order to achieve improvements in patterns of water use and supply continuity, greater sustainability must be built into economic systems, infrastructure development and natural resources management. Greater attention to the three key areas of action described below will be needed.

The first key area is a greater focus on the implications of economic activity for water use, in terms of both quantity and quality. Every day, decisions in sectors such as agriculture, forestry and energy impact on the management of water to a greater extent than decisions taken within the water sector itself. Countries with limited water resources should, through their economic development plans, explicitly seek less water-resource-intensive economic activity.

Water-use considerations should also be built into economic development planning. Chinese officials, describing efforts to reduce pollution levels in two important lakes over a period spanning almost 10 years, have concluded that “the treatment of the lake basin should be combined with win-win solutions of economic growth and environmental improvement … industrial restructuring and cleaner production should be promoted and a new industrialization path taken… eco-agriculture should be promoted to follow an ecological and market-oriented path that turns the wastes into resources… with these measures the [sic] water pollution prevention will be successful.”

The second approach is that of investment in natural water infrastructure. River systems, freshwater lakes, floodplains, wetlands, aquifers and forests and other vegetative cover in river basins constitute the natural water infrastructure critical to maintaining the integrity of the water cycle. Integrated River Basin Management is an approach that invests in maintaining the functions of the river basin and is being adopted by countries such as Thailand.

The Living Murray River Basin project in Australia sought to mitigate the impacts of the overextraction and diversion that had reduced the flow at the mouth of the river to some 27 per cent of the natural flow, and of deteriorating water quality related to the fertilization of agricultural fields and increased salinity. To prevent further impacts on aquatic plant and animal communities, the loss of agricultural productivity, recreation and tourism, impacts on drinking water quality, risks to human health and the compromising of the cultural values of indigenous people, the River Murray Improvement Programme was introduced and the Living Murray project initiated to investigate ways to restore river flows. The 2003 River Murray Act establishes 15 ‘Objectives for a Healthy River
Murray’ and gives the Australian Government clear powers over the use of the river, allowing it to improve the management of planning, irrigation practices, pollution and rehabilitation programmes. Under the programme, major infrastructure and land management improvements will be made to reduce the flows of polluted drainage water to the river system from irrigated pastures to 20 per cent of the baseline. Revegetation and livestock management strategies are targeted at reducing sediment loads. The project also seeks to involve communities and local government in reducing pressures on the river system.133

Such investments seek to maintain the ecosystem services which are not valued in the market but which can often exceed market values. One example given in the Millennium Ecosystem Assessment report shows that the social benefits associated with original mangrove cover in Thailand (timber, charcoal, non-timber forest products, offshore fisheries and storm protection) fell to zero following its conversion to shrimp farming. This resulted in the loss of a total economic value of between US$1,000 and US$36,000 per hectare of mangrove, with the economic value of the shrimp farming estimated at about US$200 per hectare.134

The third key area is that of infrastructure development geared towards water efficiency, rainwater capture and water re-use. As in the energy sector, patterns of infrastructure development and management will determine future water consumption patterns. In the agricultural sector, the Islamic Republic of Iran’s plans for developing pressurized irrigation systems are expected to save 1.044 billion m³ of water per year (almost half of the amount currently used) and potentially double the amount available for drinking and other uses.135 It is predicted that green building initiatives in Singapore will reduce water use in buildings certified under the “Green Mark” programme by up to 30 per cent, as has been achieved by similar initiatives in the United States.136

Urban development planning that explicitly takes into account the possibility of water capture can go a long way towards facilitating water recycling. The integration of wastewater treatment plants into urban plans so that they are close to the sources of water to be recycled, as well as to the water to be used, may also increase the economic feasibility of water recycling.

Options for future infrastructure development depend very much on the current level of infrastructure development and the resources available. Urban stormwater run-off and treated wastewater is being used for landscaping purposes in Australia, where private companies are purchasing treated water at the plant exit for distribution to the horticultural and agricultural industries, and there are experiments underway involving the storage of treated wastewater. In the dry city of Adelaide, the re-use of 16,000 m³ of water per day fulfils some 19 per cent of water demand.137

Singapore is now producing ultra-pure water from raw domestic sewerage, at a rate of over 32,000 m³ per day, at a facility which is now a tourist attraction. The solution is seen as cheaper and more effective than desalination and is facilitated by Singapore’s fully sewered wastewater and sanitation systems. There are also plans to site a reservoir in the middle of the city state. Bio-remediation, phytotechnology (the use of micro-organisms and plants to remove toxins and improve water quality) and artificial groundwater recharge (in which natural recharge is augmented by wastewater, including storm/flood water, grey water and treated wastewater, through recharge basins or directly into the aquifer)138 are other promising measures which can be facilitated by urban development planning.

For developing countries in particular, expanding access to water services in a situation of resource scarcity and limited investment requires specific attention. The potential of public-private partnerships for expanding access to water services has been demonstrated in Sri Lanka and in the Pacific. While making water services accessible to the general public, small piped-water networks significantly reduce unaccounted-for water. In Sri Lanka, under an ESCAP project, private companies, with the support of state agencies, are now providing piped water to poor families in return for a modest fee. This model of water services provision overcomes both the lack of resources of publicly-owned agencies
and the institutional barriers faced by poor or otherwise marginalized water users. Rather than viewing small water network operators as unwanted competition, the water utility has instead (and perhaps unexpectedly) seen the project as a welcome intervention. Currently, Colombo has 1,200 poorer urban communities sharing water from public taps. If consumption as well as wastage of water can be reduced, utility officials feel that they can increase their revenue and reduce their debt considerably by selling the water saved to other consumers, including industrial consumers, who are willing to pay a higher tariff. This project will require appropriate policy support in order to be replicated. As noted by the ADB’s case study of small piped-water networks, “small water network operators are severely hampered by their informal status.” This affects their ability to operate in a commercially viable fashion and to invest in better, more efficient, technology. In addition, the high bulk rates characteristic of model tariff schedules work against small network businesses. A comparison of two small piped-water networks operating in illegal and legal environments shows a vast difference in the levels of service offered to subscribers, the technology deployed and the tariff paid.139

Sanitation infrastructure can be designed to facilitate the treatment and conversion of sewerage to increase resource recovery. The continuing availability of economically feasible phosphate reserves is in doubt, and domestic human waste therefore represents a massive waste of phosphorus, as well as of nitrogen and potassium. Much of the treated sludge produced by the more than 1,180 night soil treatment facilities in Japan which serve about 30 per cent of the population is used in agriculture; treatment facilities could be extended to produce methane.140

In less developed countries, appropriate sanitation infrastructure development may focus on meeting immediate sanitation needs, reducing future water demand and protecting water supplies. In the Pacific islands, the choice of sanitation infrastructure is especially critical to protecting freshwater systems and coastal ecosystems. Fragile groundwater systems are easily and irreversibly contaminated by pit latrine systems or piped sewerage systems. Ecological sanitation systems deployed in Tuvalu are proven to simultaneously address the goals of expanding access to sanitation services, of reducing the amount of water needed per person and of closing the nutrient cycle by recycling the valuable phosphorus and nitrogen content of human waste for agricultural use and therefore increasing agricultural production.141 In the northern Viet Nam, dehydrating toilets that divert urine and dehydrate faeces have been used since 1954; the waste produced is used to boost agricultural productivity. However, technical issues relating to pathogen control still persist (depending on the climate and model) and proper management is needed.

In India, the sanitation solutions pioneered by Sulabh International help to meet sanitation needs while reducing pressure on water resources and water contamination. Twin pit household latrines requiring only two litres (half to one seventh of the water needed by conventional models) are produced at a minimal cost of US$10. A total of 5,500 public toilet complexes have been built by the company, including complexes that produce biogas (methane) for cooking, electricity and heating during winter, with no manual handling of human excreta. Effluents from the system can be turned into a colourless, odorless and pathogen-free liquid manure. The Sulabh approach includes children’s education, the involvement of women and house-to-house contact.142

Developing the use of ecological sanitation systems will require policy support for “alternative” sanitation infrastructure. In Bangladesh, one of the countries with the largest number of people without access to safe drinking water or sanitation in the region, every household within 100 feet (30.5 m) of a sewer line is required to connect to the line, and is taxed whether or not a connection is made.143 By specifying a particular sanitation solution, such policies may inhibit the deployment of more affordable sanitation solutions.
2.5 Increasing pressure on ecosystems: intensive agriculture

2.5.1 Agricultural production in the region: a decade of relentless growth and expansion

Agriculture remains a cornerstone economic sector for many developing countries. Accounting for around 9 per cent of the GDP throughout developing countries in the world, the sector not only improves economies by providing the revenue necessary for stimulating investments in other sectors, but also directly contributes to raising the incomes of farmers in rural areas and to enhancing food security.

Agriculture in Asian and Pacific countries has significantly contributed to the remarkable growth of the region, registering one of the most impressive sectoral performances in the past decade. The Asia and the Pacific region has been at the forefront of global agricultural production growth, with increased outputs of more than four per cent per annum during the period 1981-1999, with the exception of 1998 (see figure 2.24).

During the years 1990 to 2002, the region’s agricultural production output increased by some 62 per cent, compared to a global average increase of just 27 per cent. The agricultural production index of countries in the region for the year 2002 is shown in figure 2.25; Viet Nam, China, the Lao People’s Democratic Republic and Myanmar have shown impressive growth. The growing industrialization of the sector, achieved through an intensification of agricultural activities following the success of the Green Revolution launched in the early 1970s, have been central to the sector’s success.

A number of countries in Asia and the Pacific produce a significant share of the global production of some important agricultural commodities (see table 2.18), with China and India producing all of the important commodities.

The region’s importance as a producer of these commodities grows as developing countries increasingly participate in the international market, allowing them greater access to larger markets and opening up opportunities for the specialization of production. Despite the general trend of increasing
agricultural production, the region is still a net importer of agricultural products (Figure 2.26). Among the subregions, North-East Asia remains the lead importer of agricultural products, with China and Japan accounting for almost 80 per cent of total subregional imports and 60 per cent of total regional imports of agricultural products.

The agricultural sector has provided employment and alleviated poverty in rural areas. Around 56 per cent of the population still reside in rural areas and represent the backbone of the region’s agricultural labour force. Recently gathered data indicates that engagement in agricultural trade by developing countries generally reduces the incidence of hunger. The case of Viet Nam is cited as a clear example of this. Between 1991 and 2001, the country’s economy grew by seven per cent per annum, while the proportion of the population which was undernourished reduced dramatically from 27 per cent to 19 per cent. During the same

Table 2.18 Production of selected agricultural commodities – 15 largest Asia-Pacific producers, 2001-2003

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<tr>
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<th>Oil crops</th>
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<th>Sugar</th>
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<th>Citrus fruits</th>
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Notes:
S% Reflects percentage share of the total global production of the commodity
R Rank in total global production
period, agricultural output grew by six per cent per annum, with exports growing even faster, generating a large agricultural surplus.150

The region has demonstrated a capacity for meeting the growing demand for food. Despite the expansion of its population over the past 50 years, the region’s improvements in terms of providing food security have been one of its most impressive achievements. The Green Revolution raised the average per capita dietary energy supply from about 2,000 kcal per person per day in 1965-1966 to over 2,600 kcal per person per day in 1999-2000.151 It is projected that the per capita dietary energy supply of developing countries in the region will increase to 2,902 kcal per person per day by 2015 and 3,056 kcal per person per day by 2030.152

However, the fact remains that the number of undernourished people in the region still stands at more than 500 million, 60 per cent of the global total.153 Recent assessments which compared the periods of 1990-1992, 1995-1997 and 1999-2001 indicate that the pace of hunger reduction has slowed, with a number of developing countries backsliding. These assessments show that China, Viet Nam, Thailand and Sri Lanka steadily decreased the size of their undernourished populations throughout these periods; India, Pakistan and Indonesia significantly reduced the number of undernourished people from 1990-1997 but registered increases for the period 1999-2001; Bangladesh and Cambodia had large undernourished segments of their populations in the periods 1990-1992 and 1995-1997 but markedly reduced numbers in 1999-2001; and Afghanistan, the Philippines, Tajikistan and Uzbekistan had increasing numbers of undernourished people over the entire period.154

Integration into the global market is likely to continue in the region, highlighting the crucial role of agriculture and agricultural trade in increasing economic growth and ensuring food security. However, this growth pattern has also brought a number of critical issues to the fore, which could undermine the achievements so far. Two issues stand out: the environmental sustainability of intensified agricultural activities and the further marginalization of subsistence farmers, who are not receiving the benefits from the region’s participation in the global market and the growth of the sector.

2.5.2 Drivers of agricultural intensification

Current agricultural production patterns in Asia and the Pacific are defined by three critical factors: population increases and shifts which are correspondingly expanding and diversifying the demand for food,155,156 the opportunities presented by the globalization of markets, and the technological improvement of agricultural production processes.

The benefits of increased participation of developing countries in the global marketplace are illustrated by the case of Viet Nam in section 2.5.1. Apart from significantly reducing the incidence of hunger and poverty, globalization processes allow developing countries to gain access to technologies that can improve their production of particular commodities. Ancillary benefits of participation include improved infrastructure (including transport, particularly relating to ports or railways; energy; and communication systems) and the increased availability of non-farm goods and services. It should be noted, however, that while openness to global trade brings immense benefits to developing countries, it is equally important to recognize the major trade-offs that take place. Small-scale farmers are often the hardest hit by changes in production structures that accompany industrialized agriculture. Without policy intervention, the implications of the marginalization of small farmers for environmental sustainability can be profound, as this segment of the population may be forced through exploitative practices or farming on unsuitable land, to exert further pressure on natural resources. Where this occurs, a vicious circle of environmental degradation and poverty is perpetuated.

The decision by developing countries to intensify agricultural activities in order to trade products globally must recognize that, without built-in environmental safeguards in both the production and trading processes, threats to environmental sustainability may be magnified.
Increasing and diversifying demand for agricultural products

A nutritional transition is taking place, one manifestation of changing lifestyles and consumption patterns discussed in the previous section. Contemporary Asian diets are turning away from staples, such as rice and grain, towards a growing demand for animal-sourced food, such as meat and dairy products, and for vegetables, fruits, fats and oils. The FAO projects that for the period 2000-2010, the demand for cereals in Asian cities alone will increase by more than 11 million metric tons, almost half of the total increase in demand for raw foodstuffs; that there will also be a combined increase of almost eight million metric tons in the demand for fruits and vegetables; and that the remaining food demand will be for roots and tubers (2.2 million metric tons) followed by meat (1.9 million metric tons). Altogether, this represents a total increase in demand of more than 23 million metric tons of food.

These increases take into account regional differences in food preferences, which include: a high demand for eggs in all Asian cities; a variation by subregion in consumption of other animal products, with South Asia leading the way in demand for dairy products; a higher demand for meat and fish and other seafoods in East and South-East Asia; and lower fresh fruit and vegetable consumption in South Asia than in East and South-East Asia. These changing food consumption patterns are also shaping agricultural product demand. The need to expand the food supply in order to meet the food requirements of each individual will exert further pressures on the agricultural production sector.

Agricultural food production is not solely devoted to meeting direct human consumption needs. Changing diets and the demand for meat, fish and dairy products have a multiplier effect on the indirect consumption of grains used as feed for the livestock industry. Although cereals remain the dominant source of calories for the human population, it is estimated that as much as 36 per cent of cereals produced are used for animal feed. Other food products, such as beer, require huge amounts of grain to produce. Agricultural commodities such as jute, fibers and rubber have industrial uses, and the demand for those products that can substitute for petroleum-based products is increasing.

2.5.3 Critical pressure points of agricultural intensification

In the face of mounting pressure to meet the needs of growing populations and at the same time generate revenue by way of increasing agricultural production outputs for export, most developing countries have adopted a strategy of agricultural intensification. Farmers have shifted to producing high-value dairy and other livestock products, employing farming practices such as multiple cropping and planting high-yielding crop varieties. This agricultural success, however, also has significant negative environmental trade-offs which affect the integrity of natural ecosystems and their future potential. The critical pressure points of agricultural intensification as experienced in the region are outlined below.

Fertilizer and agrochemical use intensity

The Green Revolution relied heavily on the inputs of high-yielding varieties of crops, expanded irrigation coverage and increased use of mineral fertilizers to boost production. The regional production and use of mineral fertilizers as a proportion of global production is increasing and is dominated by North-East Asia and South Asia, particularly China and India, which have produced 64 per cent of the total regional fertilizer output (Figure 2.27). In terms of fertilizer consumption patterns, fertilizer-use intensity in the region remains high in some countries but is being reduced in several countries, as shown in figure 2.28. Countries such as India, Lao People’s Democratic Republic, Myanmar, the Philippines, Sri Lanka, Thailand and Viet Nam intensified their use of mineral fertilizers by as much as 90 per cent over the period 1992 to 2002.

Misuse and excessive use of mineral fertilizers is responsible for land degradation, soil nutrient imbalances, eutrophication and algal blooms in freshwater systems and coastal waters. The misuse of pesticides and herbicides not only impacts on insect diversity and contaminates water supplies but...
threatens the health of farmers. Organochlorines have not only killed the targeted insect pests but also their natural predators.161

**Pressure from expanding irrigation**

One in three hectares of agricultural land in the region is irrigated, as compared with one in ten for the rest of the world, and irrigated areas are expanding fast.162 Water-stressed countries such as India, Sri Lanka, Kazakhstan and Thailand are among the leaders in this respect (Figure 2.29).163 The environmental impacts of overirrigation are waterlogging, the depletion of groundwater and surface waters and the creation of routes for the chemical contamination of waterways and water bodies. The environmental havoc wrought on the ecosystems of the Aral Sea is a clear example of the devastation that can occur where over-irrigation due to underinvestment, poor maintenance, inappropriate policies and land management practices exist. The construction of large dams to meet the escalating demands for water is a controversial issue. Providing for the needs of the agricultural sector is one of the primary justifications for building large dams. More than half of the world’s dams have been built exclusively for irrigation; they support 12 to 16 per cent of global food production and water approximately 40 per cent of the more than 270 million hectares of irrigated agricultural land worldwide.164 The impacts of these structures include reduced river flow, social conflict regarding the rights of access to water and river resources, the uprooting of
existing settlements, the disruption of the culture and sources of livelihood of local communities, and the depletion/degradation of environmental resources. More efficient water use and storage measures such as rainwater harvesting and rehabilitation of traditional irrigation systems therefore has many benefits beyond the water saved.

Competition for water will intensify with the demand for increasing food production and every resource needs to be optimized. In rice-farming-rich countries, rice-fish farming can be applied as a practical response to the need to maximize agricultural production using limited resources. Trade in virtual water can help to meet food production needs in the most water-intensive of crops (Box 2.11).

**Intensifying energy use**

Another pressure exerted by agricultural intensification causing increasing concern, is its contribution to overall energy demand. Agro-industrial farming requires a massive infusion of fossil fuels in the forms of the fertilizers used (urea is a derivative of natural gas), pesticides (derived from oil) and the hydrocarbon fuel used to run the machines used for cultivation and irrigation. Agricultural energy consumption can be broken down as follows:

- 31 per cent for the manufacture of inorganic fertilizers
- 19 per cent for operating farm machines
- 16 per cent for transport
- 13 per cent for irrigation
- 8 per cent for raising livestock
- 5 per cent for drying and post-harvest processes
- 5 per cent for pesticide production.

Modern food production systems are both energy-intensive and inefficient; it can take more than 10 kcal of exosomatic energy to deliver 1 kcal of energy in the form of food delivered to a consumer. One aspect of intensive agriculture in Asia and the Pacific is the shift in the real energy cost from agricultural production to the post-harvest segment of the food production system. This is reinforced by increasing urbanization in many developing countries, which requires the movement of agriculture produce to urban centers. It is estimated that between three and five kcal are spent in processing, distribution, packaging and home preparation for each one kcal that is used in producing food at the farm level.

Food travels further than ever before, with fruits and vegetables in developed countries often travelling 2,500-4,000 kilometers from farm to store. Trucking accounts for the majority of food transport, though it is nearly 10 times more energy-intensive than moving goods by rail or barge. Refrigerated jumbo jets, which are 60 times more energy-intensive than sea transport and constitute a small but growing sector of food transport, help to supply the globe with fresh produce. The implications of energy use in agricultural intensification are not usually factored into the decision to promote intensification as a strategy for accelerating economic growth. The emerging challenge, therefore, is that of how to decouple...
food production systems from the oil industry, which many experts believe is the key to ensuring food security and maintaining environmental sustainability in the long term.

### 2.5.4 The impacts of agricultural intensification: land and soil degradation, air quality and climate change

Inappropriate land-use practices have long been the primary cause of the systematic degradation of the region’s agroecosystems. Both the intensification and the expansion of agricultural activities for crop production and pasture have caused severe environmental stress, including the conversion of forest areas for agricultural purposes, the reduction of the genetic pool of major crops, soil erosion, soil nutrient depletion, the salinization and sodification of soils and waterlogging.

A basic practice of increasing agricultural output is to bring more land into production. However, many countries already face severe constraints in further expanding land used for agricultural production. Only parts of the Pacific and Central Asia have reserves of land with crop production potential; countries in other areas will not be able to expand agricultural land without encroaching on other critical ecosystems. Despite such constraints, many countries in the region have continued to increase their arable and permanent croplands, pushing the balance of ecosystems to the limit (see figure 2.30).

Constraints in arable land are compounded by soil and slope constraints. Much of the region’s land offers less than optimal conditions for further agricultural expansion and intensification. Steep slopes (more than 8 per cent slope incline) and poor soil condition characterize many of these agricultural lands. In addition, the fertility of many of these areas has significantly declined after years of overuse and misuse of fertilizers and intensive irrigation. These conditions are particularly critical for small-scale and marginalized farmers, many of whom are poor, and who are dependent on the natural fertility of the soil. With little fertile lowland to cultivate, many poor farmers move towards the uplands, shifting pressure onto the forest ecosystems. Conversion of forested land to agricultural use are biodiversity loss and, on a more long-term basis, the influence on climate change.

Agriculture, forestry and watershed management are intimately linked. Land use changes in the uplands, particularly the removal of vegetative cover, inevitably impact on the productive potential of lowlands. The region offers many examples of how denudation and poor land-use practices in watershed areas have led to reduced storage capacity in reservoirs, lowered irrigation potential and have magnified the damaging impacts of flooding, especially on agricultural crops. The high sediment loading of the Himalayan river systems due to intensive upland agriculture and livestock activities, for example, has been causing serious damage to the lowlands of Pakistan, India, and Bangladesh. In the Philippines, the massive denudation of the Pantabangan watershed has caused severe erosion and siltation, shortening the lifespan of the dam that is supposed to support irrigation of the food basket.

![Figure 2.30 Change in arable and permanent cropland as a percentage of total land area, 1992-2002](http://faostat.fao.org).

area of Luzon. The same has been observed in the Yellow River of China.

**Land and soil degradation**

Land and soil degradation have become issues of global importance in the last 10 years. The impact of these phenomena on the productivity of agricultural lands means that they affect the lives of more than a billion people globally. Land degradation is a complex process which can take different forms and have different levels of intensity, influenced mainly by topography, soil characteristics, climatic conditions, vegetative cover and human activities (see table 2.19). Resource assessments indicate that vast areas of croplands, grasslands, woodlands and forests in Asia and the Pacific are critically affected by various forms of land degradation. The full impact of land degradation is more severe in dryland ecosystems, where it can cause desertification. For example, in South and South-East Asia, around 74 per cent of agricultural lands are severely affected by wind and water erosion as well as by chemical and physical deterioration. Central Asia is most seriously affected by desertification and erosion. In Kazakhstan alone, around 66 per cent of the total land area is desertified (see chapter 6).

<table>
<thead>
<tr>
<th>Type of land degradation</th>
<th>Country or area</th>
<th>Critical areas and predominant cause of land degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water erosion</strong></td>
<td>Afghanistan</td>
<td>Region north-east of Kabul: removal of vegetative cover and mountainous areas.</td>
</tr>
<tr>
<td></td>
<td>Central Asia</td>
<td>South-east Kazakhstan: overexploitation of vegetative cover.</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>Loess plateau, central and north-central China and some parts of north-west China: deforestation and overexploitation of vegetative cover.</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>Northern India (Punjab), Indus and Ganges: overexploitation of vegetative cover.</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Balochistan: deforestation, overgrazing and overexploitation of vegetative cover.</td>
</tr>
<tr>
<td></td>
<td>South-East Asia</td>
<td>All South-East Asian countries during the monsoon: deforestation, removal of vegetative cover, especially in areas with critically steep slopes.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>Central Asia</td>
<td>South-east Kazakhstan: overexploitation of vegetative cover.</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>North-east China, north-west China, inner Mongolia: overgrazing of rangelands and overexploitation of vegetative cover.</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>North-west India (Rajasthan and Gujarat states): agricultural activities.</td>
</tr>
<tr>
<td></td>
<td>Mongolia</td>
<td>Central-eastern steppe, Selenge-Onon and Govi and Govi-Altai regions: overgrazing of rangelands and removal of vegetative cover.</td>
</tr>
<tr>
<td><strong>Salinization</strong></td>
<td>Afghanistan</td>
<td>South-east areas of Kabul, particularly the areas of Helmand, Kabul and Arghandab rivers: agricultural activities and social conflicts.</td>
</tr>
<tr>
<td></td>
<td>Central Asia</td>
<td>Turkmenistan, Uzbekistan and Kazakhstan: agricultural activities and removal of vegetation.</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>Portions of the north-west (Punjab, Haryana, Gujarat) and Tamil Nadu: agricultural activities.</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Punjab and Indus areas: agricultural activities.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Central Asia</td>
<td>Turkmenistan, Uzbekistan and Kazakhstan: agricultural activities and removal of vegetation.</td>
</tr>
<tr>
<td></td>
<td>India</td>
<td>Portions of Northwest (Punjab, Haryana, Gujarat) and Tamil Nadu: agricultural activities.</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Punjab and Indus areas: agricultural activities.</td>
</tr>
</tbody>
</table>
The pressures to increase production, either for subsistence farming or for commercial purposes, and other unfavourable socio-economic development policies are the primary drivers for unsuitable agricultural management regimes such as the overgrazing of livestock, nutrient overloading and over-irrigation. Ecologically-fragile areas such as drylands and forest ecosystems with steep slopes are particularly vulnerable. Fragility of their soils makes Pacific Island countries extremely susceptible to the impacts of shifting agriculture, overpopulation and inappropriate land and other resource use. Australia’s efforts to reduce land degradation continue to be challenged by agricultural pressures, its dry climate, water scarcity and drought conditions.

**Air quality and climate change**

The emissions of ammonia from livestock manure can be a major source of air pollution in agricultural areas. Very little research has been done in Asia and the Pacific on the possible implications of airborne ammonia. Often considered a nuisance pollutant because of its odour, airborne ammonia can acidify soils and eutrophy water bodies. The OECD projects that the total nitrogen loading in the environment (air, soil and water) originating from livestock, will grow by 30 per cent between 1995 and 2020.175

Agricultural activities contribute to global climate change in both positive and negative ways. On one hand, the soils of the agroecosystem are good carbon sinks, properties which can be enhanced through proper farm tilling and soil conservation management. On the other, the agricultural industry is a major source of greenhouse gases. A study conducted in China, Japan176 and the Philippines177 has shown that the raising of livestock, particularly of ruminant animals such as cattle, and the cultivation of rice are significant sources of methane, while the main source of nitrous oxide emissions is the use of nitrogen fertilizers.

Given these challenges, governments promoting sustainable agriculture in the region will need to focus on the following: policies that further improve agricultural productivity while easing the pressure on ecosystems; policies to address global environmental concerns that are cost-effective and do not have cost implications for small-scale farmers; and practical strategies for educating farmers on the benefits of sustainable farming practices.

2.5.5 Mitigating the impacts of agricultural intensification

There is increasing recognition among policymakers in the region of the implications of agricultural intensification for the environment. Agricultural policies are being reviewed with a view to incorporating sound environmental principles in agricultural development frameworks. While these policy reassessments are being pursued, agriculturists and industry practitioners are already moving towards profitable, and more sustainable, strategies for agricultural production.

**Organic farming: an industry with a growing market niche**

As concern about the environmental impacts of mineral fertilizers increases, organic farming is attracting attention (see table 2.20). Organic farming has found a niche in high-income markets and organic products are commanding premium prices. The Worldwatch Institute confirms that the shift to organic farming may be a poor farmer’s best hope for maximising production and increasing economic independence as well as reducing hunger and boosting long-term production.179

**Developments in biotechnology: the new generation of the agricultural revolution**

The application of biotechnology represents the new generation agricultural revolution, following in the path of the Green Revolution.180 This technology has a wide spectrum of applications, from improving the genetic makeup of livestock, crops, forestry and fisheries, to developing protective mechanisms that can fight and resist agricultural pests and viruses. The FAO argues that the application of biotechnology should be viewed in the context, not of substituting current research work such as that on plant breeding, integrated pest management, livestock breeding, feeding and disease management, but as complementary work towards an integrated
Table 2.20 Organic farming in the Asia-Pacific region

<table>
<thead>
<tr>
<th>Country</th>
<th>Organic farms, number</th>
<th>Organic farms, per cent of all farms</th>
<th>Hectares</th>
<th>Percentage of total agricultural area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1 380</td>
<td>1.40</td>
<td>10 000 000</td>
<td>2.20</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>285</td>
<td>0.75</td>
<td>2 540</td>
<td>0.20</td>
</tr>
<tr>
<td>Bhutan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>China</td>
<td>2 910</td>
<td>-</td>
<td>301 295</td>
<td>0.06</td>
</tr>
<tr>
<td>Fiji</td>
<td>10</td>
<td>-</td>
<td>200</td>
<td>0.04</td>
</tr>
<tr>
<td>India</td>
<td>5 147</td>
<td>-</td>
<td>37 050</td>
<td>0.03</td>
</tr>
<tr>
<td>Indonesia</td>
<td>45 000</td>
<td>-</td>
<td>40 000</td>
<td>0.09</td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>-</td>
<td>5 083</td>
<td>0.09</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>1</td>
<td>-</td>
<td>36 882</td>
<td>-</td>
</tr>
<tr>
<td>Lao People’s Democratic Republic</td>
<td>-</td>
<td>-</td>
<td>150</td>
<td>0.01</td>
</tr>
<tr>
<td>Nepal</td>
<td>26</td>
<td>-</td>
<td>45</td>
<td>..</td>
</tr>
<tr>
<td>New Zealand</td>
<td>800</td>
<td>1.14</td>
<td>46 000</td>
<td>0.33</td>
</tr>
<tr>
<td>Pakistan</td>
<td>405</td>
<td>0.08</td>
<td>2 009</td>
<td>0.08</td>
</tr>
<tr>
<td>Philippines</td>
<td>500</td>
<td>-</td>
<td>2 000</td>
<td>0.02</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>1 237</td>
<td>-</td>
<td>902</td>
<td>0.05</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>-</td>
<td>-</td>
<td>5 276</td>
<td>..</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>3 301</td>
<td>-</td>
<td>15 215</td>
<td>0.65</td>
</tr>
<tr>
<td>Thailand</td>
<td>1 154</td>
<td>0.02</td>
<td>3 993</td>
<td>0.02</td>
</tr>
<tr>
<td>Turkey</td>
<td>18 385</td>
<td>-</td>
<td>57 001</td>
<td>0.14</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>1 022</td>
<td>-</td>
<td>6 475</td>
<td>0.08</td>
</tr>
</tbody>
</table>


and comprehensive agricultural research and development programme.\textsuperscript{181}

The widespread application of biotechnology is impeded by strong public opinion on the safety and environmental impacts of its use. Much of the debate revolves around the use of transgenic crops, more widely known as genetically modified organisms (GMOs).\textsuperscript{182} There are, however, less controversial areas of biotechnology which are proving valuable to agricultural production and that can potentially provide immense benefits to the poor. The study of genomics is radically boosting knowledge of how genes, cells and organisms behave in an ecosystem. The development of new tools for diagnosing and treating diseases hosted by plants and animals, improvements in animal nutrition, and the reduction of the impacts of animals on the environment, as well as the production of vaccines against animal diseases are some of the most promising areas of biotechnology application. There are now 67.7 million hectares planted with GMOs in 18 countries, representing an increase of 2.8 million ha from 1996.\textsuperscript{183} In Asia and the Pacific, at least five countries have begun to plant GMOs (see table 2.21).

**Widening support for Integrated Pest Management**

The indiscriminate use of chemicals to control pests and unwanted plants has also created serious environmental impacts. Pest resistance and resurgence were major threats to the Green Revolution and affected many farmers in the region. The early response to the problem was to develop more potent chemicals, but their application has also affected other organisms which in cases, were deemed beneficial to the crops that are being protected.
Subsequent research was directed towards the application of biological controls, particularly for major rice pests. The ensuing efforts of governments have been directed towards aggressive promotion of integrated pest management (IPM). Initial efforts resulted in mixed success, as the promotion strategy was based on the conventional promotion packages of the Green Revolution, a centrally designed information and education campaign. It was not until communities and farmers were involved in the information and education process, that the programme gained wider acceptance and greater rates of success. Farmer empowerment is now central to the promotion of IPM programmes, with farmers trained to master the fundamental ecological principles necessary to make IPM work, allowing them to apply their knowledge to develop new and locally adapted techniques. This approach, known as the IPM Farmer Field Schools, was pilot-tested in Indonesia and later expanded to other countries. The widespread promotion of IPM taught significant lessons about sustainable agriculture, emphasizing that combining the elements of technological development, adult education, local organization, alliance forming, confidence building and sharing information are critical to both agricultural growth and ensuring environmental sustainability.

**Increasing awareness of the judicious use of fertilizers**

Awareness of the negative effects on the environment of overusing or misusing chemical fertilizers has meant that a growing number of countries are recognizing the benefits of judicious use of fertilizers. In the Republic of Korea, for instance, there has been an increasing use of bulk-blended fertilizers (BB fertilizers) that allow for more balanced application of the essential minerals, rather than compound chemical fertilizers that are more prone to misuse. The use of organic fertilizer is growing in China, India, the Philippines and Thailand.

The challenges of meeting the ever-expanding demand for food in the region, whilst ensuring that the agricultural production systems do not exert excessive pressure on the environment’s sustainability, remain overwhelming. The responses of governments to these challenges, described above, are steps in the right direction and should continue to be supported by governments and promoted by the private sector and the donor community. However, even these efforts will not be sufficient to address the core issue of maintaining environmental sustainability. The imperative to decouple agricultural intensification from unsustainable patterns of growth, such as intensifying energy and water use, remain a priority for Asia and the Pacific.

### 2.5.6 Capture fisheries and aquaculture production

The FAO reports that global capture fisheries (marine and inland) and aquaculture has been high since 1991. The fisheries sector contributes more than 15 per cent of total animal protein to global food security. Between 1998 and 2002, world capture fisheries production (excluding aquatic plants) fluctuated, largely because of El Niño. Globally, China remains the leader in capture fisheries production (including aquatic plants) followed by Peru, the USA, Japan and Indonesia. At a subregional level, North-East Asia leads capture fisheries production, as China and Japan account for the bulk of total regional production.

Since 1984, global aquaculture has increased by more than 300 per cent, growing at an average of 10 per cent a year in the 1990s and making it the fastest-growing food production activity. The growth of the aquaculture industry is comparable to that created by the Green Revolution programme in agriculture during the 1970s. World aquaculture...
production is dominated by Asian countries which account for almost 90 per cent of all farmed fish, shrimp, and shellfish. China leads the production of aquaculture products, contributing some 70 per cent of global production in 2002 (see table 2.22). Aquaculture products cater to both domestic and export markets: high-valued species such as shrimp and salmon are frequently grown for export, while lower-valued species such as carp and tilapia are, for the most part, consumed locally.

The spectacular growth of aquaculture over the last decade underscores the increasing importance of the industry in meeting the growing global demand for fish. Its contribution to meeting the increasing demand for a cheap protein source for a growing population cannot be overemphasized. Whereas one third of the conventional fish catch is used in making fish meal and fish oil for animal feed, virtually all farmed fish are used as human food. Nearly one third of the fish consumed by humans is a product of aquaculture and this proportion is expected to increase further as the fish catch from the ocean and lakes declines due to overfishing and the wanton destruction of marine habitats.

In 2002, 11.6 million metric tons of seaweed (wet weight) valued at US$6.2 billion was produced, the bulk of which (89 per cent) originated from culture-based practices. The 2002 global aquaculture production of aquatic plants represents an increase of about 14 per cent from the 2000 level of 10.2 million metric tons. Chinese production of aquatic plants reached 8.8 million metric tons in 2002, representing 76 per cent of the total volume and about 71 per cent of the total value of global aquaculture production of aquatic plants.

The increasing demand for fish and other marine products is intensifying pressure on marine ecosystems. While the region has vast areas available for fisheries, it has also been noted that the industry may have already reached the maximum sustainable harvest limits. Theoretically, fish are renewable resources that can be harvested sustainably provided that appropriate fishing methods are applied. Unfortunately, current harvesting practices do not observe the natural fish recovery cycles. The most dramatic declines in fish stock globally are in South-East Asia. In some areas a decline of 40 per cent in five years has been observed. In essence, much of the current practice of capture fisheries follows a “resource mining” approach: the exploitation of species begins with those of the highest value or of lowest harvest cost; as species become exhausted, species of lower value or higher harvest cost are progressively exploited.

Other factors that contribute to the pressure on fishery resources are pollution from both offshore and land-based sources, habitat destruction, destructive fishing techniques such as bottom trawling, the use of fine-mesh nets and dynamite fishing, and global warming. Aquaculture provides a viable alternative and alleviates the demand for wild-caught fish, but without the appropriate measures to prevent environmental degradation, the practice can also have local negative environmental impacts.

### Table 2.22 Share of major Asia-Pacific countries in global aquaculture production, 2002

<table>
<thead>
<tr>
<th>Country</th>
<th>%</th>
<th>Quantity (thousand metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>70</td>
<td>27,767</td>
</tr>
<tr>
<td>India</td>
<td>6</td>
<td>2,192</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2</td>
<td>914</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
<td>828</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2</td>
<td>787</td>
</tr>
<tr>
<td>Thailand</td>
<td>2</td>
<td>645</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>1</td>
<td>519</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>15</td>
<td>6,147</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>39,799</strong></td>
</tr>
</tbody>
</table>

the region lives within 100 kilometres of the coastal areas. Of the 12 mega-cities in the region, eight impinge on the coastal zones. Coastal zones in the region remain highly vulnerable to various economic development activities.

Mangroves are unique ecosystem features of tropical and subtropical coastlines and fulfill critical functions in both conservation and providing livelihoods for communities. These ecosystems are rich in biodiversity and provide a wealth of goods and services at both local and national levels. They are, however, continuously under threat of being converted to other uses, such as tourism, or for aquaculture to produce highly valued shrimps for export and firewood, as in Indonesia.

The region accounts for about 50 per cent of the total mangrove area in the world, with South-East Asia accounting for about 78 per cent of the mangroves in Asia and the Pacific (see figure 2.31). The area of mangrove lost in the region from 1990 to 2000 represents approximately 60 per cent of the global loss, with South-East Asia accounting for the majority of the total coverage lost. The Philippines and Viet Nam have the most extensive areas of mangroves that have been converted to other land use, mostly for aquaculture (Figure 2.32).

The conversion of mangrove ecosystems for aquaculture has the most serious effects, since this activity not only induces loss of vegetation but also leads to the deterioration of water quality and the loss of biodiversity, and contributes to the decline of fish stocks. In recent years there has been a decrease in the conversion of mangrove ecosystems, attributed largely to the decision of many governments in the region to ban mangrove conversion or require the conduct of environmental impact assessments.

The value of coral reefs for the marine ecosystem is analogous to that of forests for terrestrial ecosystems. They play a valuable role in providing services such as habitats and nurseries for thousands of species of fish and marine life forms, and protect exposed coasts from the pounding of oceans and seas. However, like mangroves, coral reefs are under assault from a multitude of sources.

Reef damage in Asia and the Pacific has increased over the past 20 years, and there is reason to believe that there is a serious global decline in these resources. Coral reefs are at risk of degradation from coastal development, destructive fishing practices, sedimentation from land-based activities and marine pollution. Coastal development gives rise...
to several harmful effects such as mining, land development – particularly coastal reclamation and port or harbour dredging – pervasive sewage released near shore and discharges from industrial plants. Actual coral reef conditions are difficult to assess, but estimates based on the proximity and intensity of known risk factors such as ports, urban centers, coastal population density and prevailing land use patterns indicate the potential extent of damage to the coral reefs.\textsuperscript{201} Fishing by both local artisanal fisheries and commercial fishing operators affects about one third of all reefs.

Approximately 60 per cent of the region’s coral reefs are estimated to be at risk.\textsuperscript{202} The reefs of South-East Asia are the most species-diverse in the world and are also the most threatened, with more than 80 per cent at risk, including 55 per cent at high or very high risk (see table 2.23). The Pacific reefs, which have more reef area than any other subregion, face comparatively fewer risks as they are distant from intensive human activity.

Coral bleaching has increased the vulnerability of coral reefs and is attributed to climate change. The major El Niño and La Niña events of 1997-1998 destroyed approximately 16 per cent of the world’s coral reefs. The impact of these events stretched from the Arabian/Persian Gulf to the Atlantic Ocean. The most severely bleached were the reefs of the Indian Ocean, South-East and East Asia and some of the reefs in the Pacific. Recovery in these areas has been slow to moderate, and in some parts poor, rendering the reefs effectively dead. In areas where there is less or no human disturbance, recovery has been considerable. However, there is growing concern in the scientific community that a recurrence of the phenomenon could arrest recovery or render some reefs unviable.\textsuperscript{203}

### Initiatives for sustainable fishing: not yet sufficient

Many Asian and Pacific countries have made efforts to stem the overexploitation of fishery resources. With international support and funding assistance, coupled with industry-based initiatives, a significant level of improvement has been achieved. Interventions have primarily focused on improving governance through the development of appropriate policy and planning frameworks that reflect the multiplicity of factors and actors in the fishery sector. Among the prominent initiatives are ESCAP’s efforts to promote integrated coastal zone

### Table 2.23 Reefs at risk in Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>Reef area, '000 ha</th>
<th>Reef area, % of total</th>
<th>Threat index, % of reefs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>5 087.5</td>
<td>51.1</td>
<td>Low: 14, Medium: 39, High: 46, Very high: 1</td>
</tr>
<tr>
<td>Philippines</td>
<td>2 581.9</td>
<td>25.9</td>
<td>Low: 2, Medium: 27, High: 63, Very high: 7</td>
</tr>
<tr>
<td>Spratlys and Paracel Islands</td>
<td>575.2</td>
<td>5.8</td>
<td>Low: 0, Medium: 100, High: 0, Very high: 0</td>
</tr>
<tr>
<td>Malaysia</td>
<td>400.6</td>
<td>4.0</td>
<td>Low: 13, Medium: 44, High: 38, Very high: 4</td>
</tr>
<tr>
<td>India (Andaman and Nicobar Islands)</td>
<td>399.5</td>
<td>4.0</td>
<td>Low: 45, Medium: 53, High: 2, Very high: 0</td>
</tr>
<tr>
<td>Japan</td>
<td>260.2</td>
<td>2.6</td>
<td>Low: 22, Medium: 38, High: 37, Very high: 3</td>
</tr>
<tr>
<td>Thailand</td>
<td>178.7</td>
<td>1.8</td>
<td>Low: 23, Medium: 24, High: 51, Very high: 1</td>
</tr>
<tr>
<td>Myanmar</td>
<td>168.6</td>
<td>1.7</td>
<td>Low: 44, Medium: 36, High: 20, Very high: 0</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>112.2</td>
<td>1.1</td>
<td>Low: 4, Medium: 22, High: 49, Very high: 25</td>
</tr>
<tr>
<td>China</td>
<td>93.2</td>
<td>0.9</td>
<td>Low: 8, Medium: 14, High: 76, Very high: 3</td>
</tr>
<tr>
<td>Brunei Darussalam</td>
<td>18.7</td>
<td>0.2</td>
<td>Low: 79, Medium: 16, High: 5, Very high: 0</td>
</tr>
<tr>
<td>Singapore</td>
<td>5.4</td>
<td>&lt;0.1</td>
<td>Low: 0, Medium: 0, High: 100, Very high: 0</td>
</tr>
<tr>
<td>Cambodia</td>
<td>4.2</td>
<td>&lt;0.1</td>
<td>Low: 0, Medium: 0, High: 90, Very high: 10</td>
</tr>
<tr>
<td>Asia</td>
<td>9 885.9</td>
<td>-</td>
<td>Low: 12, Medium: 39, High: 45, Very high: 3</td>
</tr>
</tbody>
</table>

management in many developing countries, which were pursued in the early 1990s.

Since then, other agencies have built on these experiences to expand the coverage of similar programmes. In the Philippines, USAID has supported the implementation of the Coastal Resources Management Program (CRMP), which built the capacities of local governments to protect and develop their respective coastal resources. The ADB has extended loan programmes for the fisheries sector and coastal resources management to Cambodia, Indonesia, the Philippines, Sri Lanka, Thailand and Viet Nam, with components of policy and enforcement capability improvement as well as a massive information and education campaign for communities about protecting these resources. UNEP has two regional seas programmes (East Asian Seas and South Asian Seas) involving a number of countries, with certain programmes supported by the Global Environment Facility (GEF).

Private sector involvement in the sustainable management of fishery resources is also increasing. FAO’s recent establishment of guidelines for the eco-labeling of fish and fishery products from marine capture fisheries is expected to promote the sustainable management of fishery resources. FAO has also been actively promoting the FAO Code of Conduct for Responsible Fisheries, which, although voluntary in nature, stipulates the principles and standards applicable to the conservation, management and development of all fisheries. It also covers the capture, processing and trade of fish and fishery products, fishing operations, aquaculture, fishery research and the integration of fisheries into coastal area management.

These initiatives have had positive impacts on the management of fisheries and coastal resources in the region. However, despite their achievements, the challenges of the sector remain formidable. Part of the difficulty stems from the complexity of the issues involved in the management of fishery and coastal resources in the region. A comprehensive fishery and coastal resources management approach continues to be important for the region. The influence of such a policy, however, may be limited unless a major paradigm shift is embraced which recognizes that fisheries and coastal resources, like other natural endowments, are not infinite.

2.6 Urbanization and globalization of consumption patterns

2.6.1 Rapid urbanization: a defining growth pattern in Asia and the Pacific

The Asian and Pacific region has one of the most remarkable urbanization rates in the world. In 1975, two of the five cities with populations greater than 10 million (defined as “megacities”) were in the region. By 2005, there were 20 mega-cities worldwide, of which 12 were in the region. The total number of urban residents is growing at a rate of approximately 2.7 per cent per annum.

While South-East Asia has some of the fastest growing cities, South Asia, and particularly the cities of Dhaka, Karachi, Kolkata and Mumbai, are at the epicentre of this growth (see figure 2.33). and by 2015, 20 cities in South Asia are expected to have populations greater than 5 million. Urban population growth in the Pacific is likely to be slower, rising from 73 per cent of the total population in 2003 to 74 per cent by 2030. The urban populations of those countries with economies in transition are expected to approach 78 per cent of their projected total populations by 2020.

In the 1950s, the region’s urban population comprised only 20 per cent of its total population. The urban population is expected to surpass that of the rural population by 2025 (Figure 2.34). The phenomenal growth of cities highlights their critical role in development. Cities offer myriad opportunities through the creation of markets and the provision of employment opportunities. They also facilitate social transformation by serving as a melting pot for ideas and cultures, bringing in new knowledge, perspectives and human capital.

However, fulfilling this potential requires that the needs of human populations be met in an equitable and environmentally sustainable way. The dramatic growth of urban populations signals a tremendous increase in demand for physical space and infrastructure, including housing.
Part I

This implies future pressure on water and energy supplies, freshwater and coastal ecosystems and on air quality. It also implies land conversion and a mounting waste problem.

Poverty, inadequate housing, underdeveloped water supply and sanitation infrastructure, air and water pollution are among the key challenges already confronting Asian and Pacific cities. Evolving household consumption patterns are the core of these issues and the intensification of pressure on environmental sustainability across the region.

2.6.2 Globalization of consumption patterns

Urban consumption patterns are pivotal in defining whether cities follow a sustainable or unsustainable growth path. A major characteristic of urban households is their increasing consumerism and changing lifestyles, which progressively multiplies the quantity, quality and variety of products and services that are offered and demanded. The demand for new types of goods, including packaged foods, household products, electronic appliances, vehicles and other modes of personal motorized transport to meet basic needs as well as to satisfy the desire for luxury, is increasing.

Consumption patterns do not only refer to food and consumer items, but are expressed in various aspects of the consumer’s lifestyle – modes of transportation and accommodation, for example. The capacity of developing countries to manage the environmental threats posed by shifts in consumption behaviour and changing lifestyles raises serious concerns.

Changing food consumption patterns of urban households

Increasing per capita incomes accompanied by changing lifestyles are dramatically modifying Asian and Pacific diets. Contemporary regional food consumption patterns reflect a significant reduction in per capita consumption of rice; an increased per capita consumption of wheat and wheat-based products; an increasing diversity; a marked preference for high-protein and energy-dense foods; the rising popularity of convenience stores; and a growing influx of imported food products.

As discussed in the previous section, these changes in food preferences represent a decline in the environmental sustainability of consumption patterns in several respects. On the supply side, impacts can be traced to the manner in which raw
Foods are stored, processed, packaged, distributed and delivered for final consumption. For instance, vegetables sold at market may have been produced using agrochemicals and water, increasing the likelihood of water pollution near farm areas. Making fruits and vegetables available all year round involves greater energy use, both in production and in transport to markets. One study that quantified the distance travelled by food, as well as total consumption levels, reveals that Japan’s total “food mileage” for 2001 was 900 billion tonne-kilometres—8.6 times that of France, 3 times that of the USA and 2.8 times that of the Republic of Korea—with impacts for CO₂ emissions related to transport. The raising of livestock and poultry for commercial purposes is a primary source of water pollution. The manufacture of food and beverages also accounts for a significant portion of the total organic water pollution loading of industries in the region.

Demand-side impacts arise directly from the actions of urban consumers, i.e. food packaging, storage, preparation and cooking. The largest source of these impacts is the waste generated by urban households. Packaging waste is the most problematic issue, as plastics, convenient but difficult to recycle, are a popular packaging material. Food waste has huge recycling potential, but in the absence of specific systems for its collection, it is usually mixed with other household waste that goes to landfills or open dumpsites; this waste can contaminate groundwater and surface water sources. Fast foods may eliminate the need to consume energy for cooking, but these savings may be outweighed by the energy used for preserving foods through refrigeration. The transition in nutrition patterns is also affecting the health and well-being of the urban population. There has been a rise in the prevalence of “modern diseases” such as obesity, cardiovascular disease, hypertension, stress, and diabetes related to the preference for energy-dense diets.

The emergence of highly pathogenic and infectious diseases such as SARS and Avian flu has caused serious health concerns, and is associated with food transport and handling in urban areas. The spread of these diseases has been facilitated by the under-investment in maintaining sanitary conditions and public markets, the continuing popularity of ‘wet’, or live animal markets, and the increased demand for exotic wild-caught meats, which provides new pathways for disease transmission between wild animals and humans. Not only are wet markets potential sources of pathogens, but they are also significant contributors to local pollution through water and solid waste.

**Slums and poverty: unmet infrastructure development needs**

While the lifestyles and consumption patterns of rising Asian and Pacific “consuming classes” and those of the region’s slum dwellers lie at the opposite ends of the spectrum, both groups represent sources of massive environmental pressure. Slums, as defined by UN-HABITAT, are a continuing concern in this rapidly urbanizing region. Thirty-seven per cent of the region’s 1.4 billion urban residents were estimated as living in slums in 2001, with South and South-West Asia having more than 57 per cent of its urban population living in these areas (see table 2.24). Urban slums are projected to grow as urban populations increase. This represents a tremendous unmet current and future demand for water, sanitation services, energy, housing and transportation infrastructure.

While the combination of an influx of rural population into urban areas and inadequate infrastructure to accommodate it facilitate the development of slums, the lack of “legitimacy” of slum occupants either because of the often temporary nature of their stay or employment, and/or status as immigrants or refugees is a major barrier to providing the necessary infrastructure to improve their quality of life.

Slums have always been viewed negatively as they suffer disproportionately from pollution, health hazards, crime, drug use and other products of social malaise. However, slums play a significant role in supporting the urban development process. From an economic and social standpoint, slums serve as a transit point for rural migrants and can serve as a ‘melting pot’ of ideas and cultures which can give rise to new artistic expressions and economic
opportunities. Recognizing the rights of those living in slums to basic services and development opportunities should be a matter of urgent national concern, but also acknowledged as a substantial source of future environmental pressure.

### Changing urban household energy consumption patterns

In both highly industrialized countries (regional OECD countries China, India and the Russian Federation) as a group and in other regional countries as a group, residential energy consumption accounts for at least one third of energy consumed, and is therefore a major determinant of overall the overall regional energy demand.217, 218

Two key trends associated with lifestyle change and rising incomes are defining energy consumption of urban households: an increasing proclivity for acquiring durable consumer goods, such as electronic appliances, that testify to rising income and status, and the growing preference for larger, western-style houses that require more energy to heat or cool. The growing individual ownership of electricity-consuming consumer goods, such as fridge-freezers (see table 2.25), electric cookers, microwave ovens, air conditioners and clothes dryers, is increasing the demand for energy in urban areas. In China, for instance, the ownership of air conditioners rose dramatically from almost no ownership (0.34 per 100 urban households) in 1990 to ownership by slightly more than half of the urban population (51.10 per 100 urban households) in 2002.219

Electricity used per urban household increased by 200 per cent from 77.4 kWh in 1990 to 237 kWh in 2002.220 Although electricity consumption makes up only some 9 per cent of final energy consumption of the residential sector in the ESCAP region overall, this figure rises to 48 per cent for Australia, Japan and New Zealand.221

With higher disposable incomes, the preference for bigger dwellings with western-style designs has increased. Many of these designs, however, do not take into account their location’s environment and ignore the traditional designs which are more adapted to local conditions. As a result, most of these new homes require substantial amounts of energy for cooling or heating the rooms and for water heating. The lax enforcement of building codes, if any, the absence of programmes that promote the value of

### Table 2.24 Population of slum areas by subregion, 2001

<table>
<thead>
<tr>
<th>Subregion</th>
<th>Total population, millions</th>
<th>Urban population, millions</th>
<th>Urban, % of total population</th>
<th>Slum population, millions</th>
<th>Slum population, % of urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>North-East Asia</td>
<td>1,629</td>
<td>731</td>
<td>45</td>
<td>206</td>
<td>28</td>
</tr>
<tr>
<td>Central Asia and the Caucasus</td>
<td>74</td>
<td>34</td>
<td>45</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>529</td>
<td>202</td>
<td>38</td>
<td>57</td>
<td>28</td>
</tr>
<tr>
<td>South and South-West Asia</td>
<td>1,517</td>
<td>473</td>
<td>31</td>
<td>272</td>
<td>57</td>
</tr>
<tr>
<td>Pacific</td>
<td>30</td>
<td>23</td>
<td>75</td>
<td>0.82</td>
<td>4</td>
</tr>
<tr>
<td>Total for Asia-Pacific region</td>
<td>3,780</td>
<td>1,464</td>
<td>39</td>
<td>545</td>
<td>37</td>
</tr>
</tbody>
</table>


### Table 2.25 Sales of fridge-freezers

<table>
<thead>
<tr>
<th>Country</th>
<th>1995</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>0.7</td>
<td>11.5</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>0.3</td>
<td>18.9</td>
</tr>
<tr>
<td>India</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-</td>
<td>2.3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2.1</td>
<td>6.8</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Singapore</td>
<td>1.7</td>
<td>27.9</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>25.3</td>
<td>35.4</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.8</td>
<td>17.9</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>0.1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

home insulation and subsidized electricity consumption only increase inefficiency of energy use in urban areas.

One way of potentially reducing energy consumption by urban households is the selection of more energy-efficient products. Advances in technology are improving the energy efficiency of appliances. Ecolabelling initiatives by the private sector and governments mean that consumers now also have better access to reliable information on energy use and can therefore make more informed choices. Consumer education and changing consumption behaviour are critical to achieving the desired downward shift in the energy consumption of urban households while maintaining quality of life. Despite the evidence that electricity consumption is increasing, access to energy remains a major issue even in urban centres. Large segments of the population still do not have access to electric power.

Urbanization also means expanding demand for water for domestic consumption. An urbanite with access to piped water and underground sewerage systems uses about three times the amount of water as a person in a rural area, with consequent impacts on wastewater production (Table 2.26). Although income plays a major role in influencing per capita domestic water use, climate, lifestyles, attitudes to water and pricing are also key factors dictating patterns of domestic water use (Figure 2.35).

An “invisible” factor which limits access to piped water in urban areas is that of aging infrastructure. Pricing inefficiencies mean that in most parts of Asia, water tariffs are too low to influence demand, and diminish investment in improvements that would reduce transmission losses and reduce the risk of water contamination. Where illegal and informal trade in water fills the gap in the market left by underdeveloped infrastructure, the poor subsidize the rich, paying as much as 25 per cent more per unit of water purchased than those connected to a water supply.

The global bottled water industry has become a multibillion dollar industry, making it one of the most dynamic sectors of the food and beverage industry. Growing at an average of 12 per cent per annum, the industry produces an annual volume of 89 billion litres of water, valued at an estimated US$22 billion. For some, drinking bottled water is a lifestyle choice, but for others, bottled water is a more expensive, but the only, alternative to inaccessible or contaminated tap water for drinking. Although Asian and Pacific consumers account for only an estimated 13 per cent of global bottled water consumption, it is the most promising market, with an annual growth of 15 per cent. However, this change in consumption pattern is not without some serious environmental impacts. Globally, more than 1.5 million metric tons of plastics, mainly polyethylene terephthalate (PET), are used to bottle water. While PET bottles require

![Figure 2.35 Domestic water use per capita in selected countries*](http://faostat.fao.org)

Table 2.26 Average pollution loads of wastewater generated by one person in Japan, 1996

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Average, g/person/day</th>
<th>% of urine and faeces</th>
<th>% of soiled (grey) water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological oxygen demand</td>
<td>58</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>Chemical oxygen demand</td>
<td>26</td>
<td>36</td>
<td>64</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>44</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>12.5</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>1.5</td>
<td>75</td>
<td>25</td>
</tr>
</tbody>
</table>

less energy to produce and recycle than glass or aluminum, most used bottles are not recycled but are disposed of in dumpsites and landfills, which are steadily increasing in size. In cities where solid waste management is already a critical issue, the disposal of used PET bottles only exacerbates the problem.

**Expanding transportation demands and the accelerated motorization of cities**

The rapid growth of Asian cities implies a more mobile population. The growth in passenger car transport and air travel is the result of urbanization, rising incomes and patterns of infrastructure development (see figure 2.36). Rising incomes, especially among the middle class, have been behind the increases in car use (see table 2.27). Australia, Brunei Darussalam and Japan have the highest motorization rates in the region, with approximately one private car for every two people. Bangladesh, China, Myanmar and Nepal on the other hand, have fewer than five private cars per thousand people.

An increase in vehicles coupled with low road network growth and limited space for expansion in some countries have resulted in high road network densities, and attendant traffic, energy consumption increases and air pollution problems. Thailand, Malaysia and the Republic of Korea have experienced

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**Table 2.27 Motor vehicles in use in selected countries and areas (‘000)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>10 651</td>
<td>11 935</td>
<td>12 800</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>163</td>
<td>230</td>
<td>250</td>
</tr>
<tr>
<td>Brunei Darussalam</td>
<td>158</td>
<td>202</td>
<td>202</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>490</td>
<td>541</td>
<td>548</td>
</tr>
<tr>
<td>India</td>
<td>9 464</td>
<td>14 739</td>
<td>17 385</td>
</tr>
<tr>
<td>Indonesia</td>
<td>4 132</td>
<td>5 412</td>
<td>5 983</td>
</tr>
<tr>
<td>Iran (Islamic Republic of)</td>
<td>1 409</td>
<td>1 321</td>
<td>-</td>
</tr>
<tr>
<td>Japan</td>
<td>65 356</td>
<td>70 902</td>
<td>54 541</td>
</tr>
<tr>
<td>Malaysia</td>
<td>3 085</td>
<td>4 927</td>
<td>5 834</td>
</tr>
<tr>
<td>Maldives</td>
<td>2 325</td>
<td>4 828</td>
<td>5 099</td>
</tr>
<tr>
<td>Myanmar</td>
<td>209</td>
<td>264</td>
<td>290</td>
</tr>
<tr>
<td>New Zealand</td>
<td>2 077</td>
<td>2 344</td>
<td>-</td>
</tr>
<tr>
<td>Pakistan</td>
<td>1 150</td>
<td>1 717</td>
<td>1 811</td>
</tr>
<tr>
<td>Philippines</td>
<td>2 846</td>
<td>2 438</td>
<td>-</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>8 436</td>
<td>12 022</td>
<td>13 907</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>17 273</td>
<td>23 479</td>
<td>-</td>
</tr>
<tr>
<td>Singapore</td>
<td>504</td>
<td>551</td>
<td>-</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>413</td>
<td>572</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>4 649</td>
<td>5 962</td>
<td>6 806</td>
</tr>
<tr>
<td>Turkey</td>
<td>4 165</td>
<td>6 150</td>
<td>6 428</td>
</tr>
</tbody>
</table>

---

among the fastest rates of growth in network density, with growth of more than 38 per cent between 1992 and 2000\textsuperscript{231}(see figure 2.37). CO\textsubscript{2} emissions from the transport sector are rapidly increasing, not only due to the sheer volume of vehicles in circulation, but also because of the increasing preference of urban consumers for bigger and more powerful cars, the CO\textsubscript{2} emissions of which are approximately twice those of subcompact and compact types of vehicles (see figure 2.38).

One alternative to individual motorization is the improvement of road or rail-based mass transport systems. For freight, a comparison of modal energy intensities (the amount of energy required to displace one metric ton by one km) shows that trucks can use 16 times more energy than that used in transporting the same weight of material by rail.\textsuperscript{232} Data from the Republic of Korea show that the energy intensity of road transport increased from 1.88 tonnes of oil equivalent/thousand passengers (three times that of rail transport) to 2.26 toe/thousand passengers, or four times that of rail transport between 1995 and 2000.\textsuperscript{233}

Railway route development in the region increased only marginally by 1.5 per cent from 1994 to 1999, with less than 25 per cent of the entire track length electrified.\textsuperscript{234} Japan, China and Central Asia have achieved the highest level of railway electrification, with 60 per cent of networks electrified in Japan and China and 47 per cent of networks electrified in Central Asia. South-East Asia has the lowest proportion (only 1.4 per cent) of its routes electrified.\textsuperscript{235}

However, there has been increasing interest in improving mass transport systems. Ongoing railway improvement projects are taking place in Bangkok, Kuala Lumpur, Manila, Busan, Seoul and a number of major cities in China. In addition improvements in public bus transport systems in Bangkok, Kuala Lumpur, Shanghai and Shenzhen have complemented railway system upgrades. Bus rapid transit systems are either operational, planned, under construction or under consideration in 36 cities in 10 countries within Asia.\textsuperscript{236}

### 2.6.3 Environmental pressures exerted by urbanization and globalizing consumption patterns

#### Air pollution

The dramatic increase in the number of vehicles in urban areas has made transport-related fuel combustion a major source of pollution in urban areas. The environmental health impacts of ambient air pollution are well known and many epidemiological studies have been carried out to support various government initiatives to curb air pollution.\textsuperscript{237}

Annual ambient concentrations of the most commonly monitored criteria air pollutants are shown in figure 2.39. Improvements in the quality of fuel for transportation, particularly the reduction of sulphur content, have markedly lowered SO\textsubscript{2} concentrations in several cities. Similarly, the phasing out of lead as a fuel additive and the introduction of unleaded fuels have significantly reduced concentrations of atmospheric lead, which is known to have a negative impact on children’s health. Suspended particulate matter (SPM) and PM10 are the pollutants of main concern, with average annual ambient concentrations generally still substantially higher than WHO guideline values. Concentrations of SPM and PM10 increased in most cities from 1995 to 2003. Average annual ambient
Figure 2.39 Average annual concentrations of selected air pollutants, selected major cities

**Ozone (O₃)**

- Dhaka
- Singapore
- Colombo
- Jakarta
- Ho Chi Minh City
- Bangkok
- Hong Kong
- Busan

**Sulphur dioxide (SO₂)**

- Beijing
- Colombo
- Shanghai
- Ho Chi Minh City
- Busan
- Singapore
- Kolkata
- Bangkok
- Hong Kong
- Seoul
- New Delhi
- Tokyo
- Taipei
- Surabaya
- Dhaka

**Suspended particulate matter (SPM)**

- New Delhi
- Hanoi
- Mumbai
- Kolkata
- Jakarta
- Manila
- Shanghai
- Seoul
- Bangkok
- Hong Kong
- Busan

**Nitrogen dioxide (NO₂)**

- Surabaya
- Seoul
- Shanghai
- Tokyo
- Hong Kong
- Taipei
- Busan
- Bangkok
- Jakarta
- Colombo
- Singapore
- Hanoi
- Dhaka

NO₂ concentrations exceed the WHO guideline standards. Efforts to reduce SO₂ concentrations need to be intensified as this compound, along with NO₂, contributes to the formation of acid rain. Emissions of acidifying pollutants are high in South-East China and North-East India, Thailand, and the Republic of Korea, with some acid rain events having caused reductions in agricultural yields and impacts on other ecosystems.²³⁸

Solid waste (and e-waste) issues

The management of domestic solid waste is among the most pressing environmental issues for the urban areas of developing countries. A World Bank study showed that those low-income countries with a low proportion of urban population also have the lowest waste generation rates, ranging from 0.4 to 0.9 kilogram per capita per day. As average incomes rise towards the middle-income bracket, waste generation rates rise to between 0.5 to 1.1 kilogram per capita per day, while populations in the high-income category generate between 1.1 and 5.07 kilograms of waste per capita per day.²³⁹

Rapid urbanization rates and increasing incomes point to a future waste explosion. Many local governments with jurisdiction over cities already face serious challenges in the management of the solid waste generated by their constituencies. Local governments spend between 20 and 30 per cent of their budgets on solid waste management, with around 70 per cent of this expenditure on waste collection alone.²⁴⁰ It is predicted that solid waste management will become even more costly and difficult in the future as disposal options based on landfills diminish. A 2003 survey by UN-HABITAT on waste disposal methods in major cities indicated that while a substantial proportion of regional waste is disposed of in sanitary landfills, 14 out of 20 countries practiced open dumping of waste and seven of these also burned waste in the open.²⁴¹ Many local governments are fully conscious of the need to cut down the costs of waste disposal and are looking for more viable options.

Solid waste management challenges are not only attributable to the sheer volume of consumption; changing patterns of consumption patterns mean new streams of waste. PET water and beverage bottles and food packaging have been targeted by special legislation in recent years. Also recently the waste from electrical and electronic equipment (e-waste) and its associated environmental and health-related impacts has received attention in the media. E-waste is growing faster than other waste streams; the European Union has seen its e-waste grow three times faster than other municipal waste.²⁴² This rapid growth has been attributed to developments in technology, notably rapid changes in high-performance software, which lead to products being replaced after a relatively short period,²⁴³ and to market expansion.

E-waste contains toxic and hazardous substances. Cathode ray tubes found in colour television sets and colour computer monitors contain significant amounts of lead. Printed circuit boards found in computers and other electronic devices may contain lead and chromium. Some older computers contain mercury switches, and many types of electronic devices use batteries which contain nickel cadmium, nickel metal hydride, lithium or sealed lead acid.²⁴⁴ The presence of such substances complicates the recycling and disposal of e-waste from a technical, environmental and economic point of view.

In Japan, new and comprehensive environmental legislation has been introduced which encourages the prevention, reuse, recycling and recovery of e-waste. Countries such as China and developing countries in South-East Asia, including Thailand, have formulated legislation to restrict imports of e-waste as well as to regulate imports of second-hand information technology.

The implications for trade are also significant. UNCTAD estimates the value of world imports of electrical and electronic equipment in 2002 at US$349 billion, of which US$224 billion (65 per cent) originated from developing countries.²⁴⁵ The value of total imports to developed countries amounted to US$246 billion, of which US$165 billion (over two thirds) originated in developing countries, almost 80 per cent of which were in South-East Asia.²⁴⁶ Imports from China, worth US$59 billion, represented over one third of total exports
from developing to developed countries. Information and communication technology accounted for 58 per cent of the value of total imports of electrical and electronic equipment to developed countries from developing countries. Legislation in varying stages of development and finalization (see chapter 7, box 7.1) will require producers of electronic components to replace heavy metals, such as mercury, lead and cadmium with non-toxic, and/or easily recycled, alternatives. Governments and companies in producing countries need to promote proactive policies with regard to information gathering and management (including enhancing understanding of new requirements), product engineering and design in order to compete successfully in international markets and address problems related to the growing volumes of e-waste at home.

Encroachment of expanding urban areas on agricultural lands and other lands

The need for physical expansion to accommodate the rapid growth of urban centers is resulting in conversion of agricultural lands, forests and other areas which have valuable ecological functions. Market imperfections and failures and the lack of security of land tenure for much of the agricultural land in the region have facilitated the conversion of these areas for urban land use. The conversion process has engendered conflict between stakeholders. Flooding, pollution, groundwater contamination and habitat loss are just some of the serious long-term environmental consequences of these changes in landuse.

In the Philippines, for example, the conversion of prime agricultural lands in the Laguna and Cavite provinces into gated residential areas and industrial estates has not only increased energy-use intensity but has also significantly altered the area’s landscape. Water pollution of the creeks and tributaries which used to feed agricultural areas is mounting due to domestic sewage originating in the built-up residential areas. One important impact of urban encroachment is the displacement of farmers, resulting in the loss of livelihoods and fuelling the growth of slum areas.

2.6.4 Pursuing urban environmental sustainability: responses and initiatives

The fundamental issue most governments face is that of whether urban environmental sustainability and social equity can be achieved without constraining the role of cities as hubs of economic growth. The following discussions highlight a number of policy initiatives and strategic innovations undertaken both in and outside the region that provide examples of good practice in improving the environmental sustainability of urban development.

Reforms in urban environmental policy: defining how urban sustainability can be achieved

The most pressing environmental issues facing developing cities in the region today are the result of ambiguous, or non-existent urban development policies that fail to take into account their environmental implications. Critical public policy decisions in the transport, industrial, agricultural and trade sectors shape the environmental sustainability of cities, but are made without the necessary coordination among stakeholder institutions. Multilateral agencies have supported the formulation of urban environmental policies that incorporate sustainable development principles, and which emphasize cross-sectoral coordination, wider civil society participation in decision-making processes and greater transparency and accountability.

Cities such as Beijing, Shanghai, Bangkok, Kuala Lumpur and Metro Manila are developing and implementing comprehensive urban policy frameworks that reflect these critical elements. The success of these interventions is mixed, with some measures, such as privatizing environmental services, the application of the “user pay” principle and the use of environmental impact assessments as planning and regulatory tools, showing encouraging progress; other strategies require reassessment, as progress has not been ideal.

The cities of Singapore and Kitakyushu provide model examples of the implementation of holistic and environmentally sustainable approaches to urban development. The primary driver for these cities to choose these approaches may have differed (Singapore was obliged by its limited natural
Environmental sustainability under threat

resources, while Kitakyushu was compelled by civil society action, upheld by judicial courts, but they both showcase the viability of achieving environmental sustainability if the appropriate urban policy framework is in place. Other initiatives which stress the vital importance of urban environment planning are those of development planning for Kuala Lumpur, Malaysia, and the greening of urban areas in Thailand.

Patterns of urban growth reflect the failures of urban development planning, as manifested in the social inequities and deteriorating environmental conditions of many cities in developing countries. Urban development planning has always been the weakest functional link of the many critical functions governments are mandated to undertake. As a consequence of poor planning systems and weak institutional capacities, many urban centres are unable to cope with the rapid expansion of demand for the services they are expected to provide.

One area where progress has been made is the adoption of local action plans that attempt to integrate social, economic and environmental objectives. More than 6,400 local governments in 113 countries have indicated that their respective local governments have adopted, or are in the process of adopting, Local Agenda 21. Around 674 local communities/governments from 17 Asian and Pacific countries (Australia, Bangladesh, China, India, Indonesia, Japan, the Republic of Korea, Malaysia, Mongolia, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand and Viet Nam) have reported that they are preparing and implementing their own Local Agenda 21. Progress is also noted in the preparation of city local environmental management plans; 32 cities in the 49 countries of the region have indicated the existence of local environmental management plans supported by the various sectors and endorsed by their legislative assemblies.

The process of preparing a Local Agenda 21 or a local environmental management plan is self-motivated and internally financed. This indication of local government commitment merits the support of both national governments and international organizations.

**Building sustainability into urban planning**

The principles of sustainable urban design support the development of urban centres that minimize negative environmental impacts such as air pollution, and resource use such as energy and water, while maximizing quality of life. The winning team of a “special jury” prize in the International Sustainable Urban Systems Design competition developed a model of the city of Panjim, capital of the state of Goa, India, that focuses on ensuring efficient resource use, as well as the well-being of its people, communities and ecosystems. Based on detailed mapping, the team forecast long-term trends for the project area and came up with a design based on a low-tech/high-tech mixture of transportation systems, building materials and design that would condense the city without resorting to high-rise resource-intensive development.

The project design team concluded that an investment of US$60 million per year together with the time investment of citizens from many sectors could accomplish the transition of a small or medium-sized city in 30 years. The project principles are being applied in the state of Goa. Sustainable urban design principles are being applied to the development of eco-cities such as that being developed near Shanghai, China, on the island of Dongtan and to the transformation of Bangalore. UNEP and UN-HABITAT, in collaboration with the local authorities and the private sector, have been supporting the development of the “Sustainable Shenyang” and “Sustainable Wuhan” initiatives.

**Sustainable urban mobility and transport: moving people with minimal impact on the environment**

With pressure growing to enhance the quality of life in urban areas, efforts are being made to improve urban mobility. Urban development planning that fully integrates a vision for cities along the lines of the famed city of Curitiba, Brazil is gaining attention as a means of increasing the environmental sustainability of urban transportation systems, increasing the use of public transportation and lowering fuel use and pollution. The Sustainable
Urban Mobility in Asia programme is supported by various agencies including the World Bank, the ADB, UNEP and UNDP and seeks to reduce greenhouse gas emissions from the transport sector while improving urban mobility. Programme initiatives include practical interventions such as the promotion of non-motorized transport, including the construction of bicycle routes within urban areas, as well as investing in infrastructure to enhance traffic management.

**Education, information disclosure and market instruments: influencing consumer choice**

One of the more positive developments in this area, and one that has the potential to significantly shape the characteristics of household consumption habits in urban areas, is increased education and the growing public environmental awareness. At the higher income levels, urban households are sensitive to the quality of their environment and are therefore quick to act on issues which threaten the integrity of their surroundings. In Singapore, for instance, urban households have supported reductions in product packaging in order to reduce waste. Access to information and communication technology and to the Internet has empowered the proactive consumer.

As outlined in section 2.3, governments are now showing that they can influence consumer behaviour through the application of information disclosure instruments (such as ecolabelling schemes), economic instruments (such as rebates for recycling and charges for waste disposal), private-public partnerships (involving producer associations) and regulatory instruments such as zoning laws, emissions standards and charges.

Positive developments in the car manufacturing industry are also influencing the future environmental impacts of an expanding vehicle population. Car manufacturing giants in the region are investing heavily in improving the designs of future generations of vehicles. Given the increasing environmental awareness of many consumers, and anticipating that countries will be imposing stricter emissions and energy efficiency standards, car manufacturers have been accelerating research and development programmes aimed at maintaining a competitive edge in the market. For example, Honda and Toyota have introduced fuel-cell technology, hybrid cars and hydrogen-fueled vehicles; Nissan and Mazda are promoting their low-emission vehicles; and Isuzu is pioneering work on more efficient and cleaner diesel engines.254

### 2.7 Climate change: a real threat to the region

Human activity is the primary driver for the increased concentrations of greenhouse gases (GHGs) which have already brought about significant change to the earth’s climate. Emissions of GHGs (carbon dioxide, methane, nitrous oxides and others)255 have increased dramatically over the last century, largely due to fossil fuel combustion and land-use changes.256

Records of the global mean temperature show that it has risen faster in this past century than at any other period over the past ten thousand years.257 Nine of the ten hottest years since 1860 occurred between 1990 and 2005. The melting of polar caps and mountain glaciers, sea-level rises and increases in the frequency and intensity of storms and weather disturbances are just a few of the other indicators that confirm that climate change is indeed taking place. This and other mounting evidence confirms the reality of climate change. This global threat may well provide the impetus to reexamine present patterns of development.

#### 2.7.1 Climate change impacts in Asia and the Pacific

Scientists predict that, should GHG emissions continue unabated, the accumulation of greenhouse gases will cause further disruptions to weather patterns, entailing more severe weather events, increased ecosystem stresses, shifting precipitation patterns, increased ranges of infectious diseases, coastal flooding and other impacts that are only now being understood. These changes will have uncertain, but potentially devastating, consequences for communities around the globe, affecting both industrialized and developing countries.
Based on the Intergovernmental Panel on Climate Change (IPCC) model scenario of the pressures of climate change, table 2.28 summarizes projected impacts. The impacts in small island states are given special attention in view of their low adaptive capacity, high sensitivity to external shocks and high vulnerability to natural disasters. For example, Tuvalu and the Carterets islands off the coast of Papua New Guinea have already been impacted by sea-level rise and prepared evacuation plans. The projected impacts of climate change on selected countries are outlined in Annex IV of this report and highlighted by figure 2.40. UNEP’s GEO Yearbook 2006 indicates that both China and Central Asia can be expected to experience net gains in potential rainfed cereal land, while South and South-East Asia would experience net losses.

Governments may fully recognize the ramifications of climate change issues, but face tough challenges in choosing the appropriate actions to take. The IPCC acknowledges that decision-making on issues related to climate change is a process subject to uncertainty, and that it must consider the nature of the risks; the economic and environmental consequences of the action and the social appreciation of the risks involved, as well as the political acceptability of the alternatives and availability of mitigating technology. Appropriate courses of action are therefore country-specific and vary from generation to generation.

2.7.2 Greenhouse gas emission trends

The relentless drive for economic growth and rising incomes constitute the primary factors contributing to the increased accumulation of atmospheric GHGs. Developed and industrialized nations produce the bulk of the emissions which contribute to global warming. Emissions of greenhouse gases from Asian and Pacific developing countries, with the exception of China and India, are considered to be of relatively minor significance. However, certain activities such as changing land-use, deforestation or the over-application of fertilizers, have contributed to the distortion of the global natural carbon and nitrogen cycles which in turn disrupt the climatic balance.

**CO₂ emission trends**

Industrialized and developed countries, home to 20 per cent of the world’s population, have been responsible for about 63 per cent of cumulative net carbon emissions from fossil fuel combustion and land-use changes since the 1900s. The United States of America remains the world’s largest emitter, with carbon emissions from its electric power sector alone exceeding the combined annual emissions of six developing nations.

The World Resources Institute ranks countries in order of their cumulative emissions of carbon dioxide from 1900, and shows that five of the top 20 are from Asia and the Pacific, including China and India. The latter two countries, home to 40 per cent of the world’s population, have contributed 7 per cent and 2 per cent respectively to atmospheric carbon content since 1900. They are responsible for much of the growth in regional CO₂ emissions, which increased by almost 30 per cent between 1990 and 2000. Asian (excluding China) CO₂ emissions grew by 78 per cent in the period 1990-2002 (see table 2.29). The combined emissions from China and India are projected to grow by more than 4 per cent annually between 2010 and 2025.

Several smaller countries have some of the fastest rates of growth in CO₂ emissions, corresponding with their fast-growing energy consumption. Countries which have experienced the fastest rates of increase in CO₂ emissions (see figure 2.41) are those with rapidly expanding economies, notably Viet Nam and Sri Lanka. China and India continue to exhibit the largest growths, in absolute terms, in CO₂ emissions. The extent to which CO₂ emissions from fuel combustion are linked to the value of economic production (measured by GDP) varies from country to country, as shown in figure 2.42 and chapter 3, figure 3.3. Due to improvements in fuel mix, sectoral and subsectoral structures and energy efficiencies, several countries, including China and India, have managed to reduce the amount of CO₂ produced from fuel combustion for every unit of GDP earned (CO₂ intensity).
### Table 2.28 Climate change pressures: Asia-Pacific region

<table>
<thead>
<tr>
<th>Projected impacts</th>
<th>Key impact areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture and food security</strong></td>
<td>Food insecurity will be a key concern for many countries in the region. Crop production and aquaculture will be threatened by thermal and water stresses, sea-level rises, increased flooding and destruction due to an increasing frequency and intensity of tropical cyclones.</td>
</tr>
<tr>
<td>• Marine productivity will also be affected by plankton shifts.</td>
<td>Most of the region’s “food basket” and coastal areas, where there are vast areas of aquaculture (China, Bangladesh, India, the Philippines, Thailand and Viet Nam).</td>
</tr>
<tr>
<td><strong>Ecosystems and biodiversity</strong></td>
<td>Climatic change will exacerbate threats to biodiversity resources, particularly if the pressure is induced by intensive land-use change and population pressure.</td>
</tr>
<tr>
<td>• Many species in the region are likely to become extinct as a result of climate change and habitat fragmentation.</td>
<td>Desert ecosystems (arid, semi-arid and dry sub-humid zones) may experience prolonged spells of drought which may affect local ecosystems.</td>
</tr>
<tr>
<td>• Global warming will increase the vulnerability of the permafrost ecosystems of boreal Asia.</td>
<td>A 1-meter sea-level rise will inundate and destroy the Sundarbans (the largest mangrove ecosystems in Bangladesh).</td>
</tr>
<tr>
<td>• As temperatures rise, particularly during summer, the frequency of forest fires may increase in boreal Asia and tropical Asia.</td>
<td>Mongolia and China (especially the Himalayas region).</td>
</tr>
<tr>
<td><strong>Water resources</strong></td>
<td>Freshwater availability is expected to be highly vulnerable to climate change. Surface runoff will be pronounced during winter, leading to increased winter flooding. However, during summer a significant reduction in the stream flows will be observed in boreal Asia.</td>
</tr>
<tr>
<td>• Countries which use more than 20 per cent of their water resources will experience more water stress. Irrigation and agriculture will be severely affected. In water-stressed areas, water will become more scarce.</td>
<td>Arid, semi-arid and dry sub-humid areas (China, India, Pakistan and Mongolia).</td>
</tr>
<tr>
<td>• Growing competition from urban areas for water use and quality will magnify the pressure on an already scarce resource.</td>
<td>Russian Federation and China.</td>
</tr>
<tr>
<td><strong>Deltas and coastal zones</strong></td>
<td>Countries in large deltas or low-lying coastal areas will be at high risk of being inundated by sea-level rises.</td>
</tr>
<tr>
<td>• Countries in large deltas or low-lying coastal areas will be at high risk of being inundated by sea-level rises.</td>
<td>Most of the coastal zones in the region. Countries at risk are Bangladesh, India, Indonesia, the Philippines and Viet Nam.</td>
</tr>
<tr>
<td><strong>Human health</strong></td>
<td>Warmer and humid conditions will increase the incidence of heat-related and infectious diseases in the tropical and temperate zones of the region. In temperate countries, there could be a reduction in winter deaths, but also a rise in the incidence of heat stroke, especially in cities, during summer.</td>
</tr>
<tr>
<td>• A rise in the incidence of respiratory and cardio-vascular diseases among populations in arid and semi-arid areas is predicted.</td>
<td>Different climatic zones will pose different health threats.</td>
</tr>
<tr>
<td>• In temperate and tropical areas, vector-borne diseases will increase as high temperatures can be conducive to breeding mosquitoes and other disease-carrying insects.</td>
<td>Bangladesh, China, India, Philippines, Thailand, Viet Nam, Lao People’s Democratic Republic, Cambodia, Japan, the Republic of Korea and Hong Kong, China.</td>
</tr>
<tr>
<td><strong>Extreme weather events</strong></td>
<td>Developing countries in the temperate and tropical zones are already vulnerable to extreme climatic events such as tropical storms, cyclones, droughts and floods. Climate change will increase this vulnerability.</td>
</tr>
<tr>
<td>• Increased precipitation intensity during the monsoon season will increase flooding in flood-prone areas.</td>
<td></td>
</tr>
</tbody>
</table>
Climate change in Asia and the Pacific - selected impacts

* Ongoing and projected impacts
Sectoral CO\textsubscript{2} emission trends

Energy use accounts for the largest share of global greenhouse gas emissions. Emissions from fossil fuel combustion generally come from two sources: emissions related to energy production and those from energy end-use sectors, such as industry, transport and the residential and commercial sectors. Sectoral per capita emissions for 2002 are shown in Figure 2.43.

Public electricity and heat production remain the main sources of greenhouse gas emissions, contributing about 35 per cent of global CO\textsubscript{2} emissions in 2002. Coal is a major fuel for the production of electricity and heat in the region. While Asia and the Pacific accounted for some 40 per cent of global energy use in 2001, the region used 52 per cent of global energy use produced from coal. The result of this dependence on coal,

<table>
<thead>
<tr>
<th>Region</th>
<th>GtCO\textsubscript{2} per capita (2002)</th>
<th>CO\textsubscript{2} emissions from fuel combustion, million metric tons (2002)</th>
<th>% change 1990-2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD Pacific</td>
<td>10.24 (25.6%)</td>
<td>Coal 761.5, Oil 993.4, Gas 266.8, Other 13.6, Total 2 035.3</td>
<td>33.6</td>
</tr>
<tr>
<td>Former USSR</td>
<td>7.78 (-32.8%)</td>
<td>Coal 660.8, Oil 469.2, Gas 1 086.9, Other 15.3, Total 2 232.2</td>
<td>-33.3</td>
</tr>
<tr>
<td>Asia (excluding China)</td>
<td>1.14 (44.3%)</td>
<td>Coal 1 031.6, Oil 916.1, Gas 309.7, Other -, Total 2 257.4</td>
<td>78.1</td>
</tr>
<tr>
<td>China (incl. Hong Kong, China)</td>
<td>2.57 (27.9%)</td>
<td>Coal 2 620.7, Oil 617.6, Gas 69.2, Other -, Total 3 307.4</td>
<td>44.5</td>
</tr>
<tr>
<td>OECD Europe</td>
<td>7.53 (-0.5%)</td>
<td>Coal 1 241.0, Oil 1 782.3, Gas 921.6, Other 24.6, Total 3 969.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Middle East</td>
<td>6.33 (39.7%)</td>
<td>Coal 34.1, Oil 651.2, Gas 407.5, Other -, Total 1 092.8</td>
<td>85.2</td>
</tr>
<tr>
<td>OECD North America</td>
<td>15.62 (0.8%)</td>
<td>Coal 2 217.2, Oil 2 814.2, Gas 1 500.8, Other 17.2, Total 6 549.3</td>
<td>17.7</td>
</tr>
</tbody>
</table>


Figure 2.41 CO\textsubscript{2} emissions from fuel combustion

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Figure 2.42 CO₂ emissions from fuel combustion per unit of GDP


Figure 2.43 Sectoral distribution of CO₂ emissions from fuel combustion, 2002

particularly for the production of electricity, is that Asian developing countries, including China but excluding countries of the former Union of Soviet Socialist Republics, emit about 1.5 times more CO\textsubscript{2} from public electricity and heat production per kWh produced (from all fuels) than the world average (see figure 2.44).

Overall, despite the commitments to sustainable development made in 2002, the world has increased the amount of CO\textsubscript{2} emitted per kWh of electricity overall, negating the substantial progress made by OECD Europe to slow the momentum of climate change.

The transportation sector is the next largest source of emissions and is also the fastest-growing emitter of CO\textsubscript{2}, increasing emissions by some 33 per cent between 1990 and 2002.

Other sources of greenhouse gases

Land-use and forestry, including the establishment of plantations, reforestation and afforestation, the commercial harvesting of timber resources and fuel-wood gathering, all influence climate change processes. The conversion of forest lands for agricultural use and the abandonment of these areas as practiced in swidden agriculture not only contribute to the environmental degradation of these areas but also affect their carbon storage capacity. Forests store 40 per cent of all the carbon in the terrestrial biosphere, more than any other ecosystem.\textsuperscript{265} The storage of carbon in the ecosystem varies depending on the type of forest.\textsuperscript{266} The growth and regrowth of forests in temperate countries can provide sinks to absorb CO\textsubscript{2} emissions from fuel combustion. Conversely, the deforestation of tropical forests and their conversion to other land uses releases an estimated 2 billion metric tons of CO\textsubscript{2} into the atmosphere annually, equivalent to 25 per cent of the emissions from fuel combustion.\textsuperscript{267}

Agriculture is a source of GHGs, particularly methane and nitrous oxides. Just as appropriate forest management must be exercised in forest areas, appropriate agricultural practices must also be adopted to minimize the sector’s contribution of GHGs emissions (see section 2.5).

2.7.3 Meeting the challenges of climate change: mitigation, the Clean Development Mechanism (CDM) and adaptation

The United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994, and represents a global strategic response to climate change issues.\textsuperscript{268} With the ultimate objective that the “stabilization of greenhouse gas concentrations in the atmosphere….should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner,”\textsuperscript{269} the two key strategies of mitigation and adaptation are pursued.

Mitigation options for curbing GHG emissions

Mitigation measures are a broad set of policy and technological interventions aimed at reducing the emissions of GHGs in the most cost-effective and efficient manner. These measures can only be successful where countries desire to develop in the context of equity, common but differentiated responsibilities, cost-effectiveness, sustainable development and support for an open international economic system.\textsuperscript{270} Given that climate change involves complex interlinkages between climatic, environmental, economic, social, political, institutional and technological factors, there is “no
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The IPCC therefore advocates for multiple approaches to mitigating the impacts of climate change, bearing in mind that these approaches should be complementary. The misperception that action on climate change lies in the global arena, rather than at the national level is reinforced by the lack of compulsory targets for emissions reductions in the framework of the UNFCCC and the Kyoto Protocol. Bridging the gap between short-term economic gain and long-term benefits of action to mitigate climate change processes is critical to addressing the very real resource limitations faced by developing countries. However, the current fuel market situation may help to change this view. As oil and coal prices increase, investments in GHG mitigation that also lead to energy savings become more feasible, and may even present new business opportunities for developing countries.

The choices made by governments as to which set of mitigation measures will be implemented are shaped largely by prevailing political, economic, cultural and social settings and global influences. Notwithstanding the likely differences, there are certain common features which lie at the heart of effective mitigation measures:

- Energy efficiency, conservation and reforestation are critical first steps of mitigation measures, which can be taken further if innovative supply-side technologies are developed;
- Investment in developing infrastructure that increases access to energy, transportation, water, as well as housing and other urban development needs in the most eco-efficient way possible, is a vital measure to reduce future greenhouse gas emissions. Its importance in those sectors in which GHG emissions are significant, such as the energy and transport sectors, cannot be understated;
- Integrating global climate policies and domestic air pollution abatement policies can contribute to significantly reducing emissions in developing countries over the next two or three decades; and
- Policies relating to agriculture, land use and energy systems need to be integrated and linked with climate change mitigation policies.

The Clean Development Mechanism: tapping its potential

The Kyoto Protocol is a follow-up agreement to the UNFCCC intended to prompt governments (particularly the industrialized, or Annex I, countries) to reduce or limit CO₂ emissions to 1990 levels by 2012. The Protocol introduced three innovative and flexible cooperative mechanisms aimed at ensuring global cost-effectiveness in curbing GHG emissions: Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM).

Of the three mechanisms, the CDM has attracted the widest interest, due to its potential for profit and its involvement of developing countries. The CDM has two goals: to promote sustainable development in developing countries and to allow Annex I countries to earn emissions credits (more widely known as certified emission reductions (CERs)) from their investments in emission-reducing projects in developing countries. To earn credits under the CDM, the project proponent must prove that the GHG emission reductions are real, measurable and additional to what would have occurred in the absence of the project.

The implementation of the CDM in the region has progressed. In December 2005, a total of 27 projects were registered with the CDM Executive Board and were projected to reduce emissions by 18.9 million metric tons of CO₂ equivalent annually (see table 2.30), which represents 71 per cent of the total global reductions that will be earned from all 49 projects globally. India and the Republic of Korea are notable for the amount of CO₂ equivalent reductions that will be achieved through the CDM. India’s 14 projects will account for more than 27 per cent of the total emission reductions, while the Republic of Korea’s two projects will account for almost 40 per cent of total regional emissions that are avoided. What makes the...
Republic of Korea’s contribution particularly significant is that these projects will support the reduction of emissions of hydrofluorocarbons (HFCs) which are between 150 and 23,900 times more potent than CO₂ in terms of their global warming potential.279 The types of CDM project vary; in Asia and the Pacific projects will achieve GHG emission reductions or avoid GHG emissions through energy efficiency, renewable energy, gas capture and sequestration, small and medium-sized hydroelectric plants and waste incineration. The greatest shares of CERs are generated by gas capture and fuel switching, and most of the future CERs generated by these projects will accrue to Japan, the Certified Emission Reduction Unit Procurement Tender280 and the Prototype Carbon Fund (PCF).281

The potential of the CDM in the region is high, and more developing countries are becoming aware of its benefits; many have been recipients of capacity development support from both multilateral and bilateral development agencies. Table 2.30 shows that some 90 CDM projects in the region are in various stages of preparation. This number is expected to expand further following the establishment of Designated National Authorities (DNAs) in more non-Annex 1 countries, which will oversee the implementation and approval of projects, following the guidelines established at the 7th Conference of Parties.282 In the region, a total of 24 countries have already identified their DNAs, and therefore can register projects under the CDM.283

While there is increasing interest in implementing CDM projects, a number of institutional, financial and procedural barriers still need to be addressed to enhance the mechanism’s viability (see table 2.31), in addition to the hurdles posed by stakeholder misperceptions (see box 2.12).

### Table 2.30 The Clean Development Mechanism in Asia and the Pacific (December 2005)

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of CDM projects registered¹</th>
<th>Estimated emission reductions, registered projects (TCO₂/yr)</th>
<th>Number of CDM projects in various stages of preparation and implementation²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armenia</td>
<td>1</td>
<td>135 000</td>
<td>-</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Bhutan</td>
<td>1</td>
<td>524</td>
<td>-</td>
</tr>
<tr>
<td>China</td>
<td>3</td>
<td>338 016</td>
<td>9</td>
</tr>
<tr>
<td>Fiji</td>
<td>1</td>
<td>24 928</td>
<td>-</td>
</tr>
<tr>
<td>India</td>
<td>14</td>
<td>7 191 180</td>
<td>23</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>Nepal</td>
<td>2</td>
<td>93 883</td>
<td>-</td>
</tr>
<tr>
<td>Malaysia</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Philippines</td>
<td>-</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>2</td>
<td>10 550 000</td>
<td>-</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>3</td>
<td>104 130</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td><strong>Asia-Pacific total</strong></td>
<td><strong>27</strong></td>
<td><strong>18 961 137</strong></td>
<td><strong>90</strong></td>
</tr>
<tr>
<td><strong>Global Total</strong></td>
<td></td>
<td><strong>26 810 980</strong></td>
<td></td>
</tr>
</tbody>
</table>

(70.72% of global total)

Sources:
1. UNFCCC website, accessed on 14 March 2006 from <http://www.unfccc.int> and
The perception of risk is one important limiting factor to the current CDM.\(^2\) There are three main types of risks, both perceived and real:

(a) The CER price risk: this relates to the uncertain market price of the CER, which is driven by aggregate supply and demand for the amount of emission reduction units - this also makes it difficult to forecast future prices;

(b) The CER quantity risks: the CERs generated cannot be determined \textit{ex ante}; they are largely determined by the difference between actual emissions and baseline emissions. Actual project emissions may change unexpectedly due to circumstances such as plant shutdowns or the interrupted operation of power plants. In such cases the operator is unable to meet its emissions reduction targets; and

(c) Host country risks: usually defined by the host country’s political, financial, economic and social stability.

Unilateral CDM: a viable prospect with considerable potential, particularly for developing countries

The current CDM is a bilateral instrument, involving an entity or entities from an industrialized country investing in a GHG-reduction project in a developing country. Multilateral funds are mobilized and combined with private sector investments to reduce the perception of risk and stimulate the market. However, the slow response of targeted companies in industrialized countries has shifted preferences to purchasing the CERs rather than investing fully in the projects. This has led to the emergence of an alternative approach, which is a variant on the original CDM – the unilateral CDM.\(^3\)

The unilateral CDM is purported to be more flexible than the original CDM scheme, as the approach allows the host country or developing country to plan and finance projects. The attractiveness of the approach is that the host country has the

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**Table 2.31 Critical limitations to, and opportunities for, expanding the implementation of the Clean Development Mechanism**

<table>
<thead>
<tr>
<th>Areas of concern</th>
<th>Limitations</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional</td>
<td>A complex and cumbersome project approval process</td>
<td>Streamlining of the project process by reforming the CDM and the Executive Board</td>
</tr>
<tr>
<td></td>
<td>A slow approval process in host countries, attributed to weak institutional capacities</td>
<td>Strengthening of institutional and human capacity where it is inadequate</td>
</tr>
<tr>
<td></td>
<td>Marginal contribution to sustainable development (very few energy-efficiency and forest-conservation projects)</td>
<td>Preferential measures to promote CDM projects with local sustainable development benefits, including energy efficiency and forestry projects.</td>
</tr>
<tr>
<td></td>
<td>Transfer of technology is not actually taking place</td>
<td>Adoption of sector-based approaches to CDM and policy-based CDM to address technology and distribution issues</td>
</tr>
<tr>
<td></td>
<td>A perceived geographical bias of the host parties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uncertainty regarding the continuation of the CDM beyond 2012</td>
<td></td>
</tr>
<tr>
<td>Technical</td>
<td>Technical difficulties in the development of methodology</td>
<td>Standardization of methodologies</td>
</tr>
<tr>
<td></td>
<td>Complexity of baselines and additionality</td>
<td>Relaxation of baseline and additionality conditions</td>
</tr>
<tr>
<td>Financial</td>
<td>High transaction costs for project development</td>
<td>Reducing transaction costs through improvements in the project development process.</td>
</tr>
<tr>
<td></td>
<td>Uncertainty of the price and volume of CERs</td>
<td>Mobilizing additional support to finance CDM projects during the project development stages</td>
</tr>
<tr>
<td></td>
<td>Difficulties in mobilizing financial support for projects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difficulties in securing willingness of the private sector in developed countries to invest in host developing countries</td>
<td></td>
</tr>
<tr>
<td>Legal</td>
<td>Complexity and lack of transparency of the regulations in host countries, particularly regarding taxation and the adjudication of disputes</td>
<td>Reforming institutions to promote the account-ability and transparency of decision-making processes</td>
</tr>
<tr>
<td></td>
<td>Legal status of CERs</td>
<td>Interventions to recognize the CERs as a legal market instrument, particularly in developing countries</td>
</tr>
<tr>
<td></td>
<td>Distribution of CERs from projects funded under by ODA</td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from Institute of Global Environmental Studies (2005). \textit{Asian Perspectives on Climate Regime Beyond 2012: Concerns, Interest and Priorities} (Tokyo, Institute of Global Environmental Studies).
Box 2.12 Infrastructure financing opportunities via the Clean Development Mechanism

The opportunities presented by the CDM for use as a component in the financing of large-scale infrastructure projects are enormous. Large-scale projects which generate a significant amount of CERS and introduce poverty-reduction opportunities can be set up by conglomerates with the ability to realize projects in a timely manner. The CDM mechanism provides an ideal link between private and public interests. However, infrastructure development, such as the construction of new industrial plants for electric power generation, chemicals, oil and gas, cement, agribusiness and pulp and paper plantations, tends to be perceived as unrelated to environmental protection initiatives such as the CDM. Too often, the perception is that private sector gains are in conflict with environmental objectives. Despite this, a brief look at the Asia-Pacific region highlights the potential for immediate projects and CDM opportunities.

- **Large-scale renewable energy:** In archipelagic South-East Asia, such as in the thousands of islands of Indonesia, biomass is abundant but too often burned in the open air and the potential energy wasted. Meanwhile, almost all of the electricity in these islands comes from diesel generators. Mobilizing the opportunity presented by this situation is hampered by foreign exchange risks and a lack of local financing. The CDM could provide a critical boost to enhancing internal rates of return and could help to bridge additional financing sources with development risks. If this is done in conjunction with captive industrial plants nearby, the associated risks can be significantly mitigated.

- **Agri-business (agricultural plantations):** In addition to the opportunities to replace diesel provided by biomass energy, many traditional plantations have huge pools of decaying biological effluent. The CDM offers the possibility of structuring a methane capture facility which can bring in new revenue while generating CERS and introducing better overall environmental management.

- **Industrial processes upgrades:** Heavy industries continually assess the value of upgrading their processes and technologies. These industries need to consider possible CER generation as a first step in upgrading their current process. Companies in sectors which generate heavy chemicals as final and intermediate products and in sectors where industrial processes use heavy chemicals, can also explore generating CERs through efficiency improvements in their efficiencies.

**Threats to the blossoming of CDM potential:**

**“On the Ground” mismatch:** A history of confrontation and conflict between community and environmental groups and industry has created a divide that reduces the potential for cooperation to develop win-win solutions to environmental problems. Too often, environmental protection and commerce are viewed as opposing interests. Engagement in achieving mutually beneficial objectives is rarely seen, and the CDM can fall in the same trap. There is also a mismatch between the types of projects being developed by designated national authorities (DNA) in developing Asia and their attractiveness as commercial ventures. The projects are purely from the perspective of corporate finance, often “unbankable” due to their size, financial returns which are not commensurate with the risks, and a lack of professional and technical capacities to implement the projects successfully.

**Misconceptions:** In order for a vibrant CER market to develop, large block generators of CERS, as found in heavy industry and infrastructure projects (which generate millions of metric tons of CERS), are needed. However, conglomerates often view environmental concerns and the CDM as financial burdens akin to taxes. In order for the CDM to be “scaleable” across Asia, conglomerates must be mobilized to generate CERs for their own self-interest.

Too often, regional forums on the CDM are dominated by the public sector. There is too much “public push” and too little “market pull”. Private-sector skepticism about the CDM can be overcome by emphasizing the purely financial element of the CDM. The CDM as a financing element can add a percentage point or two to the internal rate of return and introduces new sources of international financing. The simple message that the “CDM = money” works.

Corporate finance firms which deal with heavy industries and construction for infrastructure development are important intermediaries in reconciling environmental, social and public interests with commercial interests in the context of maximizing CDM opportunities. At present, the limited number of corporate finance firms promoting the CDM represents an open market with limited competition. Paradoxically, the lack of competition works against pioneering corporate finance firms as awareness of CDM as a source of financing is commensurately low, hampering the growth of the CER market. Greater emphasis on the role played by market intermediaries in effectively creating greater CDM “market pull” is critical to developing CDM markets and promoting greener infrastructure and industrial development.

human, institutional and infrastructural capacity to mobilize the capital necessary for the initiative, thereby assuming all the associated risks of the project.286

Linked with an appropriate CER discounting scheme,287 the unilateral CDM has the potential to contribute significantly to the net global reduction of GHGs without the imposition of any reduction targets on developing countries.288 For example, a developing country implementing a project has generated two million worth of CERs and has sold 1 million CERs on the carbon market to developed countries. The remaining 1 million CERs retained by the developing country thus represents a net global GHG emission reduction.

One concern raised about the scheme relates to access to technology and the transfer of capacities, which may constrain the host country since it will assume all the costs and risks associated with the project. Proponents of the unilateral CDM maintain, however, that such concerns would be adequately addressed under a CER discounting scheme. Since CERs are economic instruments and are considered purchasing agreements, developing countries may be able to use them as collateral, giving the countries access to financial resources that will enable them to acquire new technologies and hire technical experts who can assist with developing actions and interventions to reduce climate change.

The unilateral CDM means that developing countries can become active participants in global emissions reductions, rather than merely being passive hosts to projects identified by developed and industrialized countries under the original CDM. If the “Cuyamapa Hydroelectric Project” in Honduras289 is an indication of the scheme’s acceptability and appeal, and depending on the market response, unilateral CDMs can become a significant option for those developing countries in the region that have the capability to support this type of project.290

Incorporating adaptation measures into development planning

Adaptation measures are actions which reflect the ability of societies to adjust to climate change in order to mitigate potential damage and take advantage of opportunities or cope with the consequences of climate change.

Human adaptive capacities vary depending on the climate and the magnitude, scale and frequency of climate-related risks and can be maximized through market forces or by direct government intervention (see table 2.32). In general, market response is slow and its effectiveness may be further hampered by factors such as the maturity of institutions, the protection provided by legal frameworks and various sources of market failure.291 The public sector is expected to lead in both reactive and anticipatory responses to addressing climate-change vulnerability and risks.

It is vital to emphasize the value of anticipatory adaptive measures, given their potential to significantly reduce vulnerability to, and risks posed by, climate change. Central to this exercise is the recognition of planning as an important component of the adaptive strategy which should be spearheaded by the public sector at all levels, from the community to the national level.

Unfortunately, the absence of sustainable development plans and the continued sectoral orientation of development planning highlight the inadequacies of government efforts to address climate change in the context of coastal zone development plans, urban development plans and land-use planning. This situation is yet more acute in developing countries, as primary development objectives are directed towards economic expansion. In this context, developing countries should be encouraged and assisted by developed countries to formulate development plans that incorporate climate-change concerns.
2.8 Natural disasters in the region: a constant threat

The Asian and Pacific region is among the most disaster-prone regions in the world and is subject to hydrometeorological (floods, cyclones and droughts), geological (earthquakes, landslides and volcanoes) and others disasters, such as epidemics, insect infestations, hot and cold waves and forest fires (see table 2.33).

UNEP estimates that 80 per cent of all natural disasters worldwide occur within Asia and the Pacific. Estimates of lives lost alone already account for about 90 per cent of total global deaths from natural disasters since 1900. Between 1995 and 2004, South Asia, South-East Asia and North-East Asia have seen the largest number of lives lost from natural disasters (see figure 2.45).

In terms of disaster damage, the region accounted for more than 50 per cent of the total global amount of damage in the period 1900 to 2004 (see figure 2.46). For the year 2004, 245 of the 641 natural hazards events recorded globally occurred in Asia and the Pacific, accounting for US$73 billion of the total economic losses valued at US$145 billion, or 50 per cent of the total loss.294

2.8.1 Natural disaster distributions and types

In Asia, droughts, floods and windstorms constitute the disasters that may not be the most deadly, but that affect the largest numbers of people. In the Pacific, windstorms, volcanoes and floods impact on the lives of more people than other disasters.

Riverine flooding continues to be a common occurrence, causing substantial annual damage, and the impact of flash floods is increasingly important. Urban flooding has become a major potential hazard in terms of its economic and social impacts as a result of the rapid urbanization process and uncoordinated infrastructure development. With regard to coastal flooding, storm surges have caused substantial loss of life and property damage in large
Table 2.33 Relative intensity of natural hazards faced by selected countries in the Asia-Pacific region

<table>
<thead>
<tr>
<th>Country</th>
<th>Cyclones</th>
<th>Floods</th>
<th>Droughts</th>
<th>Landslides</th>
<th>Tsunamis</th>
<th>Earthquakes</th>
<th>Volcanoes</th>
<th>Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>S</td>
<td>S</td>
<td>-</td>
<td>-</td>
<td>L</td>
<td>-</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
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<td>S</td>
<td>S</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>-</td>
<td>L</td>
</tr>
<tr>
<td>China</td>
<td>M</td>
<td>S</td>
<td>S</td>
<td>L</td>
<td>L</td>
<td>S</td>
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<td>M</td>
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<tr>
<td>Cook Islands</td>
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<td>S</td>
<td>L</td>
<td>M</td>
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<td>-</td>
<td></td>
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<tr>
<td>Fiji</td>
<td>S</td>
<td>S</td>
<td>M</td>
<td>S</td>
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<td></td>
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<tr>
<td>India</td>
<td>M</td>
<td>S</td>
<td>S</td>
<td>L</td>
<td>-</td>
<td>M</td>
<td>-</td>
<td>M</td>
</tr>
<tr>
<td>Indonesia</td>
<td>L</td>
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<td>M</td>
<td>L</td>
<td>L</td>
<td>S</td>
<td>M</td>
<td>M</td>
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<td>Iran (Islamic Republic of)</td>
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<td>-</td>
<td>-</td>
<td>S</td>
<td>-</td>
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<td>Japan</td>
<td>S</td>
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<td>M</td>
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<td>S</td>
<td>S</td>
<td>L</td>
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<tr>
<td>Kiribati</td>
<td>L</td>
<td>S*</td>
<td>S</td>
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<td>L</td>
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<tr>
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<td>-</td>
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<td>M</td>
<td>L</td>
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<td>Micronesia (Federated States of)</td>
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<td>L</td>
<td>-</td>
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<td>M</td>
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<td>Philippines</td>
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<td>L</td>
<td>S</td>
<td>S</td>
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<td>Solomon Islands</td>
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<td>Sri Lanka</td>
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<td>Thailand</td>
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<td>Viet Nam</td>
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<td>S</td>
<td>S</td>
<td>L</td>
<td>-</td>
<td>L</td>
</tr>
</tbody>
</table>


S - severe  
M - medium  
L - low  
* - coastal flooding
and heavily populated delta areas such as those of Bangladesh and Viet Nam, while tsunamis generated by submarine earthquakes and other geological disturbances took their toll in 2004 in South and South-East Asia.

About 15 per cent of the world’s cyclones originate in the Bay of Bengal, causing severe flooding on the east coasts of India and Bangladesh. Windstorms frequently impact Pacific island communities.

The region is also very vulnerable to droughts, with 31 droughts recorded over the last 10 years. Prolonged droughts in South Asia (mainly in Afghanistan, Pakistan and India) since 1998 have compromised food security and caused widespread famine and food shortages. The high temporal and spatial variations in the distribution of water resources across the region are responsible for Asia’s vulnerability to water-related disasters. Between 2000 and 2004, over half a billion people (one in eight of the region’s population) across Asia and the Pacific were affected by drought. An almost equal number were affected by flooding in the same time period.

Between 1900 and 2005, earthquakes have resulted in a total loss of nearly 530,000 lives and nearly US$200 billion in the Asian and Pacific region. Two thirds of all large earthquakes take place in the “ring of fire” around the Pacific, and the

Note: Including tsunami-related deaths
Himalayan region is also one of the world’s most seismically active regions. While all subregions in Asia and the Pacific experience seismic activity, the areas of highest activity are in South Asia (Afghanistan, India, Islamic Republic of Iran, Nepal and Pakistan), China, Indonesia, Japan, Papua New Guinea and the Philippines.298

In terms of the estimated economic value of the damage caused by natural disasters in the period from 1995 to 2004, North-East Asia (particularly China and Japan) sustained damage of a higher economic value than any of the other subregions.

In 2000, a survey quantified the annual economic losses caused by cyclone-related disasters, showing that these losses varied from US$5.5 million in Hong Kong, China to as high as US$1,960 million in Japan every year. Attempts were also made in several countries to rank the severity of cyclone-related hazards according to the magnitude of impacts – see, for example, Malaysia and the Philippines (Table 2.34).

The impacts of river floods, as well as of flooding in urban areas, resulting from cyclones were considerable in many countries. Flash floods were also found to be frequent in many countries, while data on coastal floods, particularly storm surges, were generally not readily available. The survey, supported by the data held by the OFDA/CRED International Disaster Database, indicated that the loss of human lives and the economic damage from cyclone-related disasters (wind storms and floods) accounted for more than half of the total losses from natural disasters (54 per cent of deaths and 57 per cent of economic damage).299 This pattern, however, has changed significantly in recent years, with the annual average number of deaths from natural disasters in the past 15 years reduced to about 42,000 from a high of about 100,000 50 years ago. On the other hand, annual economic damage has increased to US$29 billion in the last 15 years compared to US$10.6 billion per annum 50 years ago.300

2.8.2 Vulnerability to natural disasters

An expanding population with limited habitable space, coupled with unsustainable patterns of development, is among the primary reasons for the high human, social and economic losses in the region caused by natural disasters. Both the rural and urban poor are particularly vulnerable, as they are often forced to settle in low-lying flood-prone areas, on unstable hillsides or in other disaster-prone marginal areas. For example, in Bangladesh over a million people live on islands formed by silt deposits and along the vulnerable flood plains and coastal areas. Over 85 per cent of the population of China lives on alluvial plains or along river basins, concentrated in one third of the total area of the country. In Viet Nam, where the distribution of the population is similar, the dykes along rivers which usually provide protection are sometimes breached by flood waters, causing extensive inundation.

Environmental degradation, caused by the unsustainable patterns of development taking place in many countries of the region, is exacerbating the effects of natural hazards. The damage caused by natural hazards is higher in countries where environmental degradation is severe. Deforestation, soil erosion, overgrazing, over-cultivation, flawed agricultural practices and the degradation of natural buffers all amplify the effects of natural hazards (Box 2.13). Land degradation and desertification pose a serious threat to the region in the wake of growing populations and enhanced food demand.

Equally critical are the unseen effects of human interventions that subtly but significantly contribute to the vulnerability of societies to disaster. The influence of climate change on weather-related natural disasters is acknowledged and supported by credible scientific evidence such as that
produced by the World Meteorological Organization in 2002. Since 1980, scientists have been warning of the increasing intensity, severity and frequency and wider spatial distribution of extreme weather events.

Despite these events, development policies still do not generally consider their impact on disaster-related risks. The increasing number of mega-cities in the region is giving rise to an emerging area of concern – the vulnerability of underground spaces. With land increasingly scarce in many of the mega-cities in the region, creating new space underground is becoming an attractive option. However, the expansion of underground infrastructure such as rail systems, shopping areas, and underpasses in most mega-cities has taken place with little consideration of the associated risks from extreme hazards such as flooding, fire and earthquakes. The enforcement of zoning and strict building laws and the incorporation of natural disaster risk management into planning are often inadequate, making these infrastructures vulnerable to disasters. For instance, in Tokyo the frequency of underground flooding is high, particularly during the rain and typhoon months, with 17 reported incidents occurring between 1999 and 2001 and involving some fatalities despite extensive precautions. The likelihood that these events also occur in other megacities is high, but they are generally either not reported at all or under-reported. The implications for many developing countries, which have a low capacity to handle such events, are worrying.

Box 2.13 Protection by natural coastal barriers in the December 2004 tsunami

The deadliest tsunami in history occurred in South-East Asia on 26 December 2004. Following an earthquake of magnitude 9.0 on the Richter scale off the coast of Sumatra, a massive tsunami struck low-lying coastal areas throughout the Indian Ocean, killing at least 176,000 people; nearly 50,000 people to date are still listed as missing. While tsunamis are rare events, their destructive power is enormous. In heavily hit areas, they can reduce buildings to rubble, wiping out entire communities with little warning. Tsunami survivors must often cope with the trauma of losing family members, friends, homes and livelihoods. At the same time, they must deal with severe environmental degradation, which makes a return to normal life difficult.

The most pressing environmental concerns following the Indian Ocean Tsunami were the proper disposal of large quantities of debris, the contamination of groundwater, soil salinization, coastal erosion and the disruption of environment-related activities such as farming, fishing and eco-tourism. In the Maldives, the debris contained hazardous materials such as asbestos, and groundwater supplies were contaminated with nitrates and fecal coliform. Many other tsunami-affected communities face similar environmental hazards.

26 December 2004 marked the second time in just over 120 years that a devastating tsunami has struck South-East Asia. Because of the highly destructive nature and relative frequency of tsunamis in the Indian Ocean, it is imperative for governments in the subregion to prepare for the next catastrophe. In recognition of this imperative, governments have already begun planning the installation of a tsunami early warning system, which, however, only represents one step in the safeguarding of coastal communities. Evidence that coastal forests, mangroves, sand dunes and coral reefs can mitigate the force of the giant waves is mounting. Not surprisingly, human settlements that are located behind natural barriers tend to suffer far less damage than those with no natural barriers. In Sri Lanka, vegetated sand dunes are credited with protecting large areas of the Lunama-Kalametiya Sanctuary and the Godawaya area, while mangroves bore the brunt of the tsunami’s force in Medilla, the Kalametiya Lagoon and Kahandamodara.

Over the past 20 years, the coastal ecosystems of South-East Asia have been replaced by hotels, aquaculture ponds and residential areas. The conservation and restoration of these natural barriers will not only provide protection against tsunamis, but also restore a wide range of ecosystem services such as erosion control, biodiversity protection, fisheries rehabilitation and tourist attractions. The economies of South-East Asia depend upon these services which can play an important role in plans for adaptation to sea-level rise and the increased frequency of extreme weather events associated with climate change.

2.8.3 Linking disaster risk management with growth and development: the emerging imperatives for coping with natural disasters

Different natural disasters affect people and the environment in various ways. It is critically important to recognize these differences, as well as the link between economic growth and natural disasters. Low economic losses do not necessarily reflect small impacts on development. For developing countries, particularly the least developed, even a relatively small economic loss may be critically important to the capacity to recover from disaster.

For example, it is estimated that the proportion of economic losses in developing countries from flooding alone can be as high as 13 per cent of GDP, compared with just 2 per cent of the GDP of developed countries. Earthquakes often cause the most expensive damage, although these losses are concentrated geographically. On the other hand, floods may register relatively low economic losses but their total human impact may be higher. Droughts cover bigger areas, and affect large numbers of people and have generally lower economic impact.

The increasing severity of natural disasters and the escalating costs of damages are compelling justifications for governments to review their current outlooks on disaster risk management. Support for a more holistic approach to disaster management has been increasing in the past few decades, manifested by the growing number of countries which are taking steps to improve their disaster preparedness capabilities. A number of laudable efforts can be cited, particularly in improving policies aimed at minimizing the risks of disasters through planning and the promotion of zoning laws, especially in urban areas. UN-HABITAT conducted a survey in 2002 of disaster preparedness in 48 cities in the 49 countries of the region. Thirty-four cities indicated that a building code was enforced, 32 cities undertook hazard mapping and 24 cities had established natural disaster insurance schemes for public and private buildings.

The value of information and communication is one aspect of disaster preparedness that has not been given due attention. The Red Cross promotes the view that information is a vital form of aid in itself, and that disaster-affected people need it as much as the basic relief necessities (i.e. water, food, medicine or shelter) that are provided. Lessons learned from past disasters underscore the fact that sharing information with the most vulnerable groups can significantly reduce casualties and save lives, livelihoods and resources. The International Federation of Red Cross and Red Crescent Societies (IFRC) considers that information may be the only form of disaster preparedness that most vulnerable groups can afford. Early warning systems, supported by a robust forecasting system, are the most practical way of ensuring that accurate information can be shared in a timely way with vulnerable communities, making the difference between life and death. It is estimated that establishing early warning systems has a cost-benefit ratio of 10 or 15 to 1. Japan has demonstrated the benefit of a very well-established disaster preparedness system, and similar observations have been noted, however localized, in the Philippines, India, and Bangladesh. On the other hand, the Asian tsunami experience has shown that even where the best information possible is generated (such as was available to scientists in the Pacific), the lack of effective early warning systems to process and disseminate the information immediately can lead to disasters of horrific proportions.

While there is growing recognition of the benefits of disaster and risk management, there is also a need to reorient current disaster management perspectives. The mindset must shift from the reactive and the charitable to one of anticipation and pre-emptiveness. As experience shows, countries are usually generous with post-disaster relief efforts, but less so when it comes to pre-disaster preparedness, spending US$100 on relief for every US$1 spent on preparedness. Recent research has focused on the root causes of the continued increase in economic and human losses caused by natural disasters, which have occurred despite the economic growth and development that have taken place in the region. This increase has largely been attributed to the current orientation of disaster management, which
Part I focuses exclusively on reducing the impact of disasters on development rather than on a truly integrated risk management approach which, in addition to disaster management, promotes development that helps to reduce and not to increase disaster risks. It is predicted that the benefits of such a reorientation of perspectives will be immensely valuable, especially for Asia and the Pacific, since this approach reduces the level of disaster risks to societies and, if pursued alongside sustainable development strategies, can help significantly to reduce expenditure on emergency and reconstruction efforts and to reduce human losses when a disaster strikes.
End notes


2 UNIDO defines pollution-intensive industries as comprising the following subsectors of manufacturing: paper and paper products, industrial chemicals, petroleum refineries, non-metallic mineral products, iron and steel, and non-ferrous metals. Website accessed on 23 March 2006 from <http://www.unido.org/userfiles/PembletP/figc.jpeg>.

3 One study that covers 15 countries and areas including China, Taiwan Province of China, India, Indonesia and the Russian Federation, and reported by the World Bank (*Greening Industry: New Roles for Communities, Markets and Governments* (New York, Oxford University Press, 2000)), has found that a growing proportion of total pollution was attributable to Asian developing countries during the 1970s and 1980s. See Brandon, Carter and Ramesh Ramankutty (1993). *Towards an Environmental Strategy for Asia*, World Bank Discussion Papers No. 224. Chapter 4 pp. 65-73 (Washington DC, World Bank) accessed on 18 November 2005 from <http://www.worldbank.org/nipr/work_paper/224-4>. The authors reported that there were multiple increases in pollution intensities in Thailand and the Philippines, accompanied by a two-thirds decrease in pollution intensity in Japan from the late 1970s to the late 1980s. A study focusing on trade between the USA, Japan, Australia and the ASEAN countries (Angitro Abimayu “Impact of Free Trade on Industrial Pollution: Do Pollution Havens exist?” ASEAN Economic Bulletin, v 13, no. 1 (1996)), found that there has been a faster expansion of “dirty” industry in ASEAN countries than in their developed trade partners.

4 Brandon, Carter and Ramesh Ramankutty (1993), op. cit. This study applied the World Bank’s Industrial Pollution Projection System (IPPS) model developed in the early 1990s and sought to assist regulators in developing countries to estimate pollution loads attributable to industrial activity. A series of sector estimates of pollution intensity (defined as pollution per unit of output or pollution per employee in the sector) was derived from merging production and emissions data from 2,000,000 factories in the United States of America during the late 1980s. The pollution intensities were then applied in other countries to estimate the pollution loads of different industries. See World Bank New Ideas in Pollution Regulation programme website, “Estimating Pollution Load: The Industrial Pollution Projection System (IPPS),” accessed on 23 March 2006 from <http://worldbank.org/nipr/ipps/ippsweb.htm>.

5 Brandon, Carter and Ramesh Ramankutty (1993), op. cit. Estimates of toxicity intensity are based on the linear acute toxicity index, which combined United States of America coefficients of pollution intensity (pollution produced per unit of product) and weighted each coefficient by acute toxicity for over 30 industries in the late 1980s. The result was an index for each industry that showed the relative toxicity of pollutants produced per US$1000 of product from each industry. This index may not be wholly applicable to other countries or other time periods. However, it is assumed that the relative toxicity of industrial subsectors is not likely to change significantly with time.


8 European energy-intensive industry representatives assert that implementing the Kyoto Protocol will place an unfair burden on them and will lead to possible reductions of production and “generate changes in trade flows as imports into the EU from countries with no carbon constraints would naturally increase, especially for products with little elasticity in demand.” European energy intensive industries (2004). “Energy intensive industries call upon EU decision-makers to pay more attention to the impact of emissions trading upon their competitiveness” Joint statement, January 2004, accessed on 23 March 2003 from <http://www.cebureau.be/Cem_warehouse/1-ENERGY%20INTENSIVE%20INDUSTRIES-JANUARY%202004.PDF>.


12 This discussion relates to the debate about “pollution havens”. Many studies conducted in the 1990s concluded that pollution abatement constituted too small a proportion of total costs to influence location decisions – i.e. that the pollution haven effect was unlikely. A more recent study identifies the possible reasons for which pollution haven effects have not previously been observed.
It further concludes that the effects of pollution costs on net imports are not only “statistically significant, they are economically significant”. For each product group studied, net imports increased when pollution abatement costs increased; i.e. it was found to be more cost-effective to import a particular product when pollution abatement costs increased. The increase in net imports was also found to represent “a considerable fraction of the increase in total trade volumes over the period.” See Levinson, Arik and M. Scott Taylor (2004). “Unmasking the Pollution Haven Effect” National Bureau of Economic Research Working Paper Series, Working Paper 10629. Another study shows that whether or not investment is influenced by environmental stringency can depend on the source of investment. Investigating almost 2900 manufacturing joint ventures in China, Dean and others showed that “low environmental levies are a significant attraction only for joint ventures in highly-polluting industries with partners from Hong Kong [China], Macao [China] and Taiwan [Province of China]. In contrast, joint ventures with partners from OECD sources are not attracted by low environmental levies, regardless of the pollution intensity of the industry.” See Dean, Judith, Mary Lovely and Hua Wang (2005). “Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China,” World Bank Policy Research Working Paper 3505, February 2005 (Washington DC, World Bank), accessed on 23 March 2006 from <http://ideas.repec.org/p/wbk/wbrwps/3505.html>.


22 See UNEP (2004), ibid.


28 ISO 14000 is an internationally recognized environmental management system which, through a generic set of specifications, establishes standards for all aspects of environmental management that can be applied across a wide range of organizations. See the website of the International Standards Organization, accessed on 12 April 2006 from <http://www.iso.org/iso/en/iso9000-14000/understand/inbrief.html>.
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Chapter 2


Known as PRTRs, these information systems typically document pollutant emissions in substantial detail and make them available to the public without interpretation for the lay person.


Others include the OECD Principles of Corporate Governance, OECD guidelines on Multinational Enterprises, the UNEP FI initiatives, the United Nations Global Compact, the Global Reporting Initiative and the Equator principles.

A UNEP survey of stakeholder ratings of sustainable production tools and initiatives in the Asian and Pacific region indicates that public reporting is ranked along with environmental accounting as one of the least-recommended measures for strengthening sustainable production at the national level. This may be a reflection of generally negative perceptions in the industry regarding public disclosure. Legislation, regulation, policies and training and financial incentives ranked as the most important. See UNEP (2004), op. cit.


World Resources Institute (2000), ibid.


International Iron and Steel Institute (2005), op. cit.

Based on data in Kuo, Chin S. and others (2001), op. cit.


Ecolabelling schemes such as that of the Forest Stewardship Council and, within the region, that in Indonesia, seek to improve the sustainability of forest management. However, in 2002, the total area of forests
certified by the Forest Stewardship Council in the region only constituted some 4 per cent of the global total. Despite being established to improve the management of tropical timber forests, such certification schemes seem to have had limited impact in tropical areas.


56 Wood Resources International LLC and Seneca Creek Associates (2004), ibid.

57 “Non-Wood Forest Products” refers to animal and plant products other than wood derived from forests or forest tree species. FAO defines Non-Wood Forest Products as goods of biological origin other than wood that are derived from forests, other wooded land and trees outside forests. See the FAO Non-Wood Forest Product webpages, accessed on 20 April 2006 from <http://www.fao.org/forestry/foris/webview/forestry2/index.jsp?siteId=2301&sitetreeId=6366&langId=1&geoId=0>.


59 While commodity prices have increased rapidly in recent years, long-term declines in real commodity prices from 1980 to 2002 have been observed. The World Bank’s price indices for agricultural commodities, crude oil and metals show declines of 47 per cent, 43 per cent and 35 per cent respectively. With the exception of nickel, real prices of minerals are expected to decline in the longer term as production costs continue to fall and new technologies and managerial practices improve. See Annex 2 “Global Commodity Price Prospects”, in World Bank (2005). Global Economic Prospects 2005 (Washington DC, World Bank).


65 These increases can be compared with the global increase in electricity consumption of 50 per cent in the same period (1980-1990). See World Bank (2003). World Development Indicators 2003 (Washington DC, World Bank).


68 Based on IEA (1999a and 1999b) and (2004a and 2004b), ibid.


Of the 20 per cent savings, it is assumed that half results from zero-investment measures, six per cent from low-cost investments and four per cent from high-investment measures. See ESCAP (2004), op. cit.

ESCAP (2004), op. cit.


See the website of the UN Framework Convention on Climate Change, CDM project activities webpage “Project 0349 : Sihwa Tidal Power Plant CDM Project”, accessed on 20 April 2005 from <http://cdm.unfccc.int/Projects/DNV-UK1143710269.08/view.html>.

Saghir, Jamal (2005), op. cit.


World Alliance for Decentralized Energy (2005), op. cit.

Saghir, Jamal (2005), op. cit.

Saghir, Jamal (2005), op. cit.

Under the ESCAP 5P (Pro-Poor Public-Private Partnership) project, the Cinta Mekar microhydro power plant was financed by a private company and the community organized into a cooperative. The power plant generates about 54,000 kWh a month and earns profits of about US$3,300 which are shared equally among the community. For more information see the ESCAP website, accessed on 18 April 2006 from <http://www.unescap.org/esd/energy/cap_building/ppp/>.


Metschies Consult and German Technical Cooperation GTZ, for the German Federal Ministry for Economic Cooperation (2005), ibid.


The water exploitation index (WEI) is the mean annual total demand for freshwater divided by the long-term average freshwater resources. If between 10 and 20 per cent of annual renewable freshwater resources are withdrawn each year, a country’s water supply is said to be under low stress. WEI values between 20 and 40 per cent indicate situations of water stress, while WEI values greater than or equal to 40 per cent indicate severe stress. See European Environment Agency (2003). "Indicator Fact Sheet (WQ01c) Water exploitation index", Version 01.10.03, available online at <http://themes.eea.eu.int/indicators/all_indicators_box>.

Water availability per capita is also known as the Falkenmark Index. If this value is greater than 1,700 m³ per capita per year, only occasional or local water problems are expected. Less than 1,700 m³ per capita per year but over 1,000 m³ per capita per year signals periodic or regular water stress. Less than 1,000 m³ per capita per year is said to be an indicator of chronic water scarcity.


Glacial lakes are formed when debris-covered glaciers retreat, leaving behind closed water bodies dammed by debris that are vulnerable to basin erosion and seismic tremors. In 2002, UNEP and the International Centre for Integrated Mountain Development found that the building pressure of water from increased glacial melt could cause 24 glacial lakes in Bhutan to burst their naturally created dams, endangering the communities in their paths.


Worldwatch Institute (2001), op. cit.


Data for 2004. See the Water Resources and Hydropower Planning and Design General Institute, China (2004), op. cit.


See Water Resources and Hydropower Planning and Design General Institute, China (2004), op. cit.


Other benefits of these systems include increased plant yields, reduced tillage operations and tillage energy use (by some 50 per cent), a quick post-harvest turnaround of fields that can permit two crops to be harvested in some years, reduced fertilizer and systemic pesticide use and pollution (where irrigation systems are used to deliver agrochemicals directly to the root zone) and reduced salinization and land degradation.

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120 Based on data from the Millennium Indicator database and United Nations Population Division.


122 In 2000, China’s per capita water consumption in rural households was estimated at 89 litres per day. Urban per capita water use was estimated at almost three times this amount at 244 litres per day. See Guan, Dabo and Klaus Hbacek, Leeds Institute of Environment, School of the Environment, University of Leeds (2004). "Lifestyle Changes and its influences on energy and water consumption in China", in Proceedings for the International Workshop on Driving Forces for and Barriers to Sustainable Consumption, Leeds, 2004. Earlier estimates for India put urban per capita water use (with piped water and underground sewerage) at three times the rural per capita figure of 40 litres per day (assuming availability of other water sources for bathing and washing clothes in rural areas). See Meinzen-Dick, Ruth and P.P. Appasamy (2002). “Urbanization and Inter-sectoral Competition for Water” in Finding the Source: The Linkages between Population and Water (Washington DC, Woodrow Wilson International Centre for Scholars), accessed on 12 December 2005 from <http://wwics.si.edu/topics/pubs/popwwaw1.pdf>.


126 Meinzen-Dick, Ruth. and P.P. Appasamy (2002), op. cit. The authors point out that tradeable water rights, a market solution that has been proposed in developed countries, will require adequate physical infrastructure for transfers, effective information systems and effective mechanisms for dealing with the consequences for third parties, conditions not often found in developing countries. Given the low economic value of water used for agriculture, tradeable water rights can result in diminished food production, as farmers sell water for industrial purposes and eventually exhaust their own supplies.


134 Millennium Ecosystem Assessment (2005), op. cit.

135 Department of Environment, Soil and Water Pollution and Waste Management Bureau, Islamic Republic of Iran (2004), op. cit.

Also an important factor is the shifting age structure following the ageing of the “baby boomer” generation. Generally the baby boomer generation have high incomes and can afford to maintain relatively comfortable lifestyles. Their dietary preference is for a lower calorific intake and an increased demand for fish, fruits and vegetables. It is predicted that a growing aging population will significantly shape the future pattern of food consumption in the region.


Inoue, Sotaro and Boonjit Titapiwatanakun (2000). “Dietary pattern change in Asian countries. Research on food consumption structure and marketing system (sic) under economic fluctuations in Japan and other Asian countries” (Tokyo, National Research Institute of Agricultural Economics).


ADB (2000). The Growth and Sustainability of Agriculture in Asia (Manila, ADB).

FAO (2003c). Selected Indicators of Food and Agriculture Development in Asia-Pacific Region 1992-2002, Regional Office for Asia and the Pacific publication 2003/10, (Bangkok, FAO Regional Office for Asia and the Pacific). FAO’s definition of Asia and the Pacific does not include Armenia, Azerbaijan, Brunei Darussalam, Georgia, the Russian Federation, Singapore and Turkey.

FAO (2003c), ibid.


World Commission on Dams (2000), ibid.

FAO (2003a), op. cit.


Exosomatic energy is the transformation of energy outside the human body, as differentiated from endosomatic (or metabolic) energy, which is the transformation of food energy into power within the body.

Giampeitro, Mario and David Pimentel (1994), op. cit.


Hongmin Dong, Qing He, Yue Li and Xiuping Tao (2000). “Livestock Production and CH₄ Emission from Enteric Fermentation of Domestic Livestock in China”, paper presented at the Workshop on GHG Inventory for the Asia and the Pacific (Japan, Institute for Global Environmental Strategies).


FAO (2004b), op. cit.

The FAO and the Cartagena Protocol on Biosafety employ narrower definitions of modern biotechnology. (see FAO <http://www.fao.org/biotech/index.asp?lang=en>, accessed on 15 March 2006 and the Convention on Biological Diversity <http://www.biodiv.org/biosafety/default.asp>, accessed on 15 March 2006). In the context of this report “GMO”, “transgenic organisms” and “genetically engineered organisms” are used synonymously but it should be noted that they are not technically identical.

FAO (2004d), op. cit.


The Field Alliance, ibid.


FAO (2004d), op. cit.

FAO (2004d), op. cit.

FAO (2004d), op. cit.

FAO (2004d), op. cit.

FAO (2004e). *Status and Potential of Fisheries and Aquaculture in Asia and the Pacific* (Bangkok, FAO Regional Office for Asia and the Pacific).

OECD (2001), op. cit.


ESCAP estimate based on data from FAO (2003d), ibid.

Millennium Ecosystem Assessment (2005), op.cit.

Millennium Ecosystem Assessment (2005), op.cit.


206 The 12 cities are: Tokyo and Osaka (Japan); Shanghai and Beijing (China); Mumbai, Calcutta, and Delhi (India); Dhaka (Bangladesh); Karachi (Pakistan); Jakarta (Indonesia); Metro Manila (the Philippines); and Moscow (the Russian Federation). United Nations Department of Economic and Social Affairs Population Division (2004). *World Urbanization Prospects: The 2003 Revision* (New York, United Nations).

207 United Nations Department of Economic and Social Affairs Population Division (2004), ibid.


214 OECD (2001a), op. cit.


216 Slums are characterized by UN-HABITAT as areas suffering from: backlogs in the delivery of basic services as demand outstrips institutional capacity and financial resources; inadequate access to shelter and insecure tenure; severe overcrowding, homelessness and environmental health problems; increased vulnerability to environmental health problems, environmental shocks and natural disasters; intra-city inequality; residential segregation and lack of participation in decision-making processes. See UN-HABITAT (2003a). *Slums of the World: The Face of Urban Poverty in the New Millennium* (Nairobi, UN-HABITAT).


218 The other countries and areas include Armenia, Azerbaijan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, Georgia, Hong Kong, China, Indonesia, the Islamic Republic of Iran, Kazakhstan, Kyrgyzstan, Lao People’s Democratic Republic, Mongolia, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Tajikistan, Timor-Leste, Thailand, Turkey, Turkmenistan, Uzbekistan, and Viet Nam.

219 Although the values may reflect national sales volumes, the figures reflect consumption patterns of the durable goods in urban or in highly urbanized areas of the countries.


223 In 1995 in India, the average water use in rural areas was 40 litres per capita per day while in urban areas, households connected with piped water systems used 70 litres per capita per day and households with both piped water and underground sewerage systems used 125 litres per capita per day. Meinzen-Dick, Ruth and Paul Appasamy (2002). “Urbanization and Intersectoral Competition for Water” in *Finding the Source: The Linkages between Population and Water* (Washington DC, Woodrow Wilson International Centre for Scholars), accessed on 13 March 2006 from <http://wwics.si.edu/topics/pubs/popwawa3.pdf>.
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226 United Nations agencies do not see bottled water as a sustainable alternative to tap water. Bottled water does not therefore feature among the primary parameters for gauging improved access to water under Millennium Development Goal 7.

227 UNESCO (2003), op. cit.

228 UNESCO (2003), op. cit.


231 Based on data from ESCAP (2003), op. cit.


233 ESCAP (2004), ibid.


237 The Health Effects Institute identified 138 papers and peer-reviewed literature published between 1980 and 2003 presenting the health impacts of ambient air pollution in Asia. The bulk of the studies were conducted in East Asia and a number were conducted in South Asia and South-East Asia. Health Effects Institute (2004). *Health Effects of Outdoor Air Pollution in Developing countries of Asia: a Literature Review* (Boston, Health Effects Institute).


242 EU volumes of electronic waste total more than eight million metric tons a year.

243 This is much less the case in developing countries. In Thailand, for example, the average period for which electrical and electronic equipment are used before replacement is very long (e.g. 18 years for television sets and 7 years for computers). Pollution Control Department, Ministry of Natural Resources and Environment, Thailand. “Mitigation Measures Examples from Thailand,” presentation at the Regional Expert Group Meeting on E-Waste in the Asia Pacific, UNEP/Regional Resource Centre for Asia and the Pacific, Pathumthani, Thailand, 22-23 June 2004.


246 Voseenaar, Rene and others (2006), ibid.

247 Voseenaar, Rene and others (2006), ibid.


249 Hardoy, Jorge Enrique, et.al. (2006), ibid.

United Nations Division for Economic and Social Affairs (2002). *Second Local Agenda 21 Survey, Background Paper no. 15 for the WSSD Preparatory Session.*

UN-HABITAT (2003a), op. cit.


The United Nations, in citing as examples these specific brand names, does not in any way endorse the products or the companies mentioned.

The Kyoto Protocol includes in the category of ‘other’ GHG gases hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF$_6$). These gases are man-made chemicals and do not occur naturally. HFCs are manufactured as replacements for the CFCs which have been phased out; PFCs are mainly used in various applications in the semiconductor industry; and SF$_6$ is generally used in the electronics industry. These gases are emitted in small quantities but have disproportionate effects because of their atmospheric lifetimes. Of the three chemicals, SF$_6$ is the most potent as measured in terms of global warming potential. Information from Energy Information Agency, available at <http://eia.doe.gov>, accessed on 14 March 2006.

The combustion of fossil fuels, particularly by the energy sector, is the largest source of global anthropogenic greenhouse gas emissions and, based on the 2002 total primary energy supply (TPES) accounts, represents 83 per cent and 76 per cent of emissions in OECD and non-OECD countries respectively. Another source is agriculture, which accounts for about 8 per cent. International Energy Agency (2004). *CO$_2$ Emissions from Fuel Combustion 1971-2002* (Paris, OECD/IEA).

OECD (2001), op. cit.


IPCC (2001a), ibid.

IPCC (2001a), ibid.


Baumert, Kevin and Nancy Kete (2002), op. cit.


FAO (2001), ibid.


The UNFCCC Secretariat provides organizational support and technical expertise to the negotiations and institutions and facilitate the flow of authoritative information on the implementation of the UN Framework Convention on Climate Change and the Kyoto Protocol. As part of their functions the Secretariat serve as the repository of all national reports of the Parties and decisions of the Conference of Parties. For an update on the status of country commitments to the Convention please visit the UNFCCC website at <http://unfccc.int/documentation/items/2643.php>.


IPCC (2001b), ibid.

For more information on the mitigation measures please see the IPCC (2001b), op. cit.

Under the emissions trading scheme, industrialized countries will be allowed to meet their commitments by buying and selling excess emissions credits among themselves. By creating a financial value for emissions credits, market forces will provide a cash incentive for governments and industry to switch to cleaner fuels and industrial processes, achieving emissions targets and

275 The joint implementation programme, on the other hand, will permit industrialized countries to cooperatively implement projects that will reduce GHGs. An investor from one country would receive emissions credits equal to the amount of emissions reduced or avoided as a result of the project. The recipient country would receive new technology and know-how. Article 6 of the Kyoto Protocol, accessed on 14 March 2006 from <http://unfccc.int/resource/docs/convkp/kpeng.html>.


277 The CDM Executive Board supervises the implementation of the CDM under the authority and guidance of the Conference of Parties (COP)/ Meeting of Parties (MOP), and is accountable to the COP/MOP. For more details of the functions of the CDM EB see <http://cdm.unfccc.int/EB>, accessed on 14 March 2006.

278 While Republic of Korea is an OECD member it is Non-Annex I Party of the UNFCCC and therefore can be a recipient of CDM financing.


280 The Certified Emission Reduction Unit Procurement Tender is a tender process funded by the Dutch Government in order to acquire CERs. The tender mechanism was closed in January 2002, however, after the Dutch government found the tender mechanism too inflexible and costly and was severely criticized by a number of NGOs.

281 The Prototype Carbon Fund (PCF) is a World Bank-initiated consortium of power-generating and oil companies and the governments of the Netherlands, Norway, Finland, Canada, Sweden and Japan. The consortium is involved in acquiring CERs.

282 The guidelines were approved at the 7th Conference of Parties (Marrakech Accords of 2001) under Decision 17/CP.7 Modalities and procedures for a clean development mechanism, as defined in Article 12 of the Kyoto Protocol.

283 As if December 2005, the countries in the ESCAP region that had established designated national authorities were: Armenia, Azerbaijan, Bangladesh, Bhutan, Cambodia, China, Fiji, Georgia, India, Indonesia, Japan, Lao People’s Democratic Republic, Malaysia, Maldives, Mongolia, Nepal, New Zealand, Pakistan, Papua New Guinea, the Philippines, the Republic of Korea, Sri Lanka, Thailand, and Viet Nam. Information accessed on 14 March 2006 from <http://unfccc.int/2860.php>.


285 The decision by the CDM Executive Board to accept the registration of projects without Annex 1 participants was made during its 18th Meeting in February 2005. See Report of the 18th Meeting of the Executive Board of the CDM, accessed on 16 March 2006 from <http://cdm.unfccc.int/EB/Meetings/018/eb18rep.pdf>.


287 The CER discounting scheme is another idea that is being explored in the region.

288 Chung, Rae Kwon (2005), op cit.

289 The first unilateral CDM project endorsed and approved in April 2005 by the CDM Executive Board.

290 Jahn, Michael and others (2004), op. cit.


296 Based on data from Université Catholique de Louvain, Brussels, Belgium EM-DAT (2005), op. cit.

297 Based on data from Université Catholique de Louvain, Brussels, Belgium EM-DAT (2005), op. cit.

299 Based on data from Université Catholique de Louvain, Brussels, Belgium EM-DAT (2005), op. cit.

300 ESCAP (2006). Enhancing regional cooperation in infrastructure development including that related to disaster management, United Nations publication, Sales No. E.06.II.F.13 (Bangkok, United Nations).


303 United Nations University (2005), ibid.


305 UN-HABITAT (2003b), op. cit.


307 IFRC (2005), ibid.

