Chapter 3

Human Settlements

Perth 's central business district.

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Introduction

Australia's population is highly urbanised. In 1991, 85 per cent of Australians lived in settlements with populations of 10 000 or more. The remaining 15 per cent of the population lived in small country towns, on farms or in remote settlements (see Table 3.1). Although Australia's largest settlements occupy less than one per cent of the nation's land area, they have a considerable influence on the natural environment of their hinterlands.

This chapter examines the influence of demographic, economic, social and technological pressures on Australian settlements. The condition of our settlements is assessed with regard to livability, social amenity, health and resource inputs and waste outputs. The country's urban, rural and remote settlements are considered as three different kinds of interaction with the environment and various pressures, conditions and responses in these three types of settlement are examined. Finally, the chapter reviews government responses to identified problems.

Table 3.1 Proportion of Australians living in urban, rural and remote settlements, 1991

	Number	Percentage
Urban		
Big Cities[1] (above 1 million)	10 062 003	59.7
Other Cities (80 000 to 1 million)	2 025 803	12.0
Rural		
Large Rural Towns (25 000 to 80 000)	962 041	5.7
Small Rural Towns (10 000 to 25 000)	853 051	5.1
Rural Other[2] (less than 10 000)	2 452 264	14.6
Remote[3]		
Remote Towns[4] (above 5 000)	203 137	1.2
Indigenous Settlements[5]	73 297	0.4
Remote Other[6]	209 973	1.2
Total[7]	16 850 540	100.0

Notes:
1. Includes Sydney, Melbourne, Brisbane, Perth and Adelaide.
2. Includes people on farms and in small towns in the agricultural region.
3. Outside the cleared agricultural areas, i.e. areas used mostly for pastoral, mining, tourist and Indigenous purposes consistent with Holmes (1988).
4. Includes a substantial group of Indigenous communities whose members are residents of country towns mixed in with a predominantly non Indigenous population.
5. Data on the number and location of discrete Indigenous settlements and population of those settlements are drawn from ATSIC (1993). Settlements in this table are those discrete indigenous townships, outstations or groups of indigenous people living in an identifiable location often located on indigenous land and likely to be responsible for their own municipal services or which are without such services altogether.
6. Mostly pastoral and mining settlements, including communities between 100 and 5000 that have sizeable indigenous representation associated with them.
7. Includes offshore and migratory population (8971). Census data do not match the estimated resident population data published in some of the following tables.

Source: ABS, 1991.

Figure 3.1 Australia's five big cities, rural and remote areas

Note:

In this report the definition of urban, rural and remote is based on a functional approach, i.e. urban includes those surrounding small settlements which are functionally now part of the urban area although they may have once been quite separate and still look somewhat rural. The ABS urban classification does not include as many of these peripheral areas and hence they report only 76% of people live in cities above 10 000 (ABS, 1994g). Rural is defined as including cleared agricultural areas, and remote as beginning in the pastoral regions beyond the rural zone.

Metabolism of settlements

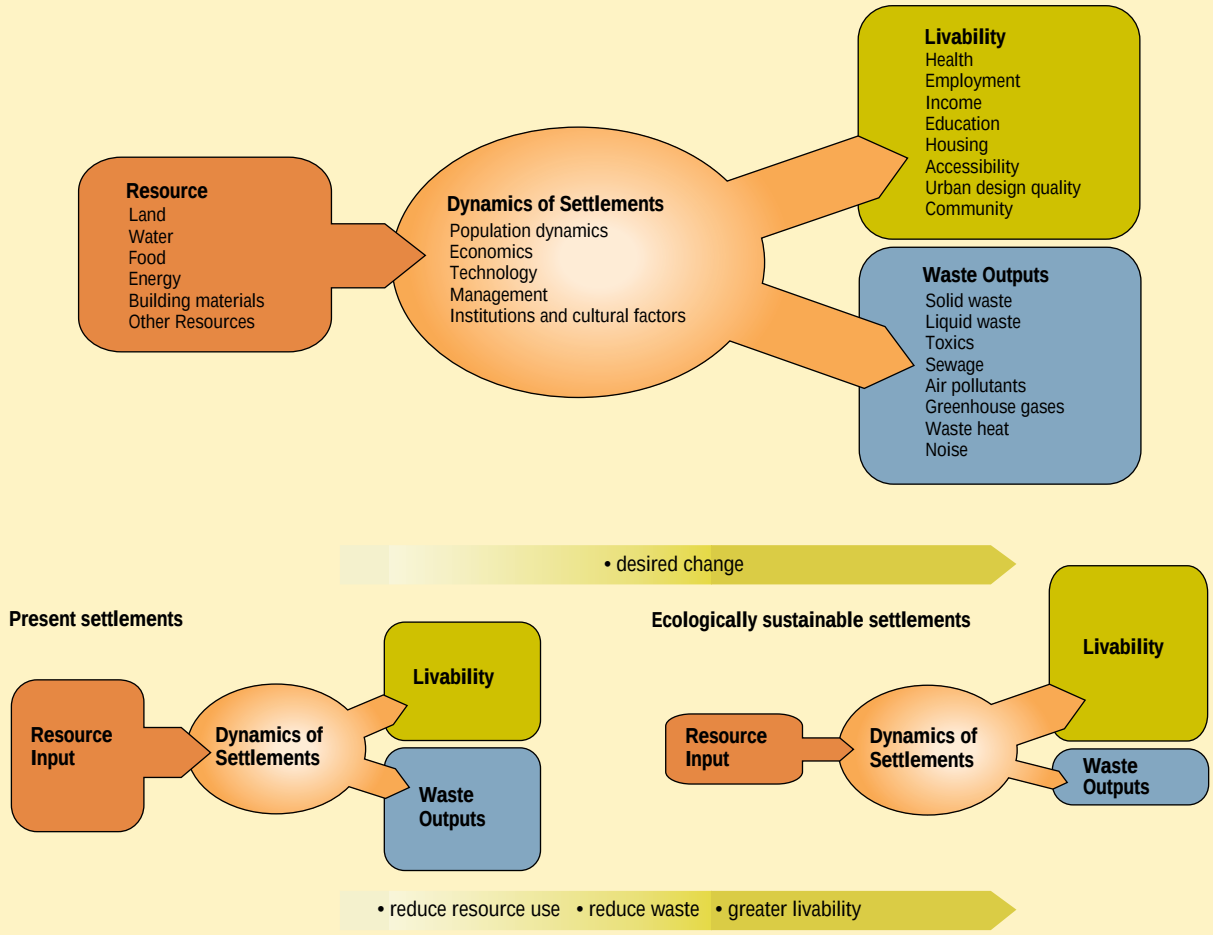
Extended metabolism model

Metabolism, the flow of resources into and waste outputs from settlements, provides a model for assessing the environmental impacts of settlements (Wolman, 1965; Boyden *et al.*, 1981; Girardet, 1992). This chapter extends the basic metabolism model to include the dynamics of settlements and livability (see Fig. 3.2). Livability is defined as the human requirement for social amenity, health and wellbeing and includes notions of individual and community wellbeing in both the human and wider environment.

Settlements are places where communities evolve economically and socially in an attempt to improve their quality of life. The products of economic and industrial developments have value for livability as well as environmental impact. This chapter looks not only at how settlements in Australia affect the environment by using resources and producing wastes, but also at the way quality of life within them can be measured using various socio-economic and health indicators. The management of the built environment and the natural environment need not necessarily be in conflict. This is the challenge of the National Strategy for Ecologically Sustainable Development (ESD) as adopted by Australian governments in 1992.

Settlements manage their resource inputs and waste outputs by engineering systems at city, industry and household scales. Such systems have various levels of efficiency and impact depending on their size and the priority given to infrastructure and technological innovation. State of the environment

Figure 3.2 The extended metabolism model of human settlements



reporting is one way that we can assess both our natural resource capacities and quality of life.

Other models

A city's pressure on the environment extends beyond its own geographic limits, as it draws on resources such as oil, minerals, timber and food, not only from its own region, but from other parts of Australia and the world. Wastes also have effects beyond the local area, especially greenhouse gases, ozone-depleting substances and hazardous materials. Researchers are developing techniques for estimating the extended environmental impact of settlements due to their resource consumption. One such method is William Rees' 'ecological footprint' (see the box on the right).

The 'ecological footprint' model and other systems that focus on resource flows in settlements help us understand their extended impact on the environment. But they do not help to assess whether or not we can reduce requirements for resources while maintaining or improving livability. For this reason the extended metabolism model is used in preference to the ecological footprint model in this chapter.

Carrying capacity and the ecological footprint

The term 'carrying capacity' is a concept usually used to determine the population of a particular species that an ecosystem can sustain without damaging its essential functions. Determining carrying capacity for human settlements is complex because not only do their consumption requirements reach well beyond settlement boundaries, so too do the effects of their waste.

Canadian William Rees has taken the concept of carrying capacity and applied it to human resource use. He defines human carrying capacity as 'the maximum rate of resource consumption and waste discharge that can be sustained indefinitely without progressively impairing the functional integrity and productivity of relevant ecosystems' (Rees, 1992).

Rees refers to the total area of land and water required to sustain a settlement as its 'ecological footprint', and has developed a method of measuring the area required to provide its resources and absorb its wastes. Because settlements are remote from much of the land producing the resources they consume, each one's 'ecological footprint' represents its 'appropriated carrying capacity'. With the increasing intensity of world trade in resources, this concept is an attempt to measure the true impact of settlement consumption patterns.

In calculations for metropolitan Vancouver, Rees showed that its population requires 20 times more land than the region represents for food production, forestry products and energy requirements alone (Wackernagel *et al.*, 1993). The bulk of the 'footprint' land is consumed for energy, because the calculation estimates greenhouse gas emissions in terms of the forest needed to take up the CO_2 or to produce the energy from biomass-derived ethanol. This is purely illustrative of the possible extent of the city's impact, and should not be seen as a direct impact.

Pressure

The major forces shaping the recent evolution of Australian settlements are those related to technological and economic development and associated population dynamics.

Technological and economic forces

Globalisation

The process of globalisation is affecting all human settlements. National and local economies are increasingly being opened to the competition of international markets and other global trends. They are being exposed to the global flows of information, capital, people, goods and services. The effects of such forces are amplified within Australia as the Commonwealth Government continues to dismantle barriers to competition by, for example, reducing tariffs and deregulating financial markets. Globalisation is changing the nature of manufacturing in Australia (reduced blue-collar production-line employment, fewer smokestack industries), reducing the need for warehousing (just-in-time production), increasing office employment (world-wide electronic communication and computerisation) and providing increased employment in information-oriented service industries.

Between 1981 and 1991, Australian employment in urban manufacturing declined by 10 per cent, resulting in the net loss of some 104 000 jobs in this sector. During the same period producer services (finance, real estate, information and communications) increased by 51 per cent, personal services grew by 36 per cent and social services increased by 30 per cent (see Table 3.2).

A later section will suggest how these changes are reflected in current patterns of urban development: in the spatial distribution of income and unemployment; patterns of housing affordability; and in processes of suburbanisation and re-urbanisation.

Globalisation of the economy can be a powerful positive or negative force for sustainability. Globalisation is also a powerful force in terms of ideas and pressures on governments. International agreements to reduce metabolic flows and improve livability are setting the global agenda. Australian settlements can adopt appropriate innovations in urban management and technology and use them to help promote wealth, livability and sustainability.

Table 3.2 Industry and employment changes in urban Australia

Employment category	1981	1991	Absolute growth	Percentage growth
Extractive industries	50 925	49 377	-1 548	-3.0
Transformative industries	1 017 906	914 015	-103 891	-10.2
Distributive industries	927 646	1 115 941	188 295	20.3
Producer services	369 942	560 046	190 104	51.4
Social services	743 078	969 171	226 093	30.4
Personal services	176 978	276 362	99 384	36.0
Total	**3 286 475**	**3 884 912**	**598 437**	**18.2**

Source: Newton, *et al*., in press.

Transport/information technology

People cluster together in cities because they can do more as a community than as individuals. The technologies for people to move around and between cities and to share information are critical to how they manage their metabolic flows and create livability.

Research shows that people in settlements tend not to spend more than about half an hour on average travelling to destinations (Manning, 1978; Pederson, 1980). This has been a pattern throughout history.

The walking city (before 1860) seldom exceeded a five km radius and so was densely populated (100–200 people per ha) with narrow streets. Many cities in developing countries retain this walking-based urban form.

The transit city (1860–1940), which could spread 10 to 20 km, tended to be linear and focused on railway stations or along tram lines, with medium-density houses and work locations (50–100 people per ha) and a strong emphasis on the central business district (CBD). Many European cities retain this transit-based urban form.

The automobile city (from 1940 on) could spread 20–40 km wherever roads were built; the density was subsequently lower (10–20 people per ha) and a much more spacious city became possible, although it used much space for roads and parking. The CBD became mainly an office centre with most other work dispersing to the suburbs. Many United States and Australian cities reflect this automobile-based urban form.

In recent decades a fourth type of city has emerged.

The multi-nodal/information city is emerging in large cities where the distance of travel, even by automobile or fast train, from the periphery to the CBD is now well beyond the half hour limit. Partly as a response, the multi-nodal/information city comprises a range of smaller subcentres with global information processing and networking capabilities equivalent to the CBD, as well as other urban services. Although linked to the rest of the city, these nodal/information subcentres can generate a large degree of self-sufficiency in their immediate urban region. The layout of these cities varies considerably: European versions are more densely settled and transit-oriented, with their subcentres strung out like pearls along a string (Cervero, 1995); the North American multi-nodal/information centres, which are more dispersed and car-oriented, are sometimes called 'edge cities' (Garreau, 1991).

All four types are represented in Australian cities to varying degrees. Remnants of high-density walking cities, like The Rocks, Fremantle and some CBD areas, are often pedestrianised. Many pre-1940

transit-based, medium-density suburbs, often called the 'inner city', are extensive in Sydney and Melbourne, but also occur in Brisbane, Perth, Adelaide, Newcastle and Hobart. Large expanses of low density car-based suburbs exist in every city, providing the main source of accomodation for the 10 million people added to the population since 1945. Emerging nodal/information subcentres are found in all major cities.

The older core and inner areas have much lower dwelling occupancies due to the age of their occupants (for example, children leave home and go to new suburbs while parents remain) and their greater housing diversity — including many more units that are occupied by smaller households, often single people (see Table 3.3).

In the 1940s, Australia's big cities had an occupancy rate of 3.9 people per dwelling. This declined to 2.6 in 1991. About one-third of the development pressure for housing in Australian cities in the post-war period came from the decline in household size which was caused by a combination of factors, including reduced birthrates, higher divorce rates, children leaving home earlier and lifestyle preferences.

This chapter often refers to two processes — suburbanisation and re-urbanisation — that are simultaneously helping to shape the new multi-nodal/information city.

Suburbanisation of work and services to outer areas is occurring along with new housing. Most new development in outer areas and the vast majority of fringe areas in major Australian cities are now beyond the 40-km limit that allows comfortable access by car (or train) to the city core in half an hour. These more dispersed locations have to function largely without relating to the historical core of the city. The resultant multi-nodal/information subcentres in these suburbanising regions include: Parramatta, Blacktown (Sydney); Dandenong, Knox, Frankston (Melbourne); Joondalup (Perth); Elizabeth (Adelaide); and Ipswich (Brisbane).

Re-urbanisation of core, inner and middle areas means that more households can live within easy access of major employment centres and services. In these re-urbanising areas there is a revitalising of older subcentres that are now becoming nodes as described above. Examples include: Chatswood (Sydney); South Melbourne, Port Melbourne, Box Hill (Melbourne); Fremantle (Perth); Tea Tree Gully (Adelaide); and Toowong (Brisbane).

Changing transport technology and globalisation processes also help to explain the settlement patterns of rural and remote areas. Many older provincial cities on the coast acted as ports for rural hinterlands and were quite contained. The spread of dispersed coastal settlements now reflects the greater availability and use of the car for transport. Many remote settlements now depend on air transport, with 'fly-in/fly-out' forming the basis of most new remote mining towns. Aeroplanes and an increasing number of four-wheel drive vehicles also provide transport for remote indigenous settlements. Many of these settlements depend on new small-scale, renewable technologies for power, water and communications.

"The Rocks", Sydney. The shape of cities past and present.

Developments in transport technology that allow easier access to remote and undeveloped regions have boosted the demand for ecotourism. This nature- or culture-based experience and activity, along with the 'return to country' of indigenous Australians, has become a source of growth in remote settlements.

Other forces shaping urban settlements

Nineteenth century Australian settlers found one resource in abundance — space. They could realistically aspire to owning a detached house of their own or a farm. Such aspirations were encouraged by the anti-city, pro-rural ideas dominant in Great Britain at the time and romanticised in Australia by writers such as Adam Lindsay Gordon and Banjo Patterson. The relatively high income of Australian workers and the proliferation of building societies that provided

Table 3.3 Population and dwellings in each zone in Australia's big cities and their adjoining fringes

	Population	No. of Dwellings	Occupancy Ratio
Core	841 588	384 660	2.19
Inner	1 111 990	476 208	2.34
Middle	3 676 856	1 380 300	2.66
Outer	4 431 569	1 542 198	2.87
Fringe	260 509	103 552	2.52
Total	**10 322 512**	**3 886 918**	**2.66**

Note:
In the case of Melbourne and Sydney, the core incorporates the heart of the city up to 6 kilometres from the centre and the inner zone of pre-1940s housing 6-10 kilometres further out. For Brisbane, Adelaide and Perth the boundaries do not extend quite so far. The middle area includes established suburbs outside the inner area where the first wave of post 1940s suburbanisation is largely complete. The outer area of each city includes the suburbs where most population growth is now occurring and the fringe is the area beyond the formal metropolitan boundaries where scattered development is occurring and at least 25% of those employed travel to jobs located within the metropolis.

Source: ABS, 1991.

Re-urbanisation is occurring both in inner city areas (Melbourne, above) and in older suburban sub-centres (Fremantle, right).

accessible finance helped make the home-owning dream a reality. In Melbourne, for example, by the 1880s some 40 per cent of households owned or were purchasing their homes, probably the highest level for any city in the world at that time (Davison, 1978).

The Victorian colonial governments fuelled the suburbanisation process by their massive investment in suburban railways. Prospective home-owners seized the opportunities these transport networks created, in part because of anxiety to leave the pollution of the inner city. In the case of Melbourne, poor sewerage and drainage meant that, by the late nineteenth century, 'Melbourne stood ankle deep in its own wastes'. As such, Melbourne was a prototype of the industrial transit city, but with a higher-than-average spread of housing. By the 1890s, Melbourne's density averaged 54 people per hectare — only about one-third as crowded as the major British cities of the time (Dingle and Rasmussen, 1991). Sydney always had a higher density (about 100 per hectare) but cities like Perth, Adelaide and Brisbane were even less crowded than Melbourne.

People embraced the wide spaces available in the New World cities of America and Australia. Twentieth century town planning and reformist movements designed to create more 'healthy' and 'morally upright' urban residents imposed measures such as minimum density standards and segregation of land uses (King, 1978; Boyer, 1983; Newman, 1992). However, Australia also has another urban tradition of residents wanting easy access to urban services, work and the kind of inner-urban community life available in areas like Paddington, Balmain, Carlton, North Adelaide and Fremantle. Many people have left these inner areas for new suburban locations, but at the same time many have moved in from outer suburbs. Preferred locations for living in Australian cities continue to be a combination of these two cultural traditions (ABS, 1981).

After World War II, immigration provided the major boost to growth in Australian metropolitan settlements (other than Brisbane), with Melbourne receiving the highest numbers of migrants until the 1970s. Since then, Sydney has received more migrants than Melbourne. Most of the growth in both cities since the mid 1980s has resulted from immigration. Perth, too, has grown rapidly mainly through overseas migration. In 1994, the proportion of the population, aged 15+, born overseas was 35 per cent in Sydney and Melbourne and 37 per cent in Perth. This is considered high by international standards (Birrell, 1994).

Population dynamics and patterns of Australian settlements

Urban settlements

The two main distinguishing characteristics of Australia's settlement pattern are the spread of urbanisation along the coastline and the concentration of Australia's population in five large cities. No inland urban centre other than Canberra is growing at an appreciable rate.

Australia's settlement pattern is dominated by the seven major capital cities: Sydney, Melbourne, Brisbane, Perth, Adelaide, Canberra and Hobart. With the possible exception of Canberra, each has traditionally held a relatively secure role as the unchallenged site of administrative, commercial and welfare services for its respective State or regional population and as the centre of industrial activities. The increasing internationalisation of the Australian economy is now challenging this dominance at a number of levels.

The outcome of increased competition between cities depends on their ability to provide goods and services for the national or international marketplace. Success can be measured by the number of basic or export-oriented firms located in a city, the extent to which it is interlinked with national and global telecommunication networks (as distinct from local or regional ones), the numbers of people with key skills (human capital), and the number of multinational corporation offices. The 1995 Business Review Weekly top 200

companies in Australia were located in Sydney (83), Melbourne (63), Perth (25), Brisbane (13) and Adelaide (eight). Some 46 per cent of Australia's outgoing overseas business telephone calls are made from Sydney, 26% from Melbourne, seven per cent from Brisbane, eight per cent from Perth and four per cent from Adelaide (Newton, 1995). Other indicators are the number of international firms based in the cities and the relative success of each city in attracting capital investment. These show the same general patterns (Stimson, 1995).

On these criteria, Sydney is rapidly increasing its dominance in the nation's urban hierarchy. It is now Australia's pre-eminent international city in terms of the location of global corporations and communications networks. Melbourne is also an international city to a lesser extent. Both differ from other major Australian cities in terms of their concentration of export-oriented industries (other than raw or lightly processed rural and mineral commodities), innovative human capital and infrastructure supporting manufacturing and producer service industries (Newton, 1995; O'Connor and Stimson, 1994 and in press). Brisbane, Perth and Adelaide remain largely regional cities but ones whose global orientations are growing — particularly in the past decade.

In this emerging new economic order, a city's population growth is less related to its economic growth than in the past. Indeed, population shifts such as the move of population from Sydney to north-east coastal New South Wales and the Queensland coast (outlined below) appear to reflect lifestyle and housing-cost factors more than the attraction of employment.

Intra metropolitan restructuring

During the past 20 years many of the manufacturing firms once located in Australia's inner metropolitan areas have either disappeared or have moved to outer metropolitan areas (Newton *et al*., in press). At the same time, service industries have also been moving. Service industries fall into two principal classes. The first consists of a range of specialist professional and managerial activities ('producer' services) required by those organisations that successfully compete in the national and international marketplace. The second comprises what could be termed 'people services', provided by both public and private sectors, and relating to the full spectrum of social (for example, health, welfare, education etc.) and personal (for example, restaurant, hairdressing, recreational etc.) services.

The major outcome of intra-metropolitan restructuring in Australian cities has been the increased concentration of producer services in core and inner metropolitan areas, while outer metropolitan areas (particularly where nodal subcentres have emerged) are increasingly becoming the workplaces for manufacturers and the providers of people services. Reflecting the concentration of different economic activities within the major cities, people with higher incomes, with professional and managerial occupations, tend now to be increasingly concentrated in the core and inner suburbs (see Fig. 3.3). It is also notable that the concentration of such households in inner areas is greater in Sydney than elsewhere, in line with Sydney's location at the top of the urban hierarchy. House prices reflect this trend. Conversely, more blue-collar and routine white-collar workers are moving to the lower-cost residential areas in the middle and outer suburbs, thus feeding the suburbanisation process.

Table 3.4 Population change in Australia's big cities 1986–1991 by urban sector

	Core/Inner/Middle	Outer
	1986-91	1986-91
Perth	+ 32 697	+106 065
Adelaide	- 3 087	+ 56 446
Melbourne	+ 6 100	+ 182 950
Sydney	+17 300	+ 184 050
Brisbane	+ 29 449	+ 111 200

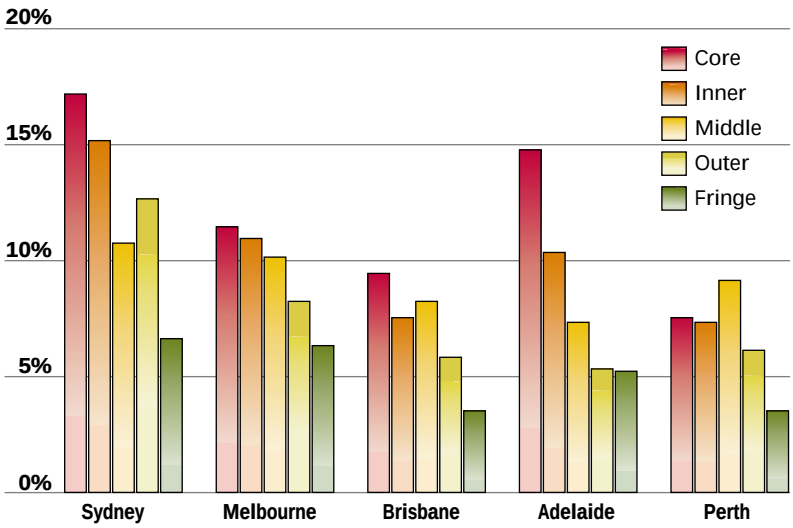
Source: ABS,1993a, b, c, d, e, and 1994a, b.

The doughnut effect and pockets of poverty

In the 1970s, Australian cities rapidly lost population in their old inner suburbs as settlement dispersed outwards, in a pattern similar to that in American cities — the so-called 'doughnut effect'. Since then a simultaneous process of suburbanisation and re-urbanisation has occurred.

Suburbanisation is still a dominant process in Australia's major cities. Although the population of the core, inner and middle sectors of major cities has remained fairly stable over the 1986–91 period, almost all metropolitan population growth has occurred in outer suburbs (see Table 3.4).

Figure 3.3 Proportion of households earning $70 000 or more per annum by urban sector in Australia's major cities, 1991



Source: ABS, 1991.

The inclusion of households moving to the extra-metropolitan fringe would highlight the continued suburbanisation pattern even further.

Although suburbanisation continues, re-urbanisation in the older areas of Australian cities is also evident, in the form of higher-density dwelling construction, the replacement or renovation of older homes and the addition of extra units on blocks (dual occupancy).

Between 20 and 25 per cent of new dwellings built in Melbourne and Sydney since 1985 can be classified as re-urbanisation. That is, construction occurred in built-up urban areas that required existing housing to be replaced or former office or industrial sites re-used for housing purposes. In Melbourne, most of this re-urbanisation consisted of detached housing, but in Sydney, higher-density development predominated. Indeed by 1993–94, 48 per cent of all residential development in Sydney consisted of medium- and higher-density dwellings. In Perth and Brisbane too, the re-urbanisation of established urban areas significantly increased in the early 1990s, mainly as higher-density units. About one-third of all housing constructed in Brisbane in the 1990s comprised medium- and high-density units.

The situation in Australian cities therefore does not resemble that of the United States, where the 'doughnut' phenomenon has left a largely poor, black and immigrant community to languish in deteriorating inner city areas. The re-urbanisation process described above suggests that a substantial proportion of households wish to relocate to more central urban areas of Australian cities, although small household sizes mean the trend is not yet significantly increasing population in these areas. As well as dwellings, the core, inner and middle areas are receiving about 50 per cent of all non-residential development, consistent with the location of new employment and global-oriented firms in these areas.

The issues of suburbanisation and re-urbanisation are highly controversial. Proponents of suburbanisation claim it provides privacy for families and space for firms, while its critics stress the environmental impacts resulting from 'sprawl' and the associated dependence on cars. They also criticise the capital costs of new infrastructure, especially when infrastructure in inner areas is sometimes underutilised. In response to these concerns, political leaders and urban planners alike have espoused policies to help consolidate Australian cities through re-urbanisation. Concerns are now arising in Australia about the rapid gentrification of inner urban areas and the loss of access to centres of employment for those on low incomes.

At a broader level comes evidence of a new and disturbing trend towards 'two Australias' emerging in urban environments. Gregory and Hunter (1995) describe an increasing disparity between richer and poorer neighbourhoods in Australian cities over the past 15 years. They show that the poorer areas now have significantly lower-income populations and are dominated by high levels of unemployment. These 'pockets of poverty' in our urban areas are scattered through traditional inner-city working class areas, in newly settled suburban areas, and in non-metropolitan areas on the fringe and coast. They are associated with the rationalisation of some previously protected manufacturing industries and reduced public sector employment. They cluster around low-cost housing.

Density still low

Urban density remains low in Australian cities compared with that in other international cities (see Table 3.5). Sydney is the only Australian city to show densities in its older suburbs comparable with those found overseas.

The data indicate that, in a global context, we have scope for re-urbanisation, although as discussed later, design is critical to achieving this goal.

The tentacles of growth

A growing pattern of low-density settlement is spilling beyond the formal boundaries of each of

Table 3.5 Urban density in people per hectare by city region and the variations within the cities by inner and outer area, 1980

	Inner Density	Outer Density	Total Density
Asian cities	464	115	160
European cities	91	43	54
US cities	45	11	14
Toronto	57	17	25
Sydney	39	16	18
Other Australian cities	21	12	13

Notes:
Inner is defined as the pre-war urban area and essentially corresponds to the definition used here. Urban density takes into consideration only that land which has been developed. All cities incorporate their region into the outer area and total city.

Source: Newman and Kenworthy, 1989; Kenworthy and Newman, 1994.

Table 3.6 Population growth in big cities and nearby urban centres, 1986–1993*

	Population growth 1986–1993	Total Population 1993
Perth	188 823	1 261 524
Adelaide	78 500	1 128 953
Melbourne	253 400	3 480 993
Sydney	313 650	4 485 850
Brisbane	358 965	1 930 321
Total	**1 209 465**	**12 287 638**
Share of Australia	72.4%	69.6%

*Note: Includes areas defined as fringe plus nearby large urban areas.

Source: ABS 1993a,b,c,d,e and 1994a,b,c,d,e,f.

the capitals. Most of these ex-urban settlements are linked to the metropolis by people who commute to jobs within the city boundaries. For example, about half the work-force of Ballan, Romsey, Kilmore and Bacchus Marsh (all rapidly growing areas outside the official boundaries of Melbourne) commute to employment in the city.

A second pattern connects previously independent provincial cities — like Geelong , Wollongong and Newcastle; and the Gold Coast and Sunshine Coast — with their nearby metropolitan capitals via extended freeway and other transport links. Infill settlement connects these previously disparate cities into one mass that shares complementary economic opportunities and resources.

By 1993, 70 per cent of Australia's population lived in these urban agglomerations (see Table 3.6). They accommodated nearly three-quarters of Australia's population growth between 1986 and 1993. Suburban development consumes about 1300 sq m of land per person — so Australia's five largest cities consumed 160 000 ha of rural land (or 100 000 football fields) as a consequence of the tentacles of urban growth in those seven years.

Migration patterns

Although Sydney's net rate of population growth has slowed, the city continues to be the major destination for overseas migrants. Between 1986 and 1991, 91 per cent of its population growth was due to international migration, compared with 55 per cent for Melbourne and 68 per cent for Perth (Newton and Bell, in press). Some of the migrants moving to Sydney are attracted by its success as a centre for globally competitive enterprises, but other migrant flows reflect the prior establishment of substantial ethnic communities.

Interstate migration is having a reverse impact. Since the 1970s a shift in population has occurred, mainly from Sydney and Melbourne, to the north-east coast of New South Wales and to Queensland. Sixty thousand people who were living in Sydney in 1986 and 30 000 from Melbourne had moved to south-east Queensland by 1991. However, since 1991, a higher proportion have moved from Melbourne. Perth also attracted significant net inflow of interstate movers in the 1980s (about 10 000 per year), but in the 1990s the net flow has been much less (about 4000 per year).

An Australian sunbelt

In the United States, the State of Florida has trebled in population since the early 1950s. Some observers believe Queensland will experience similar growth (Holmes, 1994). Between 1986 and 1991, 28 per cent of Australia's population growth occurred in mainland non-metropolitan coastal regions (see Table 3.7). This increased to 35 per cent between 1991 and 1993. Yet in 1991 only 18 per cent of Australia's population lived in these regions.

It is only the warmer coastal zones that are attracting significant numbers of people (see the box on page 3-12). The interstate migration data indicate that most of the sunbelt locations including the Gold Coast and the Sunshine Coast are drawing new residents primarily from the southern States. A tiny proportion of Gold Coast and Sunshine Coast residents commute to work

Table 3.7 Population growth in coastal non-metropolitan areas

Coastal Location	Population 1991	Share of Australian population 1991(%)	Population growth 1986–91	Population growth 1991–93	Share of Australian growth 1986–91(%)	Share of Australian growth 1991–93(%)
Qld Gold Coast	248 768	1.4	57 914	18 637	4.7	4.9
Qld Sunshine Coast	164 936	1.0	45 563	19 075	3.7	5.0
Other Qld coast	669 304	3.9	65 950	36 823	5.3	9.6
NSW N-E Coast	356 670	2.1	59 300	20 070	4.8	5.2
Newcastle Area	464 000	2.7	29 850	11 400	2.4	3.0
Wollongong Area	244 930	1.4	11 910	5 150	1.0	1.3
NSW S Coast	123 810	0.7	21 830	7 190	1.8	1.9
Victoria Gippsland	75 670	0.4	6 470	1 430	0.5	0.4
Geelong-Bellarine	200 350	1.2	14 350	2 070	1.2	0.5
Other Vic Coast	72 560	0.4	2 420	500	0.2	0.1
SA Metro Fringe	5 853	0.03	1 325	757	0.1	0.2
Other SA Coast	157 434	0.9	-1 596	-530	-0.1	-0.1
WA Metro Fringe	29 223	0.2	9 782	4 971	0.8	1.3
Other WA Coast	250 449	1.4	22 482	5 186	1.8	1.4
Total	3 063 957	17.7	347 505	132 729	28.1	34.7

Source: ABS 1993a,b,c,d,e,and 1994a,b,c,d,e,f.

within the Brisbane Statistical Division, but in no locality does this exceed 15 per cent, even in nearby local areas (ABS, 1991).

Older people and retirees form an important component of migration to south-east Queensland but, contrary to popular perception, they are not the dominant source. For the period 1986–91, only 15 per cent of interstate movers to the Gold Coast and 18 per cent of those moving to the Sunshine Coast were aged 60+, although this migration has contributed to the creation of relatively old communities. By 1991, 20 per cent of the Gold Coast and 22 per cent of the Sunshine Coast populations were aged 60 or more (Barker, 1993). This compares with 12 per cent forAustralia's total population.

Most of those moving to north-coast locations are people of working age, many of whom were displaced by the recession of the early '90s and the restructuring of older industries in the south. They often find difficulty gaining work.

As a result, many people living in coastal areas now depend on government benefits. The proportion of the population aged 15+ living on the Gold and Sunshine Coasts who depended on a Commonwealth pension or benefit reached 34 per cent and 37 per cent respectively in 1994. This compares with 29 per cent for all Australian residents. For the Gold Coast, 19 per cent of the 15+ population were receiving an age or veteran's pension and 7.5 per cent unemployment benefits. Comparable figures for the whole country in 1994 were 15.3 per cent and six per cent respectively (Birrell, *et al*., 1995). The booming coastal area of Mandurah, south of Perth, has 23 per cent unemployment. It appears that government benefits and private superannuation are helping to fuel a relocation process quite independent of the productive base of these growing coastal communities. The process is self-reinforcing for a time, as the provision of housing and social and physical infrastructure (often with substantial government subsidy) creates additional job opportunities, thereby attracting more job-seekers to these locations. The pressure on the coastal environment from this population growth is a significant focus of this chapter.

Other cities are growing too

Many north coast provincial cities and towns, which cater for a population seeking a recreation-oriented lifestyle, are booming. In Queensland the major growth points, other than the Gold and

Settlement in the sunbelt — the south-east Queensland experience

Recent decades have witnessed a trend of population dispersal along the coast. Like other areas of coastal settlement in Australia, south-east Queensland has followed the pattern of low-density ribbon development stretching along the coastline. Few available sites now remain. Urban development is now focusing on the nearby hinterland, including large areas of low-density rural residential or 'acreage' developments, as they are known in Queensland. The historical fragmentation of land-ownership in the area, plus extensive zonings for 'acreage' purposes, especially in Albert Shire, means that the impact of human settlement is diffusing widely into the coastal hinter-land and along the estuarine streams that drain the region.

Coastal urbanisation has already destroyed much of the original local ecosystem. Between 1974 and 1989, 33 per cent of the coastal bushland along the south-east Queensland coast was lost (Catterall and Kingston, 1993). Some 20 percent of the mangrove fringes in the Moreton Bay area of Brisbane have also been cleared (see Chapter 8). These losses are seriously disrupting ecosystem health and native habitats along the coastal strip which has a notable biodiversity. Further low-density development has increasingly fragmented the remaining vegetation leading to more 'edge' effects that also threaten biodiversity. These effects include the creation of numerous niches for invasion by opportunistic weeds and feral animals; and changes to the physical environment along the borders of vegetation remnants.

The diffusion of urban development has also increased the nutrient and sediment loads deposited in local marine waters. All but two of the sewage plants located in the region discharge effluent — which has not been treated for nutrient removal — into local estuaries (the exceptions are the Gold Coast City and Caloundra plants, which discharge into ocean outfalls). As well, few residential developments can hold and treat stormwater flushes before these add their load of nutrients, sediments and other pollutants to the river systems. The pollutants threaten marine ecosystems in the poorly flushed areas of Moreton Bay.

Canal development at Surfers Paradise.

In Queensland, local authorities, who control land use zonings, tend to compete for development projects. In addition, Queensland law allows foreshore areas and riverine edges to be alienated to private land-owners, thus facilitating destruction of the natural vegetation. However, it is now widely recognised in south-east Queensland that further urban growth along past lines could destroy many of the coastal values that attracted people to the area in the first place.

Hopetoun — a story of country town decline

Hopetoun's population fell by 19 per cent between 1976 and 1991. It now has just 703 people. This downturn is the result of a drastic decline in the income of the district's farmers.

When the cereal- and sheep-farmers don't have money to spend it's not long before the small businesses begin to struggle. Hopetoun has lost many of the services which made it the hub of the Shire of Karkarooc. Gone are the former State Rivers and Water Supply Office, the solicitor, the Westpac Bank, the court house, Elders office, the Massey Ferguson dealership and the weekly visit from the dentist. The doctor lives in the town only during the week. If you need urgent care from a doctor on the weekend it is a one-hour drive to Birchip in a car or ambulance. A solicitor visits the town occasionally.

The schools are declining; teachers leave and are not replaced. The only four apprentices in the town include the butcher, the baker and a mechanic. Most of the school graduates go to larger centres like Melbourne or Bendigo to work, or go to university. Some drop out and remain unemployed.

The nature of work has changed noticeably as many people try to supplement their income by doing extra jobs. Members of farming families work in town or elsewhere on a part-time basis. Shearers work at the silos and the swimming pool over summer. The hats and tasks have changed because of the reduced income from farms, businesses and services.

Despite its decline, Hopetoun is still a lively community. It has a wide range of sporting facilities and many active groups. But its ageing population contains more than 80 widows and widowers living alone. This trend, along with a continuing loss of young people and low farm incomes, places the town in a serious position of decline.

— Kerry Conway, Hopetoun resident and farmer

Sunshine Coasts, are Hervey Bay (next to Fraser Island) and Cairns. Cairns is emerging as an international city servicing foreign tourists through its gateway airport to the the Great Barrier Reef. The State has other coastal cities with an industrial or port base, like Bundaberg, Gladstone, Rockhampton and Mackay, which are growing but at a considerably slower rate.

Elsewhere in Australia, provincial cities other than those servicing coastal recreation have generally maintained their population growth. Most are benefiting from the relocation of residents from smaller country towns and rural hinterlands. These cities play important roles as suppliers of community services and as centres for wholesaling and retailing, often at the expense of nearby smaller towns.

Some provincial towns also benefit from increased industrial growth due to their relatively low land and labour costs or their proximity to primary resources and producers (Beer *et al.*,1994).

Rural settlements

Rural Australia (defined as cropped or cultivated zones) covers a wide range of climatic and land use areas, from northern Queensland to Tasmania and across to south-west Western Australia, and as far inland as receives sufficient rainfall to support agricultural activities. Generally, rural areas — particularly those with links to metropolitan or provincial cities — are maintaining their populations. However, in the drier wheat/sheep belt, population numbers are declining across all States, with losses generally between zero and five per cent of population between 1986 and 1991. The Conargo, Jerilderie and Bland areas in the western Riverina of New South Wales, for example, lost 13 per cent, seven per cent and six per cent of their populations respectively over the period (McKenzie, 1994).

Population decline, both on the land and in the small rural towns servicing farming communities, undermines the economic viability and livability of these towns. The Hopetoun story (see the box above) illustrates this process. Although not subject to the pressures of rapid growth like the coasts, inland settlements with declining populations sometimes struggle to cope with environmental problems. Farmers, communities, businesses and shires do not have the necessary money to invest in rehabilitating degraded land in their areas or to improve urban services like sewage treatment and recycling.

Remote settlements

Although only a small proportion of Australia's population lives in remote settlements, they service vast areas of the continent and are a significant part of what defines our country. Remote-area land use patterns are diverse, ranging from pastoralism, tourism, mining and indigenous communities. Remote settlements demonstrate a high degree of functional diversity relative to their size, acting as

Fossil Downs — a case study of pastoral settlement

Although it shares many of the characteristics of pastoral communities in remote areas, Fossil Downs station is unique in other respects. These days, most pastoral stations are run by managers acting on behalf of absentee lessees. Fossil Downs is one of the few in north-western Australia to have been consistently owner-operated over the last century. In recent years, indigenous corporations have purchased a number of pastoral station leases (25 in the Kimberley region).

Fossil Downs station covers slightly less than 400 000 ha. It has a good supply of water and the homestead is surrounded by an oasis of lawns, trees and shrubs, which are watered from a bore. It has been subjected to the same economic pressures and climatic vagaries as other stations.

In response to these pressures, the number of Aboriginal stockmen has fallen from 30 in the 1960s to three today. There are only three or four other employees.

Among the ramifications of this widespread decrease in station populations, every individual — owner and employee alike — now does the work previously undertaken by two or three people. Family members often work in nearby towns during the day, as well.

Fitzroy Crossing, the nearest settlement, has a dentist and a small hospital staffed by two doctors. A health sister visits an indigenous community near Fossil Downs once a fortnight and services the station at the same time. Primary and high schools are located in Fitzroy Crossing. Children on pastoral stations generally remain home doing either School of the Air or correspondence lessons until year seven, when they leave home to attend boarding schools in either Perth or Brisbane. The area has limited sporting and recreational events and facilities.

Supplies and stores for Fossil Downs are sea-freighted from Perth to Derby, where the pastoralists pick them up in their own truck — a journey of 280 km each way. Floods during the wet season often make the roads impassable, so the family place the annual store order for staple items like salt, rice, sugar and flour in October or November, just before the 'wet'. The station used to produce its own fruit, vegetables, bread and ice-cream, but because of reduced staff these items are now delivered from Perth each fortnight — roads permitting.

Annette Henwood, owner of Fossil Downs.

foci for their service regions and as links to services outside their region (Holmes, 1988).

Remote area land use is being rationalised and restructured by continuing downward trends in commodity prices and through efforts to protect fragile lands (through programs such as Landcare).

Pastoral areas

The effects of climatic variation, deterioration in pasture quality, increases in soil erosion, onset of cattle tuberculosis and its subsequent eradication, and shrinking global markets have all contributed to a decline in the number of cattle and sheep in the pastoral industry. Lower stock numbers tend to make the whole industry less financially viable, which affects the economic and social infrastructure of remote areas. For example, all abattoirs in the Kimberley region of Western Australia and a number in the Northern Territory have now closed.

Pastoralists on less viable stations cannot afford to keep pace with new production techniques and management methods, or to maintain the land resource itself. Some pastoralists are diversifying into tourism.

Tourist areas

Remote settlements receive a much lower proportion of tourists than do the large urban settlements, but their relatively small size makes the impact of tourism more significant.

The rapid growth of tourism — especially in remote areas — places both ecological carrying capacity and recreational carrying capacity under pressure, and has caught many natural-resource managers and nearby remote settlements by surprise (Dowling, 1993). Many tourist centres in remote locations lack the necessary resources to monitor the impacts of tourism on the environment and culture of their settlements.

Ecotourism is receiving much attention as a way of reducing the environmental impacts of tourism. Although usually consisting of activities that are environmentally friendly, it can still affect fragile areas unless limited to 'the maximum number of people who can use a site without an unacceptable decline in the quality of the experience gained by the visitors' (Mathieson and Wall, 1982).

Mining settlements

Resource extraction has given rise to the establishment of many settlements within Australia since the first phase of European settlement. The gold rushes of the mid 19th century spawned mining towns such as Ballarat and Bendigo that still exist today. Other towns have declined and died as their resource base was exhausted.

Australia has pursued four different mining settlement strategies.

• *New single-industry towns*

Since 1960, more than 25 new towns and ports have been constructed adjacent to mine sites (Robinson and Newton, 1988).

The Argyle diamond mine, an example of a fly-in/fly-out community.

• *Expansion of existing communities*

Additional growth created by resource projects is attached to an established community within daily commuting range of the resource site(s). In many instances the existing community has an economic base other than mining (for example, Capella — agriculture; Port Hedland — transport and services; Leeman — fishing).

• *Combine town*

Several mining companies operating in the same general area have built a new 'combine' town to house and service the workforce at a central location within daily commuting range (for example, Moranbah in the Bowen Basin of central Queensland or Jabiru in the Northern Territory).

• *Fly-in/fly-out*

In more recent times companies have used the 'oil rig' philosophy to fly workers on a rotational basis into a resource site from a distant established community (usually a major urban centre). Workers are accommodated in a hostel at the site. They return to their home community upon completion of each work shift.

Remote mining ventures have increasingly opted for fly-in/fly-out, and thus direct more wealth and development to the big coastal cities instead of to remote settlements, although this may result in less impact on ecologically sensitive remote areas. However, the redirection in population creates lower levels of service and reduced livability in remote regions.

Remote indigenous communities

In the early 1970s, many indigenous people began to return from mission or government settlements to their traditional lands. The outstation or homelands movement became a milestone in the development of indigenous communities and emphasised a commitment to their traditional lifestyle and culture.

These remote communities have undergone a 'locational trade-off', which involves reduced access to an already limited labour market as well as education, training and other services in remote areas. However, many of them have increased public funding and a growing spirit of self-determination and cultural revitalisation. The process has been made feasible by small-scale technical innovations including solar technology.

Population changes in remote areas have been made feasible by small-scale, solar-based innovations in technology. These give the communities access to power, water and communications in areas that sometimes are 500–1000 km from the nearest powerline, water pipe or electricity grid.

In a 1992 survey, the Aboriginal and Torres Strait Islander Commission (ATSIC) identified 1385 indigenous communities throughout Australia — 819 of which are in remote regions (see Table 3.8).

But despite this 'return to country', many indigenous Australians have dispersed to big cities. In 1961, only five per cent of the total indigenous population were located in major cities compared with 33 per cent 30 years later, while 67 per cent now live in rural and remote areas (see Table 3.9). In the 1940s, almost all Torres Strait Islanders lived in the Torres Strait, whereas today only one-fifth of the total population reside there.

An indigenous community

This small Aboriginal community of 300–400 people is in an arid desert region several hundred kilometres from the nearest service centre. It is not named to protect the privacy of its residents. The people have returned to their country after a period of 25 years living in a government settlement. They have strong affiliations with their country and have established a number of outstations within a radius of about 100 km around their small settlement.

Natural resources

The climate is hot and dry in summer and cold in winter; temperatures range from sub-zero in winter through to the high forties in summer. The dramatic temperature changes bring intense wind gusts. Rain is usually torrential and cuts access on the unsealed road.

Three bores provide groundwater to the settlement. Although water falls within the accepted guidelines for drinking, its relative hardness creates problems with deposits on plumbing. Only 45 per cent of hot-water-supply systems are functioning. The community uses about 30 per cent more water per head than cities 'down south', but nearby mining towns use four times as much. Significant leakage occurs through pipes and taps.

Diesel generators, which provide the power, are regularly shut down for routine maintenance. Each 50-litre electric hot-water heater costs $2500 per year to run, not including significant maintenance costs. The people prefer wood as a fuel, but they now have to travel up to 50 km from the community to find it.

The economy

The settlement's economy depends largely on public-money transfers and the store. Most people in the community draw social security benefits. Although household incomes appear high ($400 per week), occupancy rates are around 12–15 per house. The Community Development Employment Project (commonly known as 'work for the dole') provides some work. Of their total budget (about $1.2 million per year from all sources) up to $700 000 comes from the community-controlled health program. The housing budget of $100 000 to $300 000 per year, depending on grant allocations, provides enough to build up to three houses.

Some members of the community are well-respected Aboriginal artists and derive an income from commissions. Others would like to work in a nearby mining town or establish an ecotourism venture, but often lack the specific skills or financial backing for such work, and little useful training is available to them.

The store is the community's largest source of economic activity and its only retail outlet. Supplies arrive by truck each week and the store cashes cheques. The extensive packaging required for rugged transit creates problems of waste disposal. The community owns and operates the store and regularly divides its profits among the various family groups. In most situations people use this money to buy motor cars so that they can move around their country and to town, and usually share in buying older cars. They have a limited choice of models that they can maintain to survive in the bush. However, the roads ensure that these second-hand vehicles rarely last more than six months.

Land and housing

People live on reserve land that is set aside for Aboriginal people. They have no freehold title to it and they cannot lease the land for enterprises. The community has responsibility for all housing, and imports all building materials.

Most people spend 80 per cent of their time living outside in the area around the house. Over a one-year period, many move between a number of houses.

Society and culture

The community has a very active social and cultural life involving traditional business, hunting and sport. People move widely across their own and surrounding country, often in large groups of up to several hundred people — men, women and children — maintaining their links to land and social connections. For successful hunting and gathering the people need to travel to favourite sites in four-wheel drive vehicles. They still move on foot across country to maintain their links with the land. They keep a large number of dogs.

Intense sporting activity takes place at some times of the year. The men form football teams and regularly travel

Table 3.8 Indigenous communities in remote Australia by States and Territory

	Number of discrete indigenous centres[1]	Population of discrete indigenous centres	Average size of discrete indigenous centres
NSW	37	4 203	114
SA	88	3 861	44
QLD	82	16 672	203
WA	182	18 602	102
NT	430	29 959	70
Total	**819**	**73 297**	**106**

Note: 1. Only includes those settlements comprised of predominantly indigenous people.

Source: ATSIC, 1993.

distances of up to 500 km or more for a game. In addition to a strong emphasis on music and painting, people talk about wanting to improve gardens and grow trees. A satellite dish and microwave communications open their links to the world, and some local radio and television broadcasting takes place through the Broadcasting for Remote Aboriginal Community System (BRACS).

Health

Since it began operating the health service, the community's health profile has improved slightly. The health service employs a part-time doctor and several nurses, as well as nine Aboriginal health workers and traditional healers to deliver primary health care.

Last year, only six births were recorded and four people died. Over 90 per cent of the children under five years have needed to be evacuated from the community and admitted to hospital for serious illness. Half the schoolchildren have active trachoma and 26 per cent suffer from conditions that predispose them to permanent kidney damage. Diabetes and obesity are chronic in the older population.

The community has a very strong anti-alcohol stand and uses Avgas for cars (a non-toluene-containing fuel) to deter petrol sniffing.

There are a large number of dogs within the community, many of them carrying diseases.

Education

Attendance rates at the primary school vary. Young people are encouraged to leave and go to high school in large urban centres, but while there, they learn skills that don't necessarily suit their small remote settlement. This gives them a feeling of disorientation and creates difficulties for the community about how to employ them.

Up to 70 different broker groups or agencies come into the community to talk about issues ranging from basic finance, welfare payments, training programs, and various government initiatives, to sporting and cultural programs, and art and craft sales.

The Community Council, which is the legally constituted body to govern the community, is unpaid, and generally not well educated in terms of management or finance control. Most of the operations are left to the work of an adviser or town clerk, and an accountant who generally lives off the settlement.

The people are concerned about land title issues and health and employment prospects for their young people, but are totally united in their fierce desire to stay in their own country rather than live on the fringe of settlements with different cultural and lifestyle perspectives.

Table 3.9 Distribution of indigenous Australians in relation to total population

Location	Total Australian population (No.)	Total Australian population (%)	Total indigenous population (No.)	Total indigenous population (%)	Indigenous population (% of total population)
Five big cities	10 062 003	59.7	62 544	23.6	0.6
Other cities	2 025 803	12.0	26 037	9.8	1.3
Rural	4 267 356	25.3	88 578	33.4	2.1
Remote	486 407	2.9	88 142	33.2	18.1
Total[1]	**16 850 540**	**100**	**265 378**	**100**	**1.6**

Note: 1. Includes offshore and migratory components.

Source: ABS, 1991.

State

Livability — the human dimension

Human settlements in Australia vary in terms not just of their physical features but also of their human qualities and the wider social amenity they offer. People in different settlements enjoy greater or lesser measures of health and happiness, have access to housing, employment and community services that are more equitable or less so and live in settlements that are more or less safe and well designed. Settlements and communities rich in these qualities are also rich in livability.

Most Australian environmental legislation defines the environment broadly — incorporating health, social and economic factors. 'Ecological footprints' and the metabolic processes that underpin them help to describe the ecological effects of human settlements. However, the structures created by those settlements (housing, urban infrastructure and services, transport systems, industrial plants and commercial facilities, together with their associated urban ecological processes) are an environment in their own right.

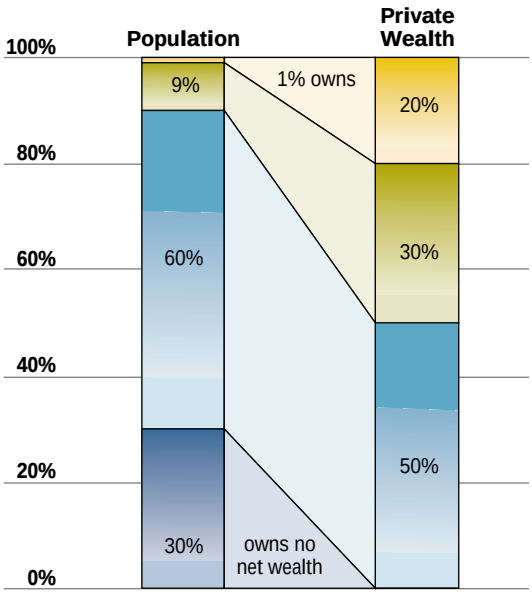
Social and economic priorities also affect the natural environment. It is now widely understood that economic weakness, social inequality and poor health standards are important forces in determining this impact.

Equality and the environment are linked in two broad ways. Firstly, poor communities or the poor in communities lack the necessary resources to manage their environments adequately. Without sufficient resources, the poor are often forced to exploit natural resources more heavily and to push natural systems beyond their sustainable level. While this point may appear to have more relevance to developing countries, it is also true in countries like Australia. For example, high rates of unemployment in country towns can influence forest-policy decisions, declining terms of trade for farm products can fuel the clearing of remnant vegetation and communities in economic decline cannot upgrade their technology and infrastructure for water, waste and transport systems.

Secondly, inequality may generate alienation and indifference towards the public realm. Large disparities in health and social amenity may undermine concern for the public realm or the 'commons', whether built or natural, whether inside cities or outside them. Even though inequality takes its heaviest toll on the poor and unemployed, economic decline and material insecurity can easily infect the mood of an entire society. Intergenerational equity in human settlements depends on equity within a generation.

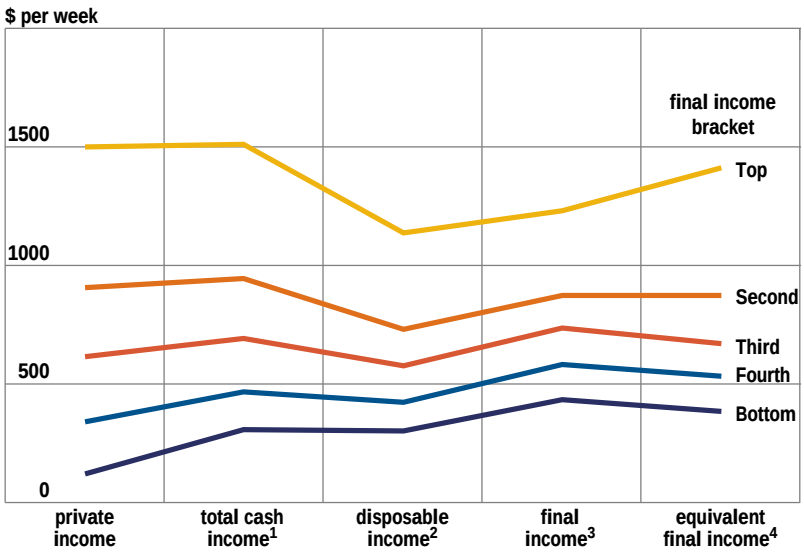
This section focuses on social amenity and health issues, with particular emphasis on whether significant patterns of inequality are developing in different parts of Australian settlements.

Figure 3.4 Estimated distribution of wealth in Australia



Source: Travers and Richardson, 1993.

Figure 3.5 The influence of taxes, government benefits and the social wage on the final income of different households



Notes:
1. Total cash income equals private income plus cash transfers.
2. Disposable income equals total cash income less income tax.
3. Final income equals disposable cash income plus non-cash benefits including the value of public health care, education and housing services — the "social wage".
4. "Equivalent final income" uses Henderson equivalence scales to allow for household size.

Source: NATSEM, 1995.

Social amenity issues

Wealth

In the financial year ending 30 June 1994, Australia's private wealth grew in real terms by 10 per cent. Following a slump in the early 1990s, the rate of growth returned to its historical average of the past two decades, so the national private asset base now stands at about $1 531 billion (Commonwealth Treasury of Australia, 1995). This places Australia in the higher-than-average per capita wealth category among OECD countries. A recent estimate of wealth distribution in Australia is shown in Fig. 3.4.

Income

The real incomes enjoyed by Australians have generally increased throughout the post-war period and until the late 1970s income distribution was also becoming more equal. However, since then, this trend has become uncertain (Saunders, 1994). Reviewing a large number of income distribution studies, the Economic Planning and Advisory Council has concluded that 'from the 1970s and into the 1980s, the distribution of income appears to have become less equal' due both to domestic social changes and Australia's changing place in a globalising economic order (EPAC, 1995). A subsequent study conducted by the National Institute of Economic and Industry Research, however, suggests the opposite. Over the 1981–94 period, the distribution of income has, despite new challenges, become more equal (Johnson, *et al*., 1995). These differences appear to be largely a result of the fact that the latter study attempts to incorporate a wide range of government non-cash benefits or social wage goods (including education, health, child care, public housing subsidies and other government concessions) into its assessment of changing income distribution. In announcing the completion of the study, the Prime Minister stated that the 'social wage' had grown by 41 per cent over the period and that it had played an important role in the redistributive process.

It will be some time before differences between the various studies are resolved but, in the meantime, it is worth commenting briefly on the positions common to most recent income distribution studies. First, it is widely agreed that the overall effect of government intervention (encompassing income taxes, transfer payments and social wage goods) is to moderate the income inequalities likely to result from the operation of market forces alone (see Fig. 3.5). Second, it is also agreed that processes of economic globalisation represent an important new force which tends to tip the balance in favour of market determined outcomes and greater inequality. This seems to be confirmed by a wider international trend towards greater income inequality. Despite Australia's standing as one of the world's 12 most equal societies, globalisation is likely to involve processes which continue to challenge our notions of equality and arrangements for social protection (Travers and Richardson, 1993). Some income inequalities in Australia are of longer standing. While income differences based on gender are closing, they are still significant (see Fig. 3.6). Income inequalities between indigenous Australians and other Australians remain stark (see Figs 3.7 and 3.15).

From the point of view of human settlements and state of the environment reporting, however, the spatial distribution of income and other resources — encompassing variations between regions rather than individual households — may be more important. This issue is explored briefly below in two ways: on a broader regional basis (using the ABS index of economic resources) and on a more closely focused neighbourhood (census collector's district) scale.

Regional income inequality

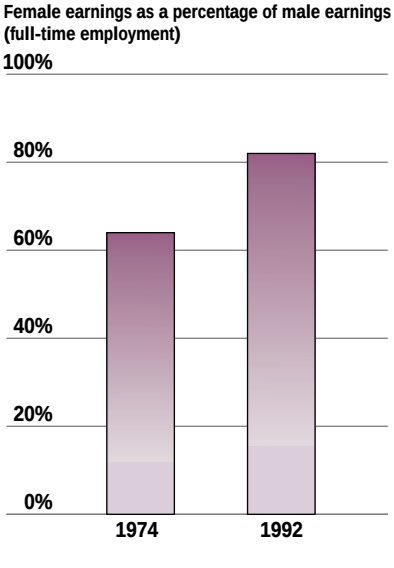
- Core and inner areas contain significantly greater proportions of high-income earning households (17.1 per cent in the case of Sydney's core) than do outer and fringe areas (see Fig. 3.9). This points to the emerging bi-modal character of inner cities, as urban manufacturing and blue-collar workers give way to a growing service economy and an expanding professional workforce. However, poorer households still retain a strong presence in inner and core areas.
- Outer areas are characterised by households with sufficient incomes to purchase a house, but often not to acquire significant wealth beyond that. The urban fringe and some of the new coastal areas are notable regions of low income in Australian cities.

Neighbourhood income inequality

In the period between 1976 and 1991:

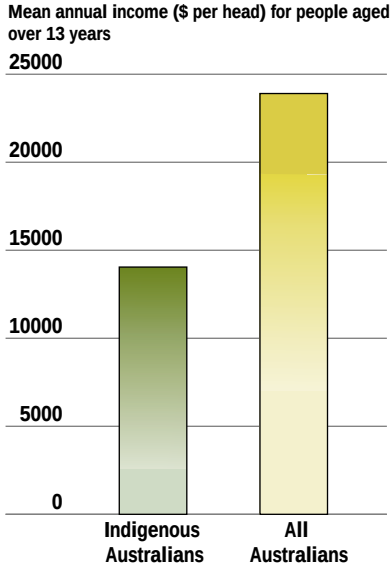
- Household incomes in higher-status neighbourhoods (top 5%) increased by $12 500 (23%) (see Fig. 3.10).
- Household incomes in lower-status neighbourhoods (bottom 5%) declined by $7400 (23%) (see Fig. 3.10).
- Additional weekly income needed by households enjoying median incomes to catch up to areas in the top percentile doubled, from $442 to $885.

Figure 3.6 Income inequality and gender



Source: ABS, 1992a and 1994g.

Figure 3.7 Income inequality and race

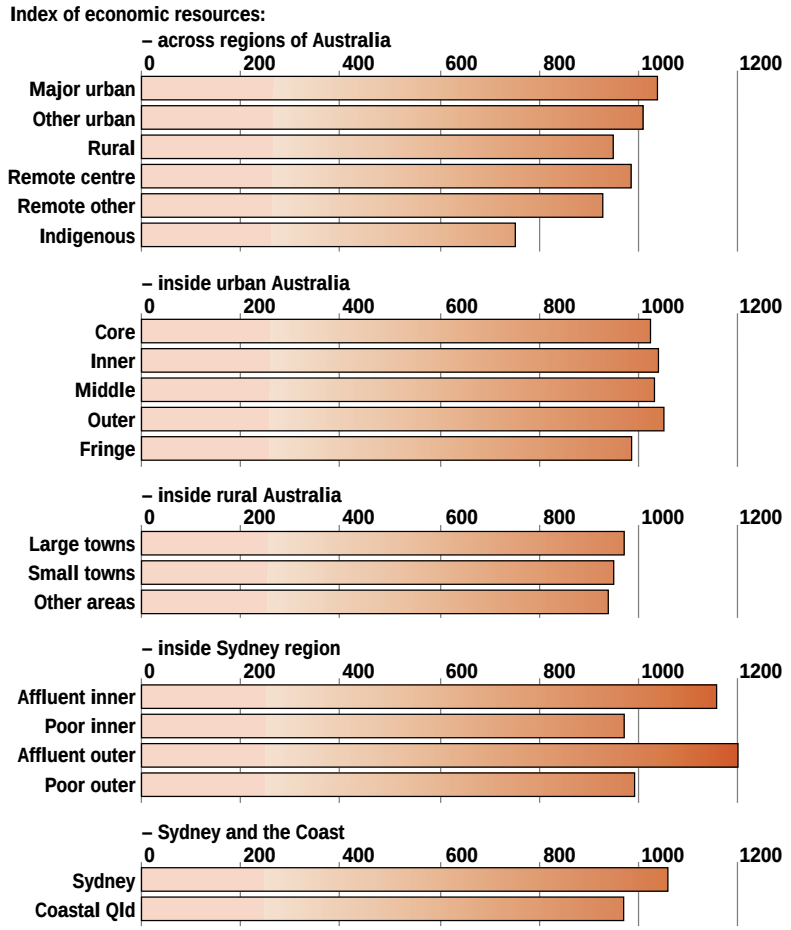


Source: 1994g and 1995a,b,and c.

Distribution of economic resources across Australia

- Larger and more economically diverse urban settlements have a clear relative economic advantage over smaller towns and centres.
- Remote indigenous settlements are areas of extreme disadvantage.
- A relatively uniform pattern occurs across large cities, apart from fringe areas where households command significantly fewer economic resources.
- Significantly greater variations occur in smaller urban regions.
- The coastal areas of New South Wales and Queensland are growing rapidly but are characterised by high levels of unemployment and a large number of welfare benefit holders.

Figure 3.8 Distribution of economic resources across Australia



Notes:
1. The index measures deviation from a national average score of 1000 on a standardised scale. The graphs indicate broad relativities only.
2. Because the index of economic resources assigns equal weight to home owning and home purchasing – owned houses and newly mortgaged houses can be very different assets – it may well overstate the advantage of outer areas where purchasers prevail over owners – see glossary.
3. The affluent and poor refer to selected local government areas which were at the high and low ends respectively of income distribution.

Source: Derived from ABS, 1991 and 1994h.

Distribution of resources across regions

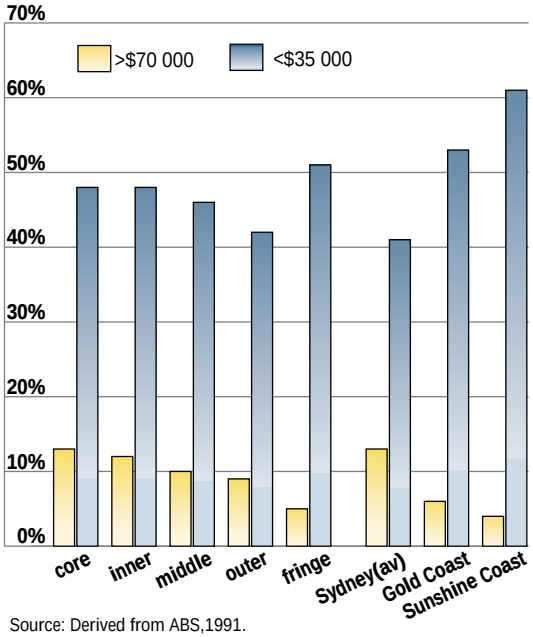
The recently developed ABS index of economic resources (ABS, 1994h) provides a way of exploring the pattern of economic advantage/disadvantage across urban, rural and remote regions of Australia (see Fig. 3.8). Although the detailed construction of this index could be improved, its attempt to incorporate employment and housing as well as income circumstances of housholds has moved in the direction of a full income accounting approach.

Distribution of resources across neighbourhoods — pockets of poverty

The spatial inequalities and variations shown above reveal that, apart from indigenous communities, the greatest differences occur between poor and affluent suburbs of big cities. In United States and British cities, these disparities have led to ghettos of poverty which, in turn, have had seriously adverse impacts on the human environment. In these cities, poverty, which tends to be concentrated in inner suburbs, has been a major cause of suburbanising and exurbanising processes. Australian cities do not have this kind of inner city problem (see Fig. 3.9). But the differences between affluent and poor areas located in both inner and outer areas of Australian cities point to disparities which may be more localised (see Fig. 3.8, -inside urban Australia and -inside Sydney region).

Gregory and Hunter (1995) have focused on neighbourhoods (defined as ABS collectors' districts and typically including 200–300 people) across urban Australia and demonstrated that disparities between them measured in terms of gross income (private and public) have increased dramatically in the period between 1976 and 1991 (see Fig. 3.10). Even though these census-based

Figure 3.9 Households in urban Australia earning more than $70 000 or less than $35 000 per year by zone

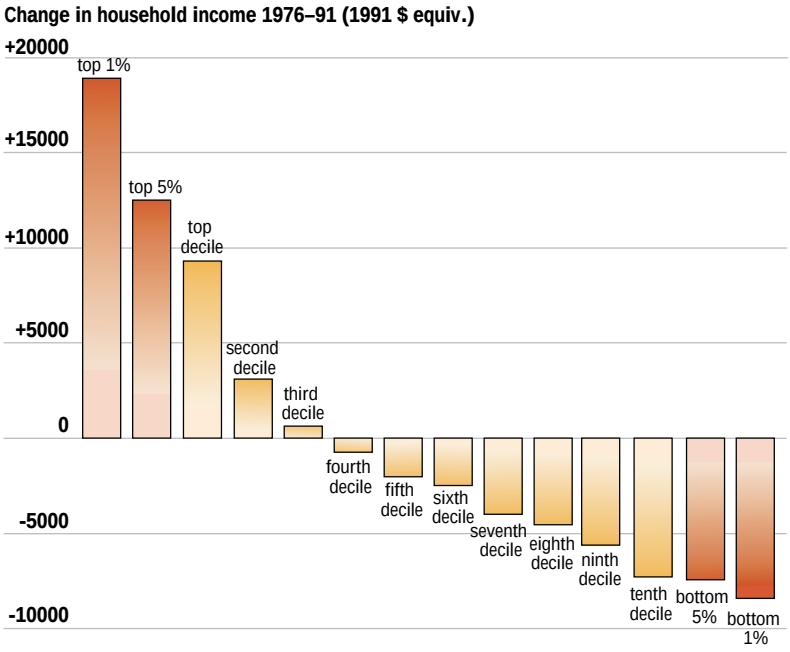


Source: Derived from ABS,1991.

income data exclude the impact of taxation and social wage goods, the changes being explored are quite distinct from changes in income distribution measured at the level of individual households. The results tell us that the most disadvantaged are congregating in particular quarters of cities to a much greater extent than previously — and perhaps forming embryonic ghettos with the range of problems these may bring.

The explanation which the researchers give for the changes in neighbourhood income that they have observed provides a further reason for concern. Widening disparities in the distribution of income across neighbourhoods and the increasing tendency for the least well-off in our cities to congregate is largely due to the availability of employment — and only to a lesser extent to a widening of salary and wage dispersion. If 'two Australias' are emerging, then the difference between them is that households in well-off Australia can find at least one job and often two. Households in poor Australia, by contrast, are experiencing increasing difficulties in finding even one. A generous social wage, including adequate cash benefits, is important for cushioning the effects of unemployment. However, for those who want jobs — because of the meaning and dignity which work brings — income maintenance can never be a satisfactory substitute. These emerging pockets of poverty have implications for regional development and ecological sustainability.

Figure 3.10 Changing income share of urban neighbourhoods by socio-economic status group, 1976 –1991



Notes:
1. Socio economic status groups defined using ABS Urban and Rural Indexes of Relative Advantage.
2. Neighbourhood analysis involve the presentation of data as group averages from Collectors Districts – the smallest geographic areas for which Census data are available (typically 200-300 dwellings).
3. Income includes gross (untaxed) monetary income from all sources including pensions and benefits.

Source: Gregory and Hunter, 1995.

Employment

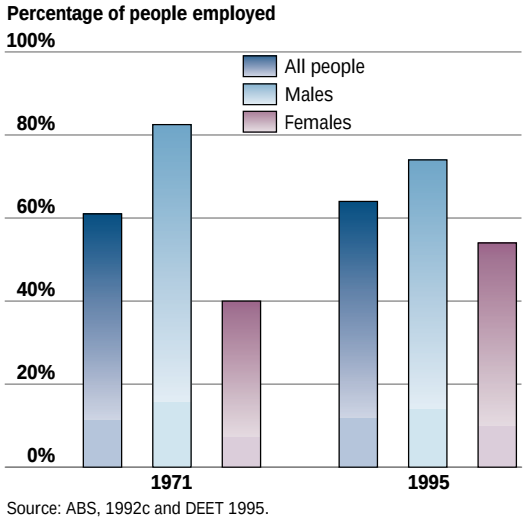
The early 1970s were a watershed in the condition of working Australia. They were preceded by a quarter of a century of high growth, during which unemployment rarely exceeded 1.5 per cent. Slow employment growth from the mid 1970s resulted in unemployment rising to more than six per cent by the end of the decade.

The recession of the early 1980s increased it even further, to more than 10 per cent. While the rate fell with subsequent strong employment growth in the late 1980s, to around six per cent, it rose again to peak at 11.2 per cent in late 1992 (Langmore and Quiggin, 1994). In recent years, strong jobs growth has caused the unemployment rate to fall to 8.3 per cent in April 1995 (DEET, 1995).

While the Commonwealth Government is aiming to significantly reduce the unemployment rate by the year 2000, economic opinion remains divided about the prospect of futher significant falls in coming years and some commentators now refer to a new 'natural' unemployment rate of eight per cent (Mitchell, 1993). They argue that progress beyond this may involve risks of inflation or calls for more drastic wage-cutting and restraint — bringing with it America's problems of a 'working poor'.

Persisting high levels of unemployment and the apparent difficulty for governments in finding remedies, again reflect Australia's new openness to global economic forces. The changing and increasingly flexible labour market suggests the

Figure 3.11 Trends in labour market participation



Source: ABS, 1992c and DEET 1995.

Overworked women

Even though women are joining the paid workforce in greater numbers (see Figs 3.11, 3.12 and 3.13) research indicates that men are not shouldering a corresponding share of necessary unpaid domestic duties (ABS, 1995d).

same openness in different ways. Against this background, there are changing patterns of employment in terms of gender, hours worked, and the incidence of long-term unemployment (see Figs 3.11, 3.12, 3.13 and 3.14).

Apart from those people living in lower socio-economic neighbourhoods, a number of groups are exceptionally vulnerable to high rates of unemployment. These include people of non-English-speaking backgrounds, those with disabilities, older people, youth and indigenous Australians. Young people have unemployment rates more than three times as high as the general rate, and indigenous people are even worse off.

Indigenous Australians are at a serious disadvantage in the labour market. Their rate of unemployment is four times higher than average, and long-term and youth unemployment are much more severe problems for them (see Fig. 3.15). The figures would be even higher if not for the Community Development Employment Project (CDEP), which accounts for 26 per cent of all indigenous employment and which redirects social security benefits into employment-generating community projects. In the absence of CDEP, indigenous unemployment would rise to 57 per cent (ABS, 1995a).

Regional distribution of unemployment

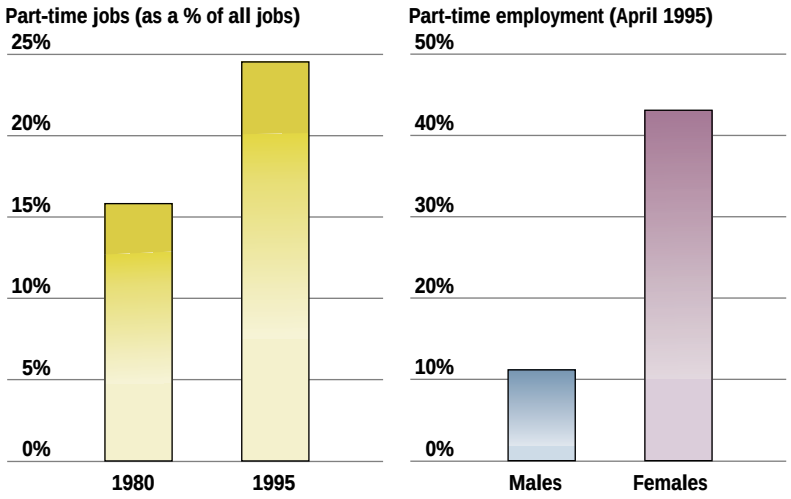
Unemployment data indicates that larger and more diverse settlements tend to be more economically robust (see Fig. 3.16). While the evidence for remote settlements suggests otherwise, their lower rate of unemployment is due to their often highly dedicated economic character and the mobility of their populations. Many people move to remote settlements in order to work — in some cases even commuting by air — and leave when their employment ceases.

The relatively high incidence of unemployment in the urban core (see Fig. 3.16) points again to its bi-modal character. However, the low level of unemployment on the urban fringe suggests that the fringe is a more uniformly low-income area.

Education

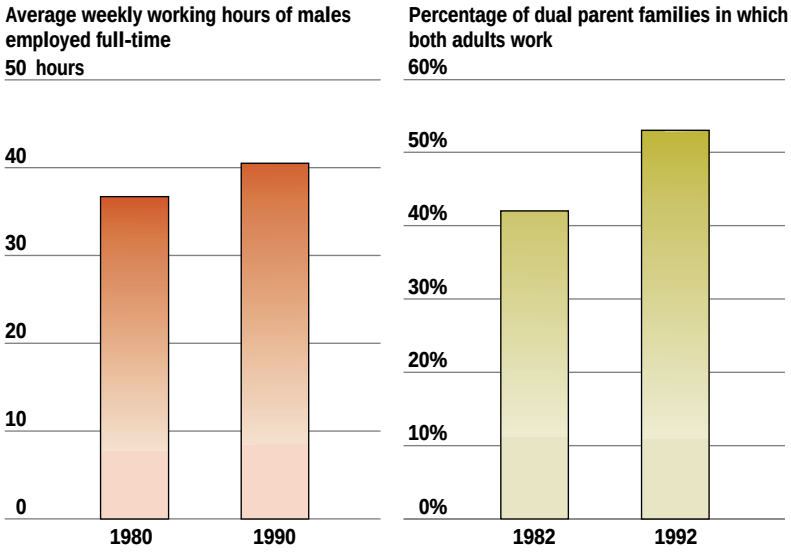
One in three Australians is now enrolled in educational or training courses of some kind. The new emphasis on education again points clearly to the dynamics of a globalising economy, increasing competition, rapid technological change and demand for a flexible and highly skilled workforce (see Fig. 3.17). Although significantly higher in absolute terms, public expenditure on education as a proportion of GDP is now slightly lower than it was in the 1970s — down from a post-war high of

Figure 3.12 Part-time employment



Source: DEET, 1995.

Figure 3.13 More work for the working



Source: Probert *et al*, 1993.

Source: ABS, 1994g.

Figure 3.14 Unemployed males and females who are long-term unemployed

Once unemployed, older people clearly experience greater difficulties in finding alternative jobs. Between 1983 and 1993, median period of unemployment almost doubled: from 15 to 29 weeks (ABS, 1994g). Reflecting the general improvement noted above, however, the number of long-term unemployed fell by 25% between March 1994 and 1995. (DEET, 1995).

Source: DEET, 1995.

5.7 per cent of GDP in 1975 to 5.5 per cent in 1993–94 (Marginson, 1993; DEET, 1995).

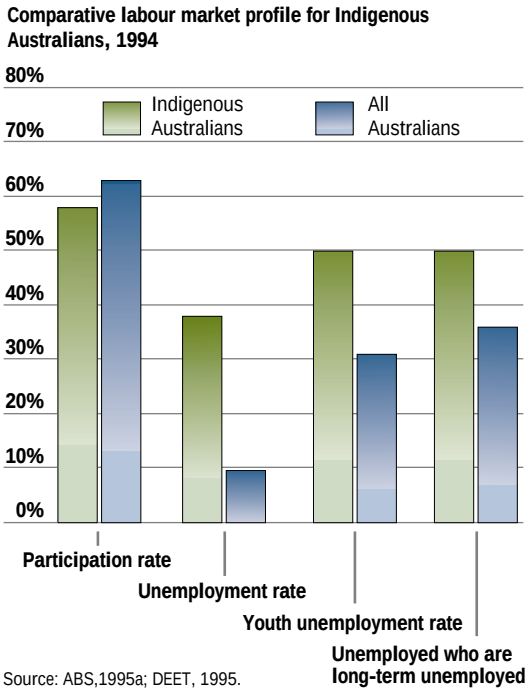
People living in rural and remote areas have less access to higher education and training facilities (see Fig. 3.18). Continuing attempts by government to redress the problem through initiatives like tertiary Open Learning courses, external education and the relocation of post-secondary education facilities in regional centres have made a difference. In many fields jobs that require specialised training depend on enterprises that enjoy large markets and economies of scale. This remains a severe constraint on the development of specialised educational and training facilities in smaller settlements.

Housing

Between the 1940s and '80s, households grew smaller and houses larger. The average household size has fallen from 3.9 to 2.6 people, and by 1986 some 50 per cent of all households consisted of one or two people. Over the same period, houses increased in size: the percentage of houses containing less than five rooms, for example, has fallen from 37 per cent to 22 per cent (ABS, 1992a). For much of the post-war period housing has become more affordable: homes owned or being purchased rose from 54 per cent of all dwellings in the 1940s to a post-war high of 71 per cent in 1966 (ABS, 1992a). In 1992, this figure stood at 69 per cent (ABS, 1994g). Since the mid 1970s, however, the proportion of houses being purchased has declined markedly — from 35 per cent in 1976 to 28 per cent in 1992 (ABS, 1992a and 1994g). If this trend continues, a growing number of young Australians will join the rental market and thus forgo the financial and non-income-related advantages of home ownership.

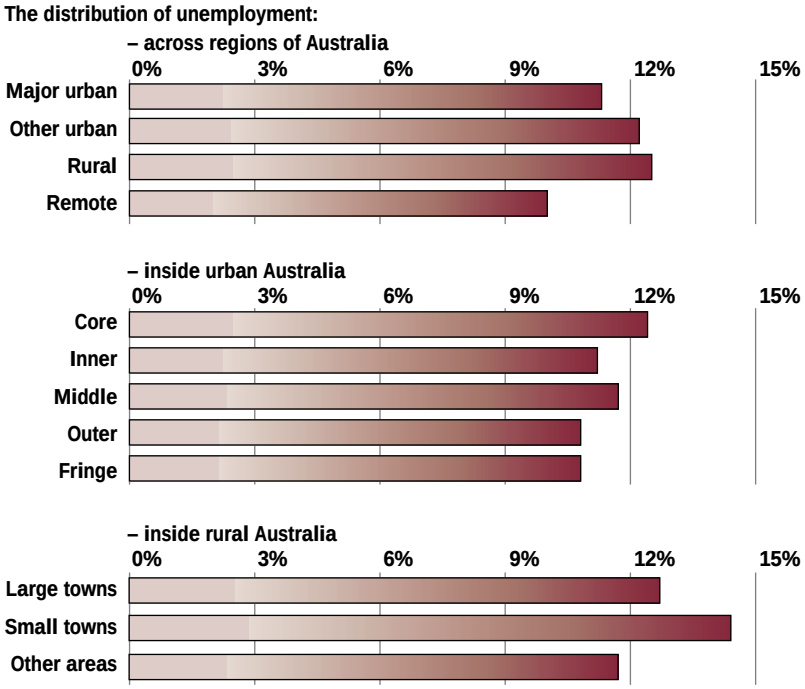
Almost one in five Australian households experience housing stress: six per cent are inadequately housed and twice as many experience difficulty in paying for their accommodation (see Fig. 3.19). Major cities experience less after-housing poverty than small towns or rural areas.

Figure 3.15 Comparative labour market profile for indigenous Australians, 1994



Source: ABS,1995a; DEET, 1995.

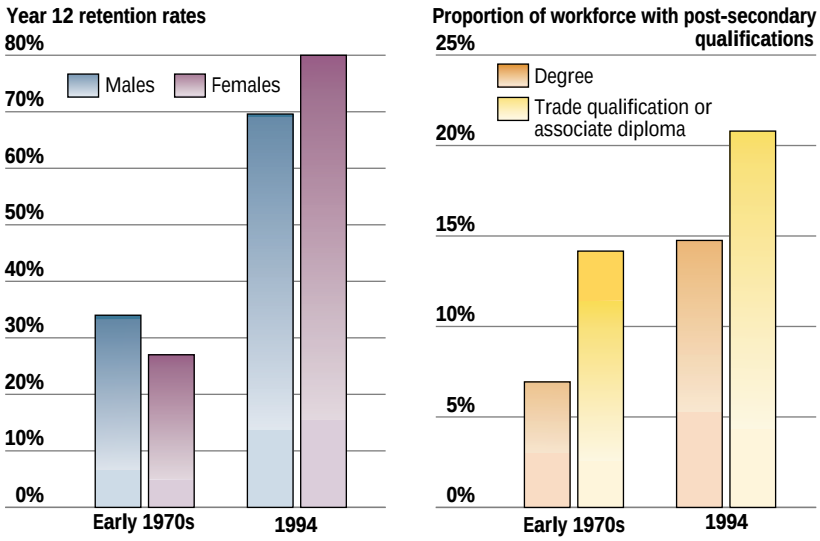
Figure 3.16 The distribution of unemployment across urban, rural and remote Australia and within urban Australia, 1991



Source: derived from ABS, 1991.

Note: Unemployment among indigenous people living in rural and remote Australia was 30% in 1994 (Jones, 1994).

Figure 3.17 Key educational commitment indicators



Sources: McLelland, 1994; Margison, 1993; DEET, 1995; ABS, 1995e.

Indigenous Australians are far worse off in terms of housing wherever they live (see Fig. 3.20). Indigenous families are 20 times more likely to be homeless than their non-indigenous counterparts (Jones, 1994).

Public housing authorities are failing to keep up with demands for assistance (see Fig. 3.22).

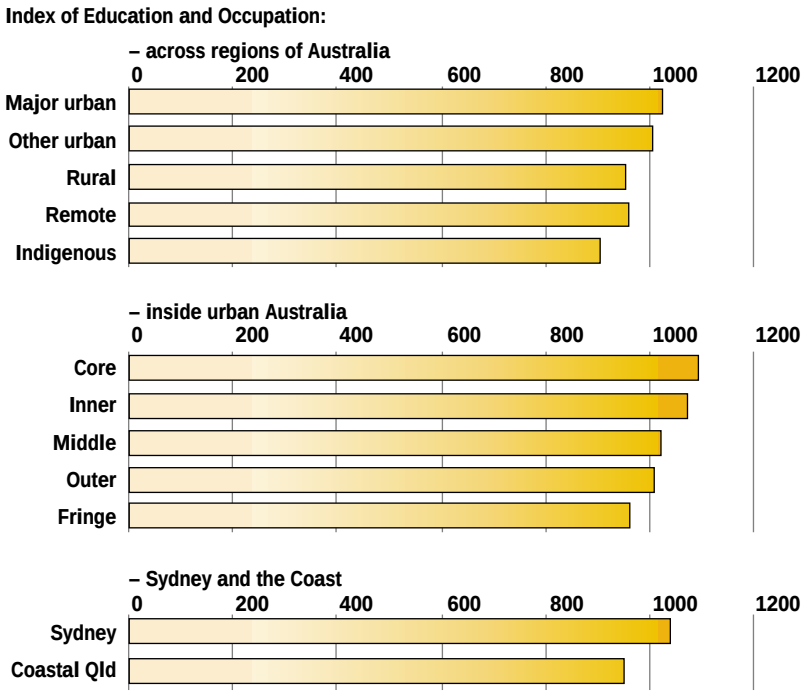
Housing affordability in major cities

As discussed in the section on population dynamics (see page 3-8), the impacts of globalisation are leading to increasing employment concentrations in core and inner city areas. While this is fuelling the process of reurbanisation in central areas, it may also be reducing the stock of affordable housing in these areas. Data on the cities of Melbourne (Maher, 1992 and 1994) and Perth (REIWA, 1994) suggest this is likely. The phenomenon may well be common to all cities. Government regulations plus demand for more accessible housing are generating pressures for consolidation throughout the city, including outer areas. Although core and inner areas already contain the highest proportions of high- and medium-density housing, a majority of dwellings in the inner and middle area remain detached (see Fig. 3.21).

ABS index of education and occupation

The ABS index of education and occupation indicates the distribution of educational and training qualifications across different types of settlement and within major cities. Once again it highlights the relative advantage of larger and more diverse settlements and the disadvantage of remote indigenous ones. Educational status and distance from the city centre have a strong correlation — confirming again the two-sided nature of the inner and core areas and their status as areas in social and economic transition. It also adds a further dimension to the picture of disadvantage characterising the urban fringe.

Figure 3.18 Distribution of educational and training qualifications across urban, rural and remote Australia



Note: The index measures deviation from a national average score of 1000 on a standardised scale.
Source: Derived from ABS, 1991 and 1994h.

Accessibility and locational disadvantage

The Australian suburb

The typical image of Australian urban life depicts a family living in a detached house with generous front and back gardens in a suburb zoned exclusively for housing. The family owns at least one car — often two or three — which provides for most of its transport needs. This popular image expresses important truths, but it is also a little too simple and overlooks important changes.

While detached dwellings are still the dominant housing form in Australia, trends towards higher-density housing in established areas are slowly beginning to change this pattern.

Australian households do rely very heavily on cars. As low-density suburbs mushroomed in the post-war period so did rates of car ownership: from 144 motor vehicles per thousand people in 1948 to 572 per thousand in 1990 (ABS, 1955 and 1992b). Again, however, indications suggest that the rate of growth of car dependence may be slowing (see page 3-37).

The proportion of households that include children belong to a declining minority — 43 per cent in 1992 compared with 47 per cent in 1982 (ABS, 1994g). It is true, however, that the outer suburbs do contain both the youngest households (ABS, 1991) and the highest proportion of those with children — 55 per cent of outer suburban households had children compared with 30 per cent in inner areas (NHS, 1992a).

In reality, the typical suburb is not as comfortable as the image suggests. A number of recent studies (for example, the Social Justice Research Program into Locational Disadvantage, 1991–95 and the National Housing Strategy, 1992a and b) have raised questions about lack of social amenity in the outer suburbs of major Australian cities. These studies have documented low levels of service provision, particularly in lower-income areas.

Conflicting interpretations

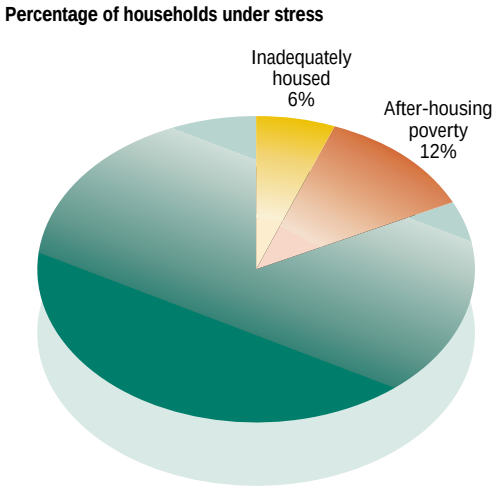
There is general agreement about the relative lack of services in outer suburban areas but considerable disagreement over its causes and wider significance. Not surprisingly, those who favour continuing low density suburban development ('suburbanisers') are less inclined to see serious or intractable problems than those who favour alternative 'reurbanising' strategies and more compact urban forms.

Suburbanisers point to the temporary nature of 'lagging' suburban services — needlessly delayed, they sometimes argue, by short-sighted fiscal restraint (Stretton, 1994; Troy, 1992). They draw attention to the attractions of suburban living and to the strong preferences urban residents continue to show for it — as reflected in market behaviour and relevant consumer surveys (NHS, 1992a;

McDonald and Moyle, in press). Suburban 'poverty' is judged to be a temporary problem, most often the passing experience of young outer suburban households yet to enjoy rising incomes and increasing equity in their homes. More serious urban poverty, this argument also sometimes suggests, is to be found in inner urban locations (Maher *et al*., 1992; Wulff *et al*., 1993). Suburbanisers argue that the private resources generally posessed by outer suburban households — especially cars — enable them to overcome the problems of distance and poor access to services (Maher, 1995). And now, also, these problems are said to be diminishing as a result of urban employment dispersion (Brotchie, 1992).

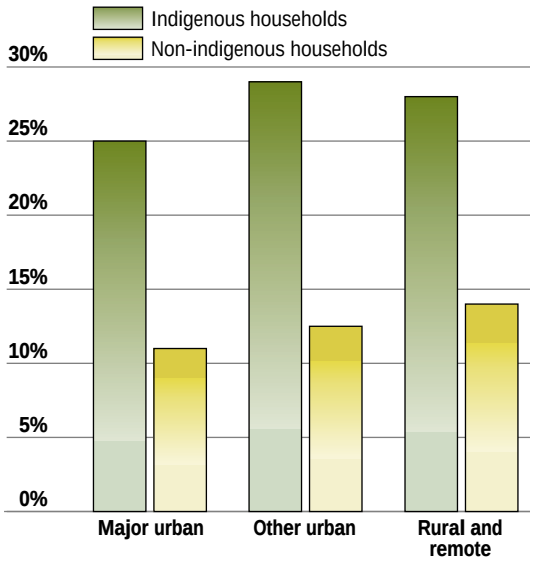
Re-urbanisers disagree. They point to examples of more enduring outer suburban deprivation that result not just from short-sighted fiscal restraint but also from the inherent inefficiency of low-density forms unable to generate sufficient economies of scale (Newman *et al*., 1992; AURDR, 1995a). Housing markets, they argue, tend to be driven by supply rather than demand, offering, until very recently, only a narrow range of choices and few examples of attractive higher density living (Newman and Kenworthy, 1992; Sarkissian and Marcus, 1986; AURDR, 1995b). They also point to evidence of longer-term outer-suburban poverty and discontent (Richards, 1994; McDonald, 1995; Wynhausen, 1995), and to the vulnerability of outer-suburban residents who have only limited access to cars (Tranter, 1994). Finally, they draw attention to the adverse impacts of increasing car use on the social, built and natural

Figure 3.19 Australians in housing stress



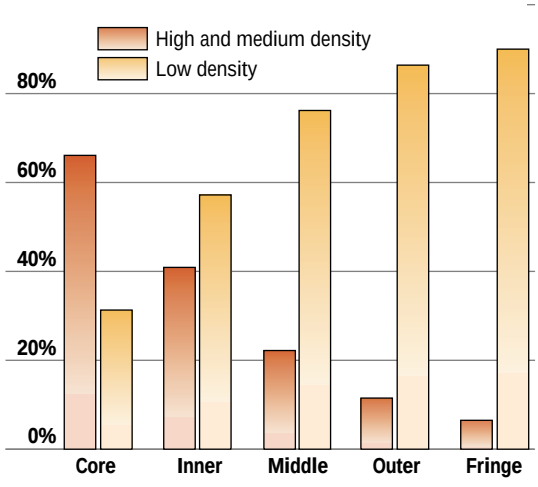
Source: Jones,1994.

Figure 3.20 After-housing poverty



Source: Jones, 1994.

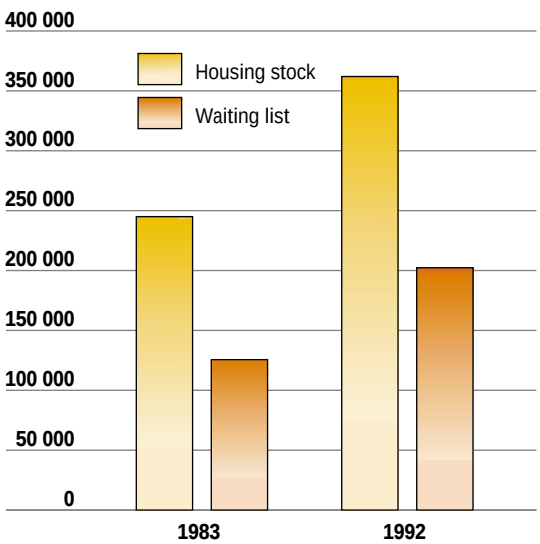
Figure 3.21 High-, medium- and low-density housing in urban Australia



Note: Some houses are not stated in the above categories.

Source: derived from ABS, 1991.

Figure 3.22 Demand for public housing outstrips supply



Source: ABS, 1994g.

The street is a very significant part of any community.

environments of our cities and dispute the claim that these are being relieved by continuing urban deconcentration (Prime Minister's Urban Design Taskforce, 1994; Engwicht, 1992; Newman *et al*., 1993).

While it is true that inner urban areas contain significant areas of social disadvantage, two other facts need to be noted in this context. First, low income households in inner areas report below average levels of access difficulties to urban services — while high income households in outer areas report above average difficulties (Newman *et al*., 1992). Second, affordable inner city housing options may well be shrinking — see the discussion of housing affordability above. This suggests a trend likely to force outward migration not just of younger aspiring home owners making a start, put of poorer renting households as well — especially where public housing policy favours cheaper outer urban development locations. Alternatively, people in these circumstances may move further afield to fringe and rural locations, thus sacrificing the access advantages of inner areas (Flood *et al*., 1991).

Although planners continue to argue about the relative merits of suburbanising and re-urbanising strategies, people are clearly choosing to move to both inner and outer areas of Australian cities. One survey, taken before the recent globalisation-related trends, showed that those wanting to move outwards were roughly matched by those wanting to move in the opposite direction (ABS, 1981). The development resulting from these demands needs to be managed more carefully and should more effectively incorporate the principles of ESD, community development and quality urban design.

Community

We can look at the idea of community from many angles, shaped as it is by a multitude of factors, among them being education, mass media, cultural and religious diversity, the role of the arts and the importance assigned to community participation in political life (Sarkissian and Walsh, 1995). However, the focus here is on the role of urban design which was highlighted in the recent report of the Prime Minister's urban design task force. Other urban planners argue that the unsustainability of settlements in terms of their metabolic flows is closely linked to their loss of community vitality — and that both are related to the way cities have been designed (Engwicht, 1992; Hayward and McGlynn, 1993).

Urban design task force

The recent report of the Prime Minister's Urban Design Task Force (1994) commented on the importance of public spaces and places:

'Australians devote great care to their private places. Yet many Australian cities struggle with a neglected stock of public spaces because of the premium placed on individual choice and because of inappropriate government and industry structures... The state of Australian streets tells the story starkly. Throughout the ages urban street networks have provided cities' essential civic communication and movement channels: in the modern city, because of the primacy of the motor car...streets have become almost exclusively conduits for cars. Yet we all know that streets have other roles... In our cities, streets must retain their function as the backbone of our society's public domain, and be made attractive for pedestrians, for children's play, for meeting other people, for resting and eating. Like other parts of the cities, streets must be designed to serve these purposes well.'

The task force outlines problems in urban design that emphasise the loss of diversity in the environment in new areas relative to older mixed-land-use areas with a greater range of housing types. It is critical of the car dependence in Australian cities and finds the coastal sprawl particularly damaging, not only to the natural environment but to community values as well.

Community and urban design

For most people, a city is much more than just a place to live and work. It is a place to belong to and be proud of, a place in which to make and maintain connections and one to enjoy in common. It is a shared and public space, which not only surrounds and connects many sites of private endeavour but also supports a diverse public and cultural life (Gehl, 1992). It is also, as Jacobs (1961) has argued, a source of vital learning, amusement and adventure for growing children and young adults.

The neglect of such spaces inside and beyond urban Australia noted by the Prime Minister's task force is also a neglect of our settlements as crucibles of community. This neglect, of course, is not universal, and there are also encouraging signs of change — particularly in some older towns and urban centres that retain richer and denser fabrics and pedestrian-friendly forms. The move towards nodal/information subcentres is partly due to the desire to create community centres. These are

forming, therefore, in older parts of the city as well as in new outer areas. In these subcentres people are trying to recreate — or to create anew — convivial public spaces in which the adverse effects of cars are controlled and more human contact is possible.

City dwellers are concerned about the importance of community and its connection with urban design. The Western Australian government recently conducted a survey and consultative process in Perth, which highlighted the fact that people felt strongly that community was disappearing from their suburbs. They were searching for a village concept in urban design (Community and Family Commission, 1992). They recognised that the development of a greater sense of community meant sharing in the management of their neighbourhoods and having closer access to each other and their local services. They saw that this was an important element in fighting the growth of crime or the fear of crime in their suburbs.

We do not have well-developed indicators of community or good urban design for Australian settlements — apart from some recent work in Perth, Melbourne and Sydney CBDs (Gehl, 1994a and 1994b; SCC, 1993). However, the Prime Minister's urban design task force suggests a growing role for these indicators in state of the environment reporting.

Health in Australian settlements

The international context

Australia is one of the healthiest countries in the world and our health continues to improve (see Fig. 3.23). Expenditure on health has been stable at about eight per cent of GDP for the last 15 years. Nevertheless, some population groups suffer wide disparities in health, with substantial room for improvement.

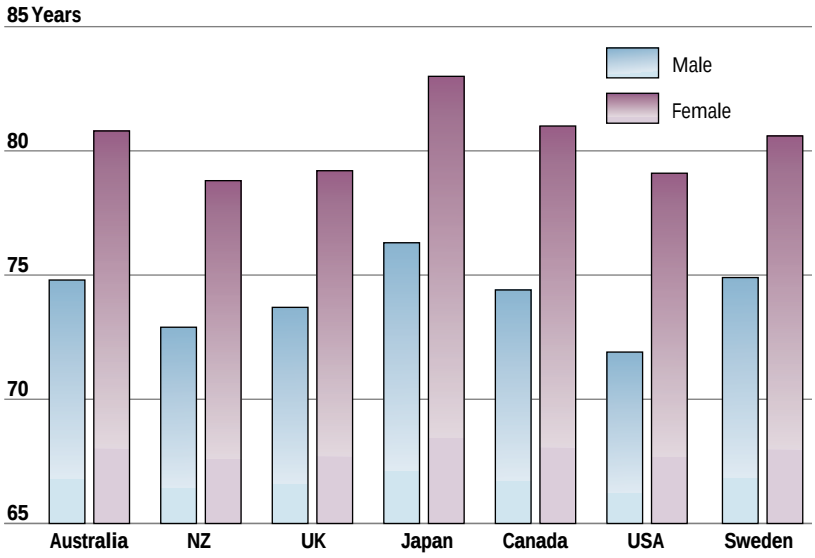
Our average life expectancy has risen continuously during the 20th century, apart from a period during the 1960s when deaths from cardiovascular disease increased, particularly for men (see Table 3.10). The increases that occurred in the first half of the century were due to rapid declines in infant and maternal mortality, particularly the lessening impacts of the infectious diseases associated with childhood and early adulthood. Access to better housing, sanitation and education, a trend to smaller families, growing incomes, the introduction of public health measures such as immunisation against infectious diseases and the development of antibiotics in the 1940s further contributed to these improvements.

Since the 1960s gains in life expectancy have been concentrated among the middle aged and older population. Some causes of death have declined dramatically. Between 1968 and 1992, for example, age-adjusted death rates from cardiovascular disease declined by 56 per cent for men and 55 per cent for women (AIHW, 1994).

The decline in deaths due to infectious diseases was accompanied by increases in both the death rates and the proportion of deaths attributed to diseases of the circulatory system and to cancers. In 1921, these diseases accounted for about 22 per cent of deaths, whereas by 1994 they were responsible for nearly 72 per cent.

In contrast to this good record, Australia's indigenous people have life expectancies and patterns of health more comparable to those of developing countries (see Table 3.11).

Figure 3.23 Life expectancy at birth for a number of OECD countries



Source: WHO, 1994.

Table 3.10 Life expectancy at birth and at age 65, 1905–1993, Australia

	1905	1921	1947	1966	1993
At birth					
males	55.2	59.2	66.1	67.6	75.0
females	58.8	63.3	70.6	74.2	80.9
At age 65					
males	11.3	12.0	12.3	12.2	15.7
females	12.9	13.6	14.4	15.7	19.5

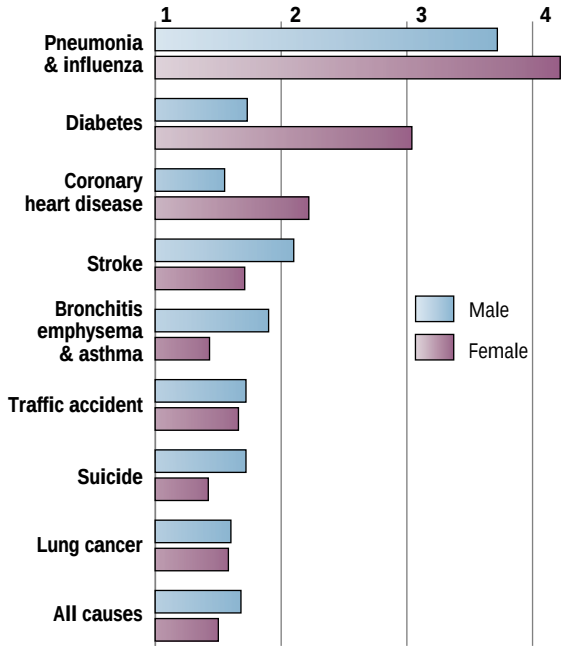
Source: Australian Life Tables, ABS, 1994i.

Table 3.11 Life expectancy at birth for indigenous people and the total Australian population, in selected states by sex, 1990–1992

	Indigenous			All
	WA	SA	NT	Australia
Males	56.3	57.8	56.8	74.5
Females	64.2	63.7	60.6	80.4

Source: AIHW,1994.

Figure 3.24 Ratios of death rates for Australians living in the most over the least disadvantaged areas



Note: The above rate ratios compare the standardised death rates of the 20% of Australians aged 25-64 years living in the most disadvantaged areas with those of the 20% of the Australians living in the least disadvantaged areas.

Source: Mathers, 1994a.

Social amenity and health

Elements of the social environment seen as important determinants of health include family income and wealth, individual education level, occupation and the working environment, marital status, social networks and social support, the living environment and culture (Mathers, 1994 a and b).

Regardless of the measure used — income, education level, occupation or other areas of socio-economic disadvantage — Australians from less-advantaged backgrounds have higher death rates and report worse health and higher levels of illness than their better-off counterparts (see Fig. 3.24).

It is difficult to make links between specific environmental hazards and particular human diseases because of the number of intervening factors, the quality and availability of data and the time-lag between exposure and the onset of disease. Many factors — ranging from genetic through to individual lifestyle and the social and physical environment — interact to cause major health problems.

The following comparisons of patterns of health across the various categories of human settlements in Australia identify differences in death rates for particular diseases that are partly caused by the social and/or physical environment.

Death rates are based on place of usual residence at the time of death and so relate to populations living in each of the settlement types at a particular

Table 3.12 Selected health indicators by broad region, 1990–1992

Indicator	Metropolitan	Other cities	Rural	Remote
Life expectancy at birth (years)	77.7	77.3	76.6	71.7
Infant mortality rate (per 1000 live births)	7.11	6.76	7.63	13.12
Age-standardised mortality rate (per 100 000 population)	679	692	734	985

Source: AIHW, 1995.

Table 3.13 Cardiovascular diseases: standardised mortality ratios[1] by settlement type, 1990–1992

Cause of death[2]	Metropolitan	Other cities	Rural	Remote
Cardiovascular diseases (ICD9 390–459)	0.97	1.00	1.05	1.31
Rheumatic heart disease (390-398)	0.97	0.97	0.98	2.79
Ischaemic heart disease (410-414)	0.97	1.02	1.06	1.29
Cerebrovascular disease (430-438)	1.00	0.97	1.01	1.20

Notes:
1. Standardised mortality ratios - see Glossary
2. Causes of death are classified according to the International Classification of Diseases (9th Revision) or ICD9.

Source: AIHW, 1995.

The health of Indigenous Australians

On almost every measure, indigenous Australians suffer poorer health than other Australians.

- Death rates are between two and four times those of the total Australian population.
- Mortality is much higher for young and middle-aged adults — males in the 35- to 44-year age group die at a rate more than eight times that for non-indigenous males.
- Life expectancy at birth is between 16 and 18 years less.
- Infant mortality rates are between two to three times as great.
- Indigenous babies weigh, on average, 200 grams less than non-indigenous babies at birth.
- Indigenous Australians are admitted to hospital about twice as often as non-indigenous Australians.
- Preventable communicable diseases continue to contribute disproportionately to high mortality and hospitalisation.
- The growing impact of non-communicable diseases — particularly cardiovascular disease and diabetes — without much decline in infectious-disease mortality is a phenomenon peculiar to indigenous Australians.

time. They also reflect the effect of the migration of older people associated with retirement or increased dependency.

Urban, rural and remote variations in health

The health of Australians as measured by broad indicators shows little variation between metropolitan and non-metropolitan settlements (see Table 3.12), with the exception of remote settlements, where the substantially worse health status of indigenous people results in significantly worse figures for the region. For some specific diseases and for some age groups, significant health differences exist between human settlements in Australia.

Cardiovascular diseases

Despite a dramatic decline in mortality related to it over the past 25 years, cardiovascular disease remains Australia's biggest health problem and is responsible for nearly half of all deaths in Australia each year. Coronary heart disease, which is the most common form, accounts for 25 per cent of all deaths, followed by cerebrovascular disease (stroke), which causes 10 per cent. The major causes of these diseases in the Australian population are thought to be a number of dietary factors (particularly those related to high blood pressure, high cholesterol and obesity), tobacco-smoking and physical inactivity.

Rural and remote settlements have higher mortality rates for coronary heart disease than metropolitan ones (see Table 3.13). Stroke death rates are also higher in remote, but not in rural, settlements. These higher ratios are partly attributable to the higher levels of cardiovascular disease among indigenous people.

The standardised mortality ratio of 2.8 for rheumatic heart disease in remote communities reflects its alarmingly high rate in indigenous people (up to 20 times more common in some remote communities than in Australian communities, generally).

Smoking and lung cancer

Most lung cancers are due to smoking and could be avoided. Age-standardised death rates for the disease increased seven-fold for men between 1945 and 1982, reflecting the very high prevalence of smoking following World War II (up to 70 per cent). After peaking at 68 deaths per 100 000 men in 1982, the rate has declined slowly (to 58 per 100 000 in 1992).

Since 1945, the female death rate due to lung cancer has increased enormously, with a six-fold increase to 17.5 deaths per 100 000 in 1992, as a result of increased cigarette consumption by women since the 1940s. The death rates for women have not yet started to decline, although in the last few years, women's smoking rates have fallen — albeit at a slower rate than men's.

Cancer

Death rates for cancers have changed little over the last 30 years, with small increases in the age-standardised death rates from 2.0 per 1000 males and 1.3 per 1000 females in 1965, to 2.3 and 1.4 respectively in 1993. Despite this relatively small absolute increase, the decrease in total mortality rates has meant that the proportion attributed to the disease actually increased from 15 per cent in 1965 to 27 per cent in 1992, making it the second leading cause of death after cardiovascular diseases. Death rates for most cancers are higher in remote settlements (particularly lung and cervical cancer), but there are fewer variations in cancer mortality among other settlement types (see Table 3.14).

Lung cancer is by far the major form causing deaths, accounting for 20 per cent. The mortality rate for lung cancer is rising in women, but falling in men. Breast cancer is the most common form of cancer in women. Death rates for skin, prostate and liver cancers are rising in men.

Much cancer mortality could be prevented. Researchers estimate that approximately one-third of cancer deaths may be attributed to tobacco smoke, another one-third to diet and about five per

Australians have the highest rate of skin cancer in the world.

Table 3.14 Cancer standardised mortality ratios by settlement type, 1990–1992

Cause of death	Metropolitan	Other cities	Rural	Remote
All Cancers (ICD9 140-239)	1.00	1.00	1.00	1.08
Digestive organs (150-159)	0.99	0.98	1.02	1.11
Lung (162)	1.01	0.98	0.96	1.19
Skin (172 & 173)	0.99	1.04	1.00	1.16
Breast (174)	1.00	1.02	1.02	0.74
Cervix (180)	0.97	1.08	0.92	2.96
Prostate (185)	0.95	1.03	1.11	0.96
Lymph, leukemia etc (200-208)	1.02	1.01	0.96	0.72

Source: AIHW, 1995.

cent to a range of physical environmental factors, including carcinogenic chemicals and materials, ionising radiation and electric and magnetic fields (Giles, *et al*., 1987).

Sunlight exposure is of particular concern. Australians have the highest rate of skin cancer in the world. Cases of melanoma are estimated to have quadrupled in the last two decades, with the highest incidence in Queensland.

Injuries

Injury is a leading cause of death in Australia, accounting for about six per cent of deaths, more than 10 per cent of hospital episodes and about 25 per cent of all handicap cases. While degenerative diseases such as heart disease and cancer occur primarily in older people, injury disproportionately affects the young and is the leading cause of death of both males and females between the ages of one and 44 years. Injury death rates are substantially higher in rural and remote settlements than in cities (see Table 3.15).

In 1993, the major causes of deaths due to injury were: motor vehicle crashes; suicide; falls (particularly in older people); homicide and drowning (particularly among toddlers). Suicide now causes more deaths in Australia than motor-vehicle crashes. The age-standardised suicide mortality is increasing by two per cent per year for men and falling by one per cent per year for women. Among young males, suicide has been rising since the 1950s. For women it peaked in the 1960s.

Mental health problems are of increasing concern. The Commonwealth, State and Territory governments have adopted a national policy and are planning a national survey to identify the prevalence of such problems in the population.

Road crashes in Australia account for more years of working-life lost than do all forms of heart disease, and more than half the loss through all cancers (Ginpil *et al*., 1992). When we consider that these affect a much younger age group than heart disease and cancer, their social impact is particularly disturbing. In the next decade, one in every ten Australian families will be directly affected by a road death or serious injury (Federal Office of Road Safety, 1992). Death rates due to motor vehicle accidents are considerably higher for people living in rural and remote areas.

Chronic diseases caused by occupational exposures to toxic and carcinogenic substances and to radiation cause considerable controversy. A large number of occupationally caused cancers are well documented — for example, the primary cause of mesothelioma occurring in Australia and other industrialised countries is recognised as occupational exposure to asbestos fibres. However, experts disagree considerably about the extent to which modern industrial and agricultural development have increased the levels of cancer and congenital abnormalities (Doll, 1992; Landrigan, 1992).

Table 3.15 Injury and poisoning: standardised mortality ratios by settlement type, 1990–92

Cause of death	Metropolitan	Other cities	Rural	Remote
Injury and poisoning (ICD9 E800-E999)	0.90	1.02	1.17	2.06
Motor vehicle accidents (E810 E819)	0.84	0.98	1.35	2.15
Accidental drowning (E910)	0.81	1.41	1.21	2.26
Suicide (E950-E959)	0.96	1.06	1.07	1.29
Homicide (E960-E969)	0.92	0.88	0.85	4.53
Production injuries[1]	0.73	0.95	1.65	2.38

Note:
1. A number of causes of death (being struck by a falling object; accidents involving machinery; falls from ladders, scaffolds; being caught or crushed; and deaths involving an electric current) are known to be mostly work related. This combination of causes has been used as an indicator of production related death.

Source: AIHW, 1995.

Table 3.16 Respiratory diseases: standardised mortality ratios by settlement type, 1990–1992

Cause of death	Metropolitan	Other cities	Rural	Remote
Respiratory diseases (460-519)	0.97	0.96	1.04	2.26
Pneumonia, influenza and bronchitis (466, 494-496, 480-492)	0.95	0.98	1.05	2.45
Asthma (493)	0.96	0.85	1.16	1.05

Source: AIHW, 1995.

The workplace

Most Australians spend a great part of their life working. Their workplaces are many and varied, but a central element (indeed a Commonwealth and State responsibility) of work is the need for a healthy and safe working environment (see the box opposite). Occupational health and safety not only affects the workers' ability to make a living, but can also have an impact on their employer's productivity levels.

Respiratory diseases

About eight per cent of deaths in Australia are due to respiratory diseases, chiefly pneumonia, influenza, bronchitis, emphysema and asthma. However, the number of deaths due to influenza is generally low, about 60 in each of the last two non-epidemic years (1990 and 1991).

The extent of asthma in the community varies with age. Recent studies have estimated the prevalence of asthma to be up to 30 per cent in children, between 15 and 20 per cent in adolescents and about seven per cent in adults. During the 1980s, asthma mortality rose significantly in Australia, and since then it has not changed for males but has increased by two per cent per year for females.

Prevalence of the condition in children appears to have doubled in the last decade (Peat *et al*., 1994).

It is now the most common chronic illness and the main cause of hospital admission in Australian children. Asthma mortality is highest in rural settlements (see Table 3.16). This may be related to higher levels of exposure to airborne allergens (such as pollens) among rural communities.

Environmental factors implicated in triggering asthma attacks include outdoor air pollutants (particularly ozone, nitrogen oxides and automotive emissions), indoor air pollutants (nitrogen dioxide and tobacco smoke), grass pollens, certain foods and preservatives, household pets and house dust-mites.

Health differences within and between urban settlements

People living in the core — and to some extent in the inner urban areas — have higher infant and total mortality rates. This reflects higher rates for several causes of death (see Table 3.17). For example, the core metropolitan area has a mortality

Work-related injury

Workplace injury and disease have a far greater impact than many people realise. Each year, about 500 Australians are killed in workplace or work-related accidents. If mortality from chronic diseases and cancers related to occupational exposures (which may have occurred many years earlier) are also taken into account, it has been estimated that up to 2700 Australians may die from work-related health problems each year and up to 650 000 suffer work-related injuries and illnesses.

At any time, work-related injury and ill-health can mean: up to 115 000 workers cannot continue at full capacity; about 200 000 workers have to permanently reduce their work-hours or change their jobs; and almost 200 000 people are prevented from working at all — disturbingly, the vast majority of these have not worked for more than a year. Work-related health problems also affect retired people — figures indicate that up to 285 000 people over the age of 65 are suffering from them.

Work-related fatal injuries are substantially higher in rural and remote settlements than in cities.

Table 3.17 Standardised mortality ratios for selected causes of death, by metropolitan settlement type, 1990–92

Cause of death	Core	Inner	Middle	Outer	Other cities
Infectious and parasitic diseases (1-139)	1.79	1.17	0.96	0.98	0.78
Cancers (140-239)	1.12	1.05	0.97	0.99	1.00
Digestive organs (150-159)	1.08	1.04	0.97	0.98	0.98
Lung (162)	1.21	1.02	0.98	1.02	0.98
Skin (172 & 173)	1.29	0.95	0.95	0.97	1.04
Breast (174)	0.99	1.08	0.98	0.98	1.02
Cervix (180)	1.03	1.02	0.92	0.99	1.08
Prostate (185)	0.90	0.98	0.92	0.98	1.03
Lymph, leukemia etc (200-208)	1.17	1.09	1.01	0.99	1.01
Diabetes mellitus (250)	1.01	1.02	0.96	0.91	0.82
Mental disorders (290–319)	1.62	1.10	0.94	0.87	1.04
Diseases of the nervous system & sense organs (320–389)	1.12	1.17	0.93	0.89	0.98
Circulatory system (390–459)	1.08	1.01	0.95	0.95	1.00
Acute rheumatic fever (390-398)	0.96	0.94	0.98	0.92	0.97
Ischaemic heart disease (410-414)	1.07	0.99`	0.95	0.95	1.02
Cerebrovascular disease (430-438)	1.14	1.06	0.97	0.97	0.97
Respiratory system diseases (460-519)	1.10	0.97	0.93	0.97	0.96
Pneumonia, influenza & bronchitis (466, 494-496, 480-492)	1.11	0.96	0.92	0.94	0.98
Asthma (493)	1.10	0.92	0.90	1.01	0.85
Digestive system diseases (520–579)	1.34	1.06	0.90	0.90	0.99
Genitourinary system diseases (580–629)	1.12	0.98	0.98	0.95	0.89
Congenital anomalies (740-759)	1.44	0.93	1.09	0.86	1.00
Perinatal conditions (760-779)	1.39	1.03	1.03	0.93	0.85
Sudden infant death syndrome (798.0)	0.93	0.77	0.92	1.01	0.99
Injury and poisoning (E800-E999)	1.23	0.94	0.84	0.85	1.02
Motor vehicle accidents (E810-E819)	0.78	0.69	0.79	0.88	0.98
Accidental drowning (E910)	1.05	0.72	0.74	0.80	1.41
Suicide (E950-E959)	1.39	1.06	0.90	0.87	1.06
Homicide (E960-E969)	1.93	1.00	0.86	0.78	0.88
Production injuries*	0.70	0.65	0.61	0.81	0.95
All causes	1.14	1.02	0.94	0.95	0.99

*Note: A number of causes of death (being struck by a falling object; accidents involving machinery; falls from ladders, scaffolds; being caught or crushed; and deaths involving an electric current) are known to be mostly work related. This combination of causes has been used as an indicator of production related death.

Source: AIHW, 1995.

Backyard swimming pools — a health hazard?

Drowning is the most common cause of death (16 per cent) among one- to four-year-olds in Australia. It is estimated that for every child who drowns, between four and ten children are admitted to hospital for near-drowning, and between five and 10 per cent of these will suffer some neurologic damage.

The drowning death rate for children aged one to four increased about 60 per cent between 1965 and 1972 at a time when, generally, child death rates were falling. This increase was associated with the construction of large numbers of above-ground and in-ground home swimming pools. By the early 1980s, child drowning rates varied more than 30-fold between different metropolitan settlements, linked strongly to the different legal requirements for fencing around pools.

Over the last decade, the introduction of legislation requiring fencing that isolates children from pools has achieved marked success. Accidental drowning rates among one- to four-year-olds have declined by nearly 50 per cent since the mid 1970s.

Table 3.18 Standardised mortality ratios for selected causes of death, by rural/remote settlement type, 1990–92

	Rural			Remote		
Cause of death	**Large**	**Small**	**Other**	**Centres**	**Other**	**Indigenous**
Infectious & parasitic diseases (1-139)	0.86	0.83	0.72	2.14	2.38	18.40
Cancers (140-239)	1.04	1.02	0.97	1.12	1.00	1.47
Digestive organs (150-159)	1.07	1.03	0.99	1.28	0.97	1.26
Lung (162)	0.95	1.06	0.92	1.12	1.17	1.76
Skin (172 & 173)	1.10	0.96	0.98	0.98	1.32	0.94
Breast (174)	1.04	1.04	1.00	0.69	0.76	0.84
Cervix (180)	0.92	0.89	0.93	2.22	2.47	9.98
Prostate (185)	1.09	1.07	1.13	1.06	0.97	0.19
Lymph, leukemia etc (200-208)	0.99	0.99	0.93	0.69	0.75	0.69
Diabetes mellitus (250)	0.97	1.11	1.13	1.88	2.25	10.63
Mental disorders (290–319)	1.04	0.95	0.93	1.69	1.15	5.01
Diseases of the nervous system & sense organs (320–389)	1.22	1.06	1.02	1.25	1.18	2.55
Circulatory system (390–459)	1.08	1.08	1.03	1.25	1.24	2.46
Acute rheumatic fever (390-398)	0.84	1.00	1.05	1.85	2.33	12.28
Ischaemic heart disease (410-414)	1.11	1.08	1.04	1.25	1.23	2.14
Cerebrovascular disease (430-438)	1.04	1.08	0.96	1.16	1.17	1.81
Respiratory system diseases (460-519)	1.01	1.10	1.02	1.79	1.89	8.89
Pneumonia, influenza & bronchitis (466, 494-496, 480-492)	1.02	1.12	1.03	2.00	1.96	10.27
Asthma (493)	1.13	1.16	1.18	0.86	1.09	1.78
Digestive system diseases (520–579)	1.05	1.04	1.06	1.55	1.69	2.70
Genitourinary system diseases (580–629)	1.08	1.06	0.98	1.94	1.76	12.14
Congenital anomalies (740-759)	1.10	1.14	0.96	0.95	1.06	1.78
Perinatal conditions (760-779)	1.03	0.90	0.94	1.36	1.23	4.48
Sudden infant death syndrome (798.0)	0.96	0.93	1.01	1.72	1.55	2.76
Injury and poisoning (E800-E999)	1.09	1.03	1.25	1.53	2.15	3.77
Motor vehicle accidents (E810-E819)	1.10	1.11	1.56	1.36	2.39	4.08
Accidental drowning (E910)	0.86	1.03	2.21	1.49	2.52	3.82
Suicide (E950-E959)	0.95	0.96	1.39	1.04	1.47	1.31
Homicide (E960-E969)	1.13	1.03	1.09	3.28	3.81	13.34
Production injuries*	0.84	1.09	0.77	1.84	2.75	2.62
All causes	1.06	1.06	1.02	1.33	1.36	3.34

*Note: A number of causes of death (being struck by a falling object; accidents involving machinery; falls from ladders, scaffolds; being caught or crushed; and deaths involving an electric current) are known to be mostly work related. This combination of causes has been used as an indicator of production related death.

Source: AIHW, 1995.

rate for infectious and parasitic diseases 79 per cent higher than the national average.

Although this urban variation is not as great as that between cities and remote areas, the very high standardised core-area mortality ratios for mental disorders (1.62), suicide (1.39) and homicide (1.93) could be linked to the pockets of disadvantaged people still resident in core areas, including the homeless who tend to congregate there.

The data on variations in mortality within rural and remote settlements (see Table 3.18) show that remote indigenous settlements have much higher mortality ratios for a range of causes of death.

Some types of settlement have standardised mortality ratios that differ significantly from the general pattern. In remote settlements, for example, skin cancer is 32 per cent higher than the national average, while in indigenous settlements it is six per cent less (as would be expected). However, the data highlight much higher general mortality rates for remote indigenous communities (apart from some cancers and suicide). Their extremely high levels of infectious and parasitic diseases for example, indicate the lack of basic and appropriate sanitation in many of them.

Key results of the 1992 ATSIC survey of national housing and community infrastructure needs indicate that 2760 people do not have a water supply that is maintained to an acceptable standard, 137 communities are without a sewerage system and 57 communities have sewerage systems not working satisfactorily (ATSIC, 1993).

Poor living conditions, inappropriate housing, poor nutrition, overcrowding and poor hygiene and a lack of basic services such as clean water and sewerage, contribute to high rates of infectious disease, rheumatic heart disease, respiratory disease, genito urinary diseases and cervical cancer.

Although many remote communities have maintained much of their social and cultural integrity, in some places the disruption of traditional indigenous society and chronic unemployment have led to high rates of alcohol abuse and petrol-sniffing, cigarette-smoking, accidents and violence.

Livability indicators

A set of social amenity and health indicators in any ongoing state of the environment reporting process would significantly assist in monitoring the state of livability in Australian settlements. The parameters and indicators set out in Table 3.19 could be used.

Table 3.19 Suggested indicators for social amenity and health

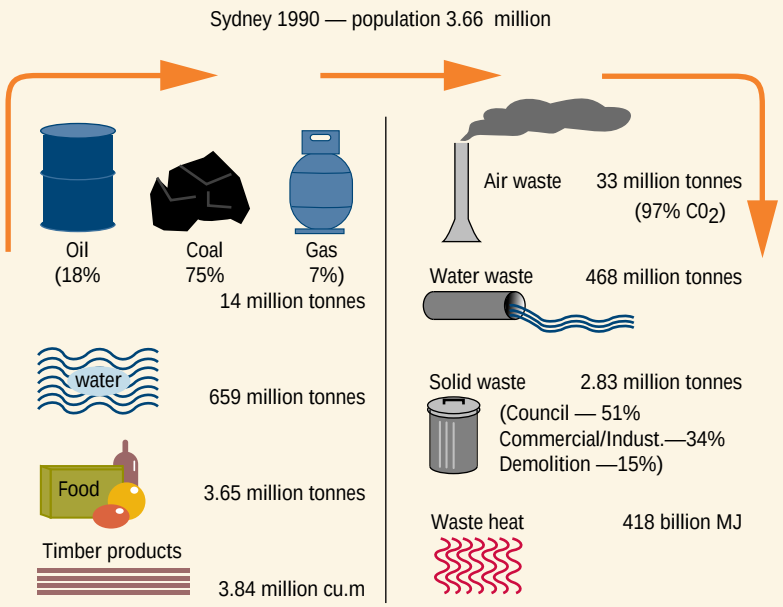
Parameter	Indicator
Wealth inequality	• percentage of private wealth owned by the richest 10 per cent of the population
Income inequality	• trends in (full) income inequality (see Johnson *et al.*, 1995) • female income as a proportion of male income • income of indigenous Australians as a proportion of national average
Unemployment	• total rate • youth rate • indigenous rate • median period
Education and training	• year-12 retention rates • proportion of workforce with post-secondary qualifications • public expenditure on education as a proportion of GDP
Housing	• percentage inadequately housed (as defined by Jones, 1994) • percentage in housing-related financial stress • percentage of indigenous households inadequately housed (as defined by Jones, 1994) • percentage of indigenous households in housing-related financial stress • national public housing waiting list
Accessibility and urban design	• modal split (%) for journey to work — or for all journeys: – car – public transport – walking and cycling • local employment availability • local housing availability • design of new developments • percentages of medium and high density developments • percentage with public transport within 500 m • mix of office/retail/residential • parking space provision (sq m) • quality urban design (see Gehl, 1994a,b; PM's Urban Design Task Force, 1994)
Health	• life expectancy • infant mortality • cause-specific mortality rates • disability-adjusted life years lost (burden of disease)

Health effects of lead exposure

In recent years, the exposure of children to lead has emerged as a particular health problem. Australian and overseas research indicates a strong correlation between concentrations of lead in the blood of young children and neurological malfunction, learning disability and retarded mental development. The major source of airborne lead in most Australian urban areas is leaded fuel used in motor vehicles. (Exceptions occur in residential areas in close proximity to lead smelters in Port Pirie, Boolaroo and Broken Hill.) Other sources of lead exposure are soil, water, dust and deteriorating lead based paint. The introduction of unleaded petrol in 1985 and the reduction of the lead content in standard petrol in 1993 as part of the lead abatement strategy have considerably reduced the amount of lead being discharged to the atmosphere by motor vehicles.

The Australian Institute of Health and Welfare has recently performed the first national survey of blood lead levels in young children on behalf of the Commonwealth Environment Protection Agency. Although the result (93 per cent had blood lead levels below 10 micrograms per decilitre (µg/dL)) is within the NH&MRC goal for 90% of children to have blood lead levels below 10 µg/dL by 1998, it is still a matter of concern that seven per cent of children exceed the target level.

Figure 3.25 Sydney's resource inputs and waste outputs, 1990



Note: 1. Waste water data do not include stormwater and waste water outside sewerage system.
2. Timber products and food data derived from national per capita data.
3. 1991 water consumption and disposal data used.

Table 3.20 Trends in resource flows, Sydney, 1970 and 1990

	Sydney 1970		Sydney 1990	
Population	2 790 000		3 656 500	
Resource inputs per head				
Energy (MJ)	88 589		115 377	
Domestic		10%		9%
Commercial		11%		6%
Industrial		44%		47%
Transport		35%		38%
Food intake[a] (tonnes)	0.52		1.0	
Water (tonnes)	144		180	
Domestic		36%		44%
Commercial		5%		9%
Industrial		20%		13%
Agricultural/gardens		24%		16%
Miscellaneous		15%		18%
Waste outputs per head				
Solid waste (tonnes)	0.59		0.77	
Sewage (tonnes)	108.0[b]		128.0[c]	
Hazardous waste (tonnes)	n/a		0.04	
Air waste (tonnes)	7.6		9.3	
Carbon dioxide (kg)	7210.0		9050.0	
Carbon monoxide (kg)	204.9		177.8	
Sulfur oxides (kg)	20.5		4.5	
Nitrous oxides (kg)	19.8		18.1	
Hydrocarbons (kg)	63.1		42.3	
Particulates (kg)	30.6		4.7	

Notes:
(a). Derived from food sales data, not consumption data. It reflects an increased use of primary foodstuffs (eg grains) in the production of meat and processed foods.
(b). Includes stormwater,
(c). Waste water within sewerage systems only

Source: NSW Office of Energy, 1995; ABARE, 1991; 1993; ABS, 1993f; 1995e; EPA NSW, 1993; Nix, 1973; Butlin, 1976; SWB 1991a, b.

Metabolism in Australian settlements

The metabolism model of human settlements (as described at the beginning of this chapter), uses an integrated approach to assess both the state of the environment in those settlements and their effects on the wider environment. This section illustrates the performance and trends in Australian settlements with respect to these metabolic processes.

No comprehensive input and output data are available for most Australian settlements. These material flows could become standard indicators on urban environments for future State of the Environment reporting. Such indicators provide a start in reducing metabolic flows at the household, industrial and city-wide levels. No Australian settlement presently collects such data in a standardised way, with data on rural and remote settlements particularly hard to obtain. This makes it impossible to present a composite picture of the metabolic flows in Australian cities. An application of the metabolism model to a large settlement is presented below. It illustrates the resource and waste flows in Sydney for the period 1970 to 1990 (see Fig 3.25 and Table 3.20). Even for Sydney, data had to be collected from a variety of sources and in some cases had to be estimated.

Metabolism and scale

A look at Sydney's resource flows between 1970 and 1990 shows that not only did the city's total population grow by 31 per cent over the 20-year period but consumption and waste-generation per head increased as well (see Table 3.20).

Since 1970, levels of air pollutants per head have fallen — particularly emissions of sulfur dioxide and particulates. This is probably due to a combination of stricter pollution control on emission stacks (the major component) and improved technology, combined with a gradual decline in industrial activity within the city. Although the level of gases which form photochemical smog (nitrogen oxides and hydrocarbons) decreased per head, nitrogen oxides increased by 20 per cent in total. The level of hydrocarbons fell by 33 per cent on a per head basis but only 12 per cent in total. These emissions are primarily from motor vehicles (see Chapter 5).

Some gains are only made at the cost of something else; for example, carbon monoxide levels have been reduced by better and more efficient motors converting carbon monoxide into more carbon dioxide — although this is a definite health and amenity improvement in cities it still contributes to greenhouse gas emissions.

Between 1970 and 1990, Australia's average consumption of primary energy per head increased by 37 per cent to 156 567 MJ, compared with 30 per cent for Sydney over the same period. This difference might be due to urban economies of scale and the high level of mineral processing outside Sydney. By 1990, the city's annual emissions of carbon dioxide had risen from 7.21 to

9.05 tonnes per head — but this is about half the New South Wales level of 18 tonnes.

As settlement size increases, resource-use efficiency also increases. This is probably due to a combination of factors, including the availability of waste-recycling facilities, bigger markets for recycled products, greater access to globally innovative technology, easier access to more-efficient forms of energy generation and greater population size and density allowing for greater economies of scale, better public transport and more efficient use of land (see Table 3.21).

The table highlights some interesting differences between the two remote settlements, which reflect their differences in both cultural attitudes and economic base. The mining settlement of Yandicoogina is considerably more energy-, water- and waste-intensive than the indigenous community described earlier (see pages 3-16 and 3-17), because it is trying to provide all the comforts of the city for a work force in a remote and arid location, without the benefits of scale to do so efficiently.

Resource inputs and their indicators

Water

Australia is the driest inhabited continent, yet we have one of the highest total water consumption levels per head by international standards (OECD, 1995). So it is important for Australian human settlements to minimise their water use. After irrigation, the next biggest water use occurs in the urban areas of large cities, where both consumption and storage are very high (due to Australia's low and erratic rainfall, and the prevalence of lawns and gardens in our urban areas) (AURDR, 1995a). For example, Sydney has to store 930 cubic metres per head compared with 250 in NewYork and 18.2 in London (Munro, 1974).

While urban water supplies must cater for industrial and commercial needs, the major demand for water is domestic. Levels of consumption vary significantly across the major cities according to rainfall, mean temperatures and humidity, availability of water, water pricing and education. Within the city, data on water use suggest that the size of the block of land is the most important factor affecting consumption because of garden- and lawn-watering. Thus, core and inner areas can consume two or three times less water per head than outer suburbs (Mouritz and Newman, 1995).

As the figures on Sydney illustrate (see Table 3.20), domestic water consumption has increased significantly over the past 20 years because of rises in both population and individual consumption rates, which can be attributed to an expectation of higher living standards and the increased proportion of houses in outer areas. Adelaide suffers real constraints to water supply and increasing water abstraction is an environmental issue for both Perth and Sydney.

An industry's water use can be monitored on the basis of its consumption per unit of GDP output. However, most industries do not have such data readily available.

Energy

Resource capacity

Australia is well endowed with a wide range of energy resources and is climatically well placed to exploit renewable energy opportunities (see Table 3.22).

Our energy consumption per head is a little higher than the average for OECD nations. In terms of energy per unit of GDP, Australia's position has only marginally improved since 1970, while Canada, the United States and the United Kingdom have all improved by more than 30 per cent. From the mid 1980s until the early 1990s,

Table 3.21 Selected per capita resource flows in four different-sized settlements, 1990

	Sydney pop. 3 656 500	Warrnambool pop. 24 720	Indigenous community pop. 300–400	Yandicoogina pop. 79-159[a]
Resource inputs (per head)				
Water (tonnes)	180	182	241	946
Food (tonnes)	1[b]	1[b]	1.07[c]	0.74[c]
Energy (MJ)	115 377	102 997[d]	29 000	177 630
Waste outputs (per head)				
Solid waste (tonnes)	0.77	0.94	0.2	1.58
Sewage (tonnes)	128	104	n/a	n/a

Notes:
(a) 1992 figure (first full year of operation).
(b) Based on average Australian food consumption/head.
(c) Based on settlement stores inventory.
(d) Includes electricity use figures for 1991.

Source: NSW Office of Energy, 1995; ABS, 1993f and 1995e; City of Warnambool, 1995; SWB, 1991 a and b; Newman *et al.*, 1994; EPA NSW, 1993; Vic DEM, 1995; CAT, 1995; BHP Pty Ltd, 1995.

Table 3.22 Australian energy reserves, production and use, 1991–92

	Demonstrated economic resources (PJ)	Production 1991–92 (PJ)	Total domestic use (PJ)
Black Coal	1 400 000	4 647	1 176
Brown Coal	410 000	497	497
Crude Oil	14 000	1 158	1 441
Natural Gas	37 000	931	677
Uranium	263 000	2 223	–
Renewables[1]	(not estimated)	230	230

Note: 1. Comprises wood, bagasse from sugar cane, hydro-electricity and domestic solar hot water heaters only. Official statistics do not currently count other uses of solar energy, for example, commercial hot water, building and swimming pool heating, photovoltaic power for communications, salt drying and clothes drying.

Source: ABARE, 1993.

Table 3.23 Energy consumption in Australia by sector, 1991–92

	Energy consumed (PJ)	Proportion of total energy consumption(%)
Agriculture	58.5	1.5
Mining	172.1	4.3
Manufacturing	1068.2	26.7
Electricity Generation	1114.0	27.3
Construction	38.8	1.0
Transport	1016.8	25.4
Commercial	152.3	3.9
Residential	334.4	8.4
Other	48.3	1.6
Total	**4003.2**	**100**

Source: ABARE, 1993.

Table 3.24 Comparison of domestic energy consumption in Australian cities with other national data for mid 1970s

	Domestic energy use per head (GJ)
Canada	62.13
United States	55.85
Netherlands	40.87
United Kingdom	27.87
Hobart	26.20
France	23.89
Canberra	23.10
Melbourne	**20.00**
Italy	15.84
Adelaide	**14.82**
Japan	13.15
Sydney	**12.65**
Brisbane	**8.99**
Perth	**8.74**
Hong Kong	4.06

Source: Newman, 1982.

Table 3.25 Trend in domestic energy use by fuel in Sydney, 1976 and 1993–94

Fuel Source	1976 energy use (GJ/head)	1993–94 energy use (GJ/head)
Electricity	7.29	9.28
Gas	3.27	2.44
Oil	1.76	1.35
Coal	0.29	0.12
Wood	0.05	3.01
Total (incl wood)	**12.65**	**16.2**
Total (excl wood)	**12.60**	**13.19**

Source: Newman, 1982; NSW Office of Energy, 1995.

Australian energy efficiency actually declined by about four per cent (AURDR, 1995a; ABARE, 1993). Thus we have considerable potential to improve our energy efficiency, and still improve our quality of life.

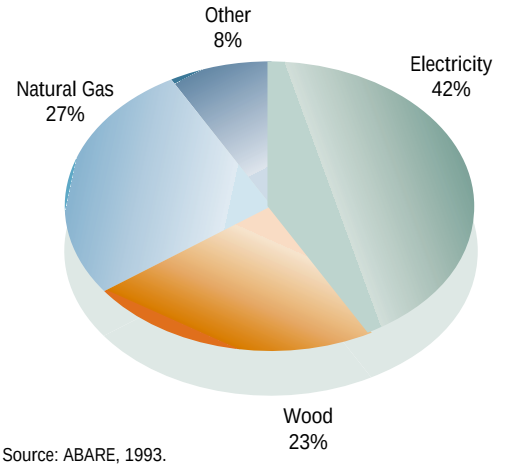
Table 3.23 shows that manufacturing, electricity generation and transport account for 79 per cent of energy use in Australia. Electricity is not constrained in terms of the base resources — either fossil fuels or renewables — but its contribution to air quality and greenhouse gas emissions is significant.

Domestic energy

Domestic energy use varies mostly with climate and to a lesser extent, household income, and household size (Newman, 1982; ABARE, 1993) (see Table 3.24). It is dominated by water- and space-heating energy services, followed by refrigeration and cooking. In 1991–92, the residential sector accounted for 12 per cent of total energy production in Australia. Owing to transmission wastage, this translates to eight per cent of energy end-use (see Table 3.23).

A range of fuels supply domestic energy (see Table 3.25). Sydney increased its domestic energy

Figure 3.26 Australian domestic fuel use, 1991–92



Source: ABARE, 1993.

Table 3.26 Per head fuel consumption by urban region in Melbourne

	inner areas	middle areas	outer areas
Distance from CBD (km)	5.5	15.5	38.8
Urban density (people per ha)	31.9	20	9.6
Jobs to population ratio	0.8	0.3	0.2
Car trips to work (%)	57.7	74.5	82.1
Gasoline use per person (MJ)	13 244	20 303	26 881

Source: Newman and Kenworthy, 1990.

consumption by 27 per cent per head from 1976 to 1993–94 largely due to an increase in the use of wood for heating and electricity. By comparison, New South Wales increased its energy consumption by 80 per cent over the same period (NSW Office of Energy, 1995).

Transport energy

Road transport accounted for one-quarter of the energy consumed in Australia in 1990–91 (ABARE, 1993). Of this, urban areas used 63 per cent directly and much of the rest was consumed in satisfying the requirements of urban areas or travelling between them (AURDR, 1995a). Australia has 20 per cent higher fuel use per head than the OECD urban average (OECD, 1994). Our vehicles have a poor average fuel economy of 11.8 L/100 km, which did not improve between 1971 and 1991. By contrast, the vehicle fleet efficiency in the United States improved by 29 per cent, to 10.8 L/100 km, between 1980 and 1988 (AURDR, 1995a).

Transport fuel use varies in Australian cities by around 15 per cent, with Perth at the high extreme and Melbourne and Sydney at the other (see Table 3.27). Larger cities generally have lower fuel use per head (Naess, 1993) because of better transit and higher urban densities.

Rates of fossil fuel consumption per head are twice as high in the outer regions of cities, where most people live (see Table 3.26). However, people feel the impact of these levels of car dependence everywhere in the city.

Table 3.28 shows how jobs in Australian cities have grown in the city core, but much less than in the rest of the city which is often often difficult to reach by public transport. This has implications for sustainable urban development. However, the trend may be offset by a greater proportion of local jobs and by the development of nodal/information centres in the suburbs which are more public-transport-oriented.

Over the last three decades, the rate of growth of car use in Australian cities has declined compared with American trends although car usage is still high compared with that in European and Asian

Australian cities are high transport energy consumers due to low efficiency cars, and heavy car dependence.

Table 3.27 Transport fuel use per head in Australian cities compared with selected international cities

City	Motor Vehicles		Public Transport		Total
	Petrol (GJ)	Diesel (GJ)	Diesel (GJ)	Electric (GJ)	(GJ)
Houston	74.51	9.40	0.29	0	84.20
Los Angeles	58.47	6.40	0.65	0	65.50
New York	44.03	6.17	0.55	1.34	52.09
Perth	32.61	6.82	0.82	0	40.25
Brisbane	30.65	5.80	0.80	0.06	37.30
Adelaide	28.79	5.40	1.01	-	35.21
Melbourne	29.10	4.54	0.25	0.35	34.24
Sydney	27.99	5.69	0.66	0.32	34.66
Toronto (Metro)	22.67	7.93	0.98	0.51	32.09
Hamburg	16.67	5.94	0.15	0.31	23.07
London	12.43	5.17	0.64	0.48	18.72
Amsterdam	6.84	2.94	0.59	0.10	10.47
Tokyo	8.49	4.58	0.25	0.72	15.35
Singapore	5.96	3.50	1.56	0	11.04
Hong Kong	1.99	2.56	0.79	0.07	5.41

Source: Newman and Kenworthy, 1989; Newman, 1994; plus new data on Toronto from Kenworthy and Newman, 1994.

Table 3.28 Changing work place destinations in Australia's major cities

	Worked at home	City core	Local area[1]	Other metro area	Total
1981 (% of all jobs)	3.93	31.17	29.12	35.28	100
1991 (% of all jobs)	3.89	27.12	30.28	38.66	100
Absolute growth 1981–91 (jobs)	21 804	14 966	219 580	342 087	

Note: 1. Equivalent to a Statistical Local Area

Source: Gipps *et al.*, 1994.

Table 3.29 Trends in use of cars and transit in global cities

		US cities	Australian cities	Canadian cities	European cities	Asian cities
Car Use (vehicle kilometres travelled per head)	1970	7 334	4 628	na	2 750	470
	1980	9 168	5 850	4 807	3 798	531
	1990	11 559	6 589	5 680	4754	1178
Public Transport (trips per head)	1970	48	118	154	249	418
	1980	57	93	202	290	430
	1990	64	91	210	359	535

Source: Newman and Kenworthy, 1989; Kenworthy and Newman, 1993; 1994.

Urban remnant vegetation is much valued. Perth is particularly fortunate in having a large amount of native vegetation — Kings Park and Botanic Gardens — in its core area.

cities. Our level of public transport use has stabilised, and remains higher than in the United States, although it is much less than the levels in European and Asian cities, which have grown sharply (see Table 3.29). However, if the pattern of dispersed fringe and coastal development continues, along with extensive freeway development, it may well be that Australia will follow the American pattern of rapidly increasing car dependence.

Constraints on transport fuel depend on global oil availability, which is far more constrained as a resource than electricity. Analysts predict that a global peak in production will occur in the early part of next century (Fleay, 1994). Australia's oil production peaked in 1994–95 and is expected to decline rapidly thereafter (AIP, 1995).

Food

The resource flow to produce food sees nutrients and energy being taken from predominantly non-urban areas for predominantly urban consumers. The remaining nutrient load is rarely returned to the area of production, but is usually discharged into the ocean or local urban environments.

Australia's food production feeds more than just Australians, although the proportion produced for export has fallen from 68 per cent in 1967 to 52 per cent in 1992. During this period, the amount of food produced increased from 214 x 10^9J in 1967 to 440 x 10^9J in 1992. At the same time, Australia's population also rose, by 5.7 million, and per capita food consumption increased by more than 70 per cent (Newman *et al.*, 1994). However, actual calorific intake has remained stable throughout this period (ABS, 1993f). One factor in this surprising equation is the increase in feedlotting; another may be food wastage occurring in the processing of food.

Raw materials and forest products

Generally, Australian settlements are unconstrained by the availability of basic materials like steel, aluminium and bricks. However, our forests provide only 92 per cent of the national demand for wood and wood products. This figure is predicted to decline further unless large-scale plantation-growing occurs (Newman *et al.*, 1994).

Increasing efficiency, more-efficient product design and the use of recycled and alternative low-energy materials are some strategies that may minimise the use of scarce resources while still improving amenity. Few data are presently available to enable the development of indicators of resource input. The most obvious constraint on settlements is the availability of firewood for remote indigenous communities, where many people must now travel more than 50 km to get wood for domestic purposes.

Table 3.30 Open space per head in Melbourne

Melbourne city region	Total open space per head (sq m)
Core	61
Inner	45
Middle	62
Outer	105
Fringe	225

Note: For every new person added to the city, about eight per cent of land lost is turned into public open space.

Source: Kenworthy and Newmann, 1991

Table 3.31 Remnant vegetation of rural areas of Western Australia

	Area of remnant vegetation (ha)	Proportion of total area (%)
Coastal shires	852 721	8
Inland shires	1 328 934	7

Source: WA Ministry for Planning, 1995

Table 3.32 Remnant vegetation in regions of Perth

City Region	Area of remnant vegetation (ha)	Proportion of total area (%)
Core	385	24
Inner	735	5
Middle	2512	9
Outer	258 416	53
Total	**262 048**	**49**

Source: WA Ministry for Planning, 1995

Land

The loss of land to urban development often indicates a loss of productive agricultural land or of important regional bushland. Monitoring the rate at which land is converted to urban use thus provides an important environmental indicator. Between 1961 and 1971, Australian cities consumed 1042 sq m per person for each unit of population increase. The loss increased to 1207 sq m between 1971 and 1981 (Newman *et al*., 1992). This is very high by world standards, reflecting Australian cities' low density. It is not surprising therefore to find substantial loss of biodiversity near large Australian cities. In Sydney only a few per cent of the original forest remains, and about 400 of the 900 native plant species in western Sydney are endangered (Benson and Howell, 1990; Metro Strategy, 1992). Around Brisbane, only 600 ha of the original 6000 ha of rainforest and only 450 ha of the original 13 000 ha of melaleuca woodland remain (ESS, 1988).

In coastal areas, the loss is serious as the land's nearness to the water's edge makes it generally more ecologically sensitive. Apart from the land resources consumed in the fragmented spread of Australian settlement along extensive sections of coastline, nearby development can seriously affect not only foreshore and littoral environments but intertidal and nearby marine coastal waters as well. South-east Queensland, for example, lost 33 per cent of its coastal bushland to development between 1974 and 1989 (Catterall and Kingston, 1993). Around Perth, 70 per cent of the original wetlands have been cleared; and drainage, filling or mining have affected the remainder (GOWA, 1992).

These patterns of coastal development have serious implications for coastal biodiversity. CSIRO estimates, for example, that 60 per cent of Queensland's rare, threatened or endangered plants lie in the urban growth areas of the State's south east (Hamilton and Cocks, 1994). Even so called 'sensitive' development poses risks to the integrity of remaining natural ecosystems, with the potential introduction of feral animals and invasive weeds, possible changes to drainage patterns and soil structure from building and road construction and altered nutrient levels from run-off and septic tanks. Development close to undisturbed areas can create 'edge effects' that, over time, can seriously affect the integrity of natural ecosystems by providing an opportunity for some of these destructive elements.

Retaining land for open space in a city can be important for managing biodiversity as well as providing a valuable source of human amenity. The area of open space per head is best monitored on a regional basis (see Table 3.30). Although small in area, many significant tracts of bush still occur in Australian cities. Table 3.31 shows the amount of remnant vegetation in each region of Perth and the proportion of the total land area.

Perth is particularly fortunate in having a large amount of native vegetation. The core area has 24 per cent, due to Kings Park and Botanic Gardens, which was set aside in the early part of this century as a visionary project to preserve native bush next to the city centre. Perth's inner and middle suburbs have some also and the outer suburbs still have a lot of remnant vegetation.

Most of the shires in the south west of Western Australia have been almost totally cleared for agriculture, and often do not have as high a proportion of remnant vegetation as the metropolitan area (see Table 3.32). This highlights the importance of managing remnant bush in urban areas as well as the critical state of remnants in country ones.

Land contaminated by industry or hazardous waste is a major resource that rarely gets accounted for properly. Programs to bring some of this land back into use — in particular the Better Cities program — have been successful at pioneering techniques in the rehabilitation of contaminated land.

Table 3.33 Suggested indicators for resource inputs to human settlements

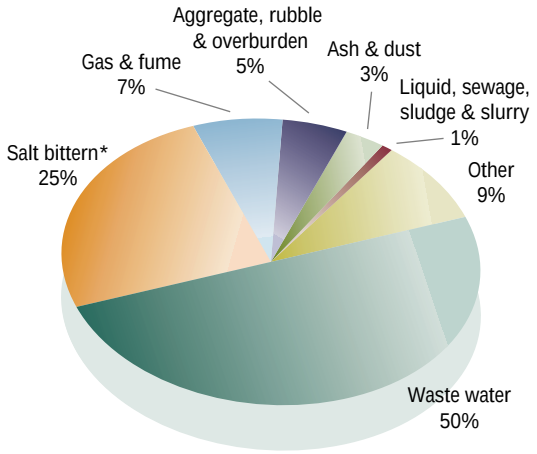
Resource inputs	Environmental indicators for urban, rural and remote settlements
Water	• Per head water consumption - domestic, commercial and industrial • Industrial water consumption per unit of GDP output • Water quality - domestic, recreational and industrial
Energy	• Per head energy consumption • Per head transport fuel consumption • Per head consumption of imported oil • Industrial energy consumption per unit GDP output
Food	• Per head food consumption (Kcals and gms protein)
Raw Materials	• Per head consumption of non-forest building materials (bricks, steel, aluminium)
Forest Products	• Per head consumption of forest products (including firewood) • Per head consumption of imported forest products
Land	• Per head consumption of urban land • Per head availability of open space • % remnant vegetation • Area of contaminated land

Waste outputs and their indicators

Industrial waste

Pollution from industrial waste can be measured either by quantifying and categorising emitted wastes according to type and toxicity, or by measuring the cumulative levels and impacts of discharged waste in air, water and soil. Limited data are available for major industries and particular factories, and from pollution monitoring sites in major centres (ESD Working Group, 1991). Recently, a number of studies have attempted to quantify and categorise waste generated and disposed of by industry. Such studies have relied on records kept by State government environmental protection and waste management authorities, and on surveys of industry. All these studies identified large data gaps, highlighting the need for more detailed record-keeping.

Figure 3.27 Proportion of industrial waste by weight



Note: These are approximations only.
*The quantity of salt bittern (a calcium carbonate, gypsum, potassium and magnesium-salt rich by-product of rock and table salt) recorded by the CSIRO survey came almost entirely from two sources, both salt production plants. These wastes are disposed of to the ocean, and contain potentially valuble products such as potash and magnesium.

Source: Beretka and Whitfield, 1993

Table 3.34 Heavy metal surveys of mussels in Corio Bay, Victoria, 1976–78 and 1987–88

	Amount of heavy metal (µg/g dry weight)	
	1976–78	**1987–88**
Cadmium	17.9	7.8
Chromium	Not available	1.0
Copper	5.8	5.3
Iron	374	267.7
Manganese	12.0	8.9
Nickel	Not available	2.3
Lead	5.9	< 7*
Zinc	219.1	180.5

*Note: Lead samples in 1987–88 were only recorded as 'less than 7 µg/g'

Source: Nicholson, *et al.*, 1992.

Table 3.35 Liquid hazardous wastes in five Australian cities

	Tonnes/year	Rate (kg/person)
Sydney	62 000	18
Melbourne	90 000	30
Brisbane	17 000	14
Adelaide	40 000	40
Perth	26 000	24
TOTAL	235 000	av. 24

Note: Much of New South Wales' process industry now occurs outside the Sydney area.

Source: Samuel, 1989.

Of 1000 Australian companies with 10 or more employees surveyed by CSIRO in 1993, 354 responded. These businesses generated more than 25 000 000 tonnes of waste per year. Waste water accounts for about half of all industrial waste (see Fig. 3.27). Impacts on the environment are being reduced by cleaner production techniques which reduce inputs and outputs from industry.

The Victorian EPA has indicated that discharge conditions for certain heavy metals in Victorian waterways have been tightened in recent years. The gradual decline in the levels of heavy metals in mussel tissue collected from Corio Bay, for example, reflects the effectiveness of these controls (see Table 3.34). It also illustrates how discharges licence conditions can yield valuable information regarding contaminant levels of water discharged by industries.

A number of changes in Australian settlements are affecting waste streams. These include: restructuring; moving of old industries to offshore locations and partly to new rural locations; the start of new value-added manufacturing with associated wastes; and the move to cleaner production, which is reducing waste streams generally.

In a similar way to measuring resource-use efficiency, we can measure the intensity of waste generation in terms of the quantity of waste generated per unit of product manufactured. Such indicators should be developed for state of the environment monitoring of Australian settlements.

Historically, most manufacturing industries have been concentrated in or near urban centres. The recent trend is to relocate these industries to regional and rural centres (Beer *et al.*, 1994), which has numerous implications for their future environmental management. Pressures resulting from these industries may have quite different impacts in regional (often inland) centres from those in metropolitan (coastal) centres. For example, unless best-practice technology is used, trade waste disposed to sewerage systems discharging to inland waters is likely to have a greater impact on the environment than that discharged to ocean outfalls, where greater dilution occurs.

Table 3.36 Hazardous waste generation by sector in Sydney, 1990

Sector	Contribution to Hazardous waste (%)
Manufacturing	76.7
Electricity gas and water	1.9
Construction	0.6
Wholesale & Retail Trade	4.6
Transport and Storage	7.1
Public administration & defence	5.0
Community services	2.8
Other	1.3

Source: EPA NSW, 1993.

There is considerable variability in the level of liquid hazardous waste generated between the State capital cities, reflecting their different levels of industrialisation. Likewise, a number of different types of hazardous wastes occur. In 1986 the Commonwealth Government introduced national guidelines for their classification, but again, accurate centralised records of the quantities of waste generated are not kept. Manufacturing is the greatest source of industrial hazardous wastes in Sydney (see Table 3.36). Those wastes that cannot safely be recycled, or disposed of directly to landfill or via sewerage, require on-site storage and transporting to specialist treatment, disposal or storage facilities.

Solid waste

Municipal solid waste comprises wastes produced by households, commercial and industrial premises, building and demolition operations, and in the provision of services and maintenance of streets, public spaces and utilities.

Australia has a much higher production of municipal solid waste per head than the OECD average — 681 compared with 513 kg per year (AURDR, 1995a), and is second only to the United States in its per capita production of domestic solid waste (see Table 3.37).

A CSIRO study of the flow of construction materials in Melbourne has found that 69 per cent is already being re-used, reprocessed or reduced (broken down) for use in building and non-building activities (for example, road base) (see Fig. 3.28). For total municipal solid wastes, estimates suggest that only between six and seven per cent was being recycled in 1989 (AURDR, 1995a). However, more recent data show some local authorities have achieved a higher recycling rate than this, which indicates considerable potential still exists. Sydney households reduced their weekly solid waste from 21.6 kg in 1993 to 18.6 kg in 1995; and increased their weekly amount of recyclables from 2.8 kg to 3.8 kg (LRRA, 1995). In 1994, large cities recycled 50 per cent of newspaper (up from 44 per cent in 1990). The main potential is garden waste and food scraps which make up 50 per cent of kerbside waste. Many councils see home composting as the preferred option for this material.

Waste in urban, rural and remote areas

Even though there are robust data on solid waste generation and disposal at the regional level, these data have yet to be harmonised for Australia. A common classification system has been agreed but has yet to be implemented. The Industry Commission (1990) estimated that in 1989, the average amount of collected household waste was lower in the State capital cities (336 kg per head per year) than in the rest of Australia (427 kg per head per year). This provides supporting evidence that larger cities have a more efficient metabolism than smaller settlements.

Waste in landfill emits greenhouse gases and leachate that can contaminate groundwater and damage waterways. Methane from landfills is

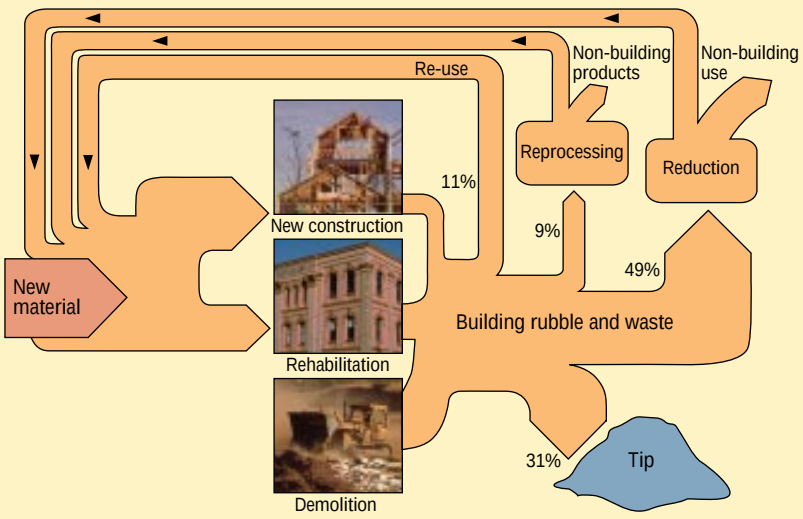
Australian cities have high solid waste generation rates. Although recycling is growing there is much more to do.

Table 3.37 Selected national waste indicators in the late 1980s

Indicator	Aust	Canada	USA	OECD	Aust/OECD ratio
Municipal solid waste (kg/per head/yr)	681	632	864	513	1.327
Industrial waste per unit of GDP (tonnes/$USmillion)	146	155	186	146	1.0

Source: AURDR, 1995a.

Figure 3.28 Construction waste flow from Melbourne central business district



Source: Solomonsson and MacSporan, 1994.

Most coastal settlements discharge sewage without tertiary treatment. The near ocean environment absorbs 10 000 tonnes of phosphorus and 100 000 tonnes of nitrogen per year.

estimated to contribute 5.1 per cent (in carbon dioxide equivalents) of Australia's total greenhouse gas emissions (NGGIC, 1994). Increasing numbers of landfill sites are being used to tap methane for energy.

Remote communities' problems associated with waste differ from those in other settlements (CAT, 1991). In many of them, the costs of landfills and waste-disposal services are prohibitive, and so above-ground dumping or burning are common. Virtually all solid waste comes from domestic sources and the maintenance of structures and living areas. The waste stream consists largely of packaging and other post-consumer waste such as fuel drums, appliances, tyres and vehicles. Often the inadequacy of maintenance services results in 'repairable' appliances and vehicles being disposed of or dumped.

The solid wastes generated by remote communities affect visual and social amenity and, in some instances, human health. The most common method of waste disposal in these communities is trench landfill, but many settlements do not have operational bulldozers to backfill and cover tipped waste.

Table 3.38 Level of sewage treatment and size of settlement

Population size served by sewerage	Proportion of population (%)	Proportion of population receiving particular level of sewage treatment (%)			
		Untreated	Primary	Secondary	Tertiary
5 000–20 000	3.2	1.1	4.0	82.3	12.6
20 000–100 000	10.2	–	8.0	74.5	17.6
100 000–500 000	23.0	–	25.9	62.9	11.2
>500 000	63.6	–	49.2	50.8	–
National average	**–**	**<0.1**	**38.2**	**57.0**	**4.8**

Source: Extrapolated from DPIE, 1991. This study surveyed the method and level of sewage treatment for different sewage treatment facilities across Australia.

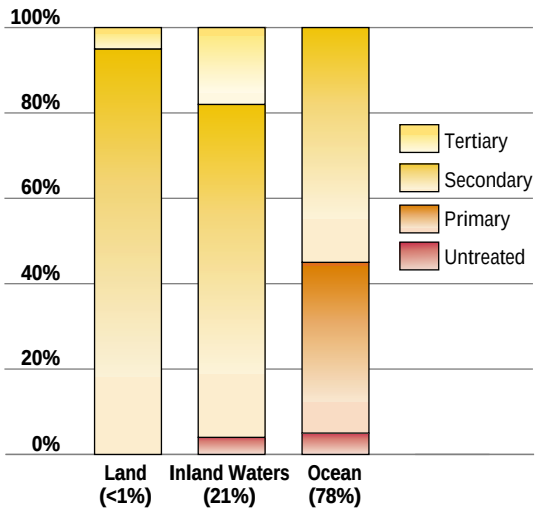
It is uneconomical to pick up re-usable and recyclable items in most such places, so virtually all materials transported into them eventually become waste. This problem presents a challenge to the providers of products as well as those trying to minimise the effects of waste in the communities.

Sewage

Sewerage systems are designed to convey water contaminated by urban activities to places where it can be disposed of without jeopardising human health. Consequently, human settlements can have a marked effect on the environmental quality of aquatic systems both within and beyond settlements. Although large urban centres have the highest proportion of population connected to deep sewerage, this varies from about 75 per cent in Perth to 98 per cent in Sydney. All urban centres in Australia with populations of more than 500 000 people are located on the coastal fringe of the continent and discharge most of their effluent to the ocean or tidal estuaries (DPIE, 1991). They generally provide primary treatment for effluent discharged via long outfalls, and secondary treatment prior to discharge via short outfalls. This means that each year around 10 000 tonnes of phosphorus and 100 000 tonnes of nitrogen are discharged to the near-ocean environment. Public opposition to such outfalls is growing.

Sewage-treatment facilities serving smaller settlements generally achieve higher levels of treatment than those serving larger populations (see Table 3.38). This is due, in part, to difficulties in treating large volumes of sewage, but also to the availability close to large urban centres of the ocean which can disperse large volumes of effluent (see Fig. 3.29). Smaller regional centres and rural towns more frequently dispose of waste to inland waterways or land, where health and pollution considerations demand higher levels of treatment prior to discharge.

Figure 3.29 Level of treatment for different methods of sewage disposal



Source: DPIE, 1991.

Small inland towns contribute significantly to eutrophication of rivers and need to adopt tertiary treatment. This can be a significant constraint on future growth.

Many small coastal settlements (populations less than 5000), discharge untreated sewage into the ocean (see Table 3.38), usually into high-energy waters. The cumulative impact of this on fast-growing coastal areas is of considerable concern (Zann, 1995).

Sewage overflows are a major source of pollution. Sydney is estimated to have between 6000 and 10 000 sewerage overflow points where overflows may occur between 50 and 100 times per year (O'Loughlin *et al.*,1992). Population growth and consequent increased sewerage connections, and/or flooding due to rainfall, can exceed the capacity of facilities and result in the discharge of untreated sewage to waterways.

Major pollutants in sewage

The discharge to sewers of heavy metals and toxic materials by domestic and commercial/industrial premises can damage aquatic and marine environments and reduce the potential for recycling sewage waters and sludges for irrigation and compost.

Government agencies regulate the types and quantities of heavy metals and toxic wastes discharged to sewer by industry to forms and concentrations considered low enough to avoid damage to the environment. Wastes often need to be pre-treated. Most discharges from industrial sewerage consist of wash-waters and non-toxic suspended solids, which are readily treated by sewage-treatment facilities and pose little environmental threat. However, in many (particularly urban) sewerage systems, the cumulative effects of heavy metal and toxic pollutants remain at levels that may reduce the potential for recycling.

Domestic disposal of unwanted household hazardous waste — such as pesticides, paints, solvents, detergents, acids, alkalis and oils — also contributes to this problem (see Table 3.39). Of particular concern is the discharge of old stocks of banned hazardous chemicals such as organochlorides (for example, DDT) and arsenate pesticides. No one knows accurately the scale of this problem, but a typical household is thought to generate between 1.5 and 2.0 kg of hazardous waste per year (Melbourne Water, 1992).

In many cases it is prohibitively expensive to collect, transport and store these wastes. Currently, no waste-minimisation strategies exist to reduce the quantities of hazardous waste that households generate.

Nutrients such as phosphorus, which are introduced into the waste stream via household cleansers and detergents, have a major impact on Australia's coastal and marine ecosystems, as these are adapted to low-nutrient conditions (EPA Vic., 1992).

Table 3.39 Household hazardous waste recovered and destroyed between October 1990 and September 1992 in Melbourne

	Quantities collected (kg)	Destroyed by Sept 1992 (kg)
Arsenical compounds	617	0
Heavy metals	1 567	901
Poisons	1 494	849
Organochlorines	4 773	111
Other pesticides	6 340	0
Oils, paints and solvents	51 886	37 162
Acid and alkalis	3 366	2 914
Other	19 533	16 735
Total	**89 576**	**58 672**

Source: Melbourne Water, 1992.

Stormwater

Human settlements dramatically increase stormwater run-off from land. Streets, roofs and other cleared and sealed surfaces channel surface run-off, increasing the susceptibility to flooding and creating other stormwater-management problems down-stream. Traditionally, drains and other engineering works have been constructed to rapidly drain and dispose of stormwater. This approach exerts pressures on the natural and human environments by causing:

- downstream flooding
- erosion and turbidity
- contaminantion of waterways
- loss of recharge and alteration of groundwater hydrology
- overloading of sewerage systems
- loss of the fresh-water resource

This report deals with the effects of stormwater on the local environment and receiving waterways in detail in Chapter 8.

Stormwater is a major cause of water pollution. Diversion through artificial wetlands creates local amenity and habitat for wildlife.

Most waste-water management systems are designed to cope with peak flows rather than provide accurate flow measurement. Given the pollution potential of waste water (in particular, stormwater), the scale of the problem needs to be accurately determined to enable adequate management. The crisis facing many settlement water supplies has prompted a number of demonstration projects attempting to turn stormwater from a pollution problem into a water resource (DEST, 1992).

Table 3.40 Estimated quantities, percentage composition and proportion of industrial emissions contributing to total air waste in the Sydney airshed, 1990

Air Waste	Industrial emissions (Kilotonnes)	Proportion of all manufacturing emissions of air waste (%)	Contribution of manufacturing to total waste load (%)
Carbon dioxide	32 300.0	99.5	37.0
Volatile organic compounds	81.0	0.3	52.6
Carbon monoxide	65.0	0.2	10.0
Nitrogen oxides	11.0	<0.1	16.7
Sulfur dioxide	12.6	<0.1	76.7
Particulate matter	7.3	<0.1	42.9
TOTAL	32 476.9	100.0	-

Note: There were approximately 10 800 manufacturing establishments in the Sydney area at this time.

Source: derived from EPA NSW, 1993.

Table 3.41 Suggested indicators for resource outputs from human settlements

Waste outputs	Environmental indicators for urban, rural and remote settlements
Solid Waste	• Per head domestic solid waste produced • Proportion of industrial solid waste recycled • Proportion of domestic solid waste recycled • Proportion of landfill gas being tapped for energy • Proportion of domestic hazardous waste collected
Sewage	• Proportion of settlement connected to sewage • Proportion of sewage treated at least to secondary level • Number of days per year beaches or rivers above WHO levels for sewage pathogens
Industrial Waste	• Level of industrial waste recycling • Industrial waste per unit of product • Proportion of industrial waste treated before disposal • Proportion of hazardous waste treated
Stormwater	• Proportion of stormwater recycled (not just discharged) • Proportion of stormwater with solids collected
Air Waste	• Per head and total output of greenhouse gases • Per head and total output of ozone-depleting substances • Per head and total output of volatile organic compounds • Per head and total output of nitrogen oxides • Per head and total output of carbon monoxide • Per head and total output of sulfur dioxide • Per head and total output of lead • Per head and total output of suspended particles
Waste Heat and Noise	• Heat generated per hectare of urban space • Number of people affected by noise above WHO recommended limits

The re-urbanisation of cities can increase the amount of impervious land surface and thus cause increased stormwater problems. Cities are recognising the need to retain if not increase the proportion of porous surfaces as well as establishing water-sensitive design through techniques like stormwater swales, holding basins and treatment areas such as artificial wetlands. The rehabilitation of urban creeks, which in the past have mostly been seen only as drains, is now taking place in our settlements.

Air waste

The main air wastes from Australian settlements are carbon dioxide, carbon monoxide, nitrogen oxides and volatile organic compounds (see Chapter 5). All, except carbon dioxide, are potentially toxic to humans and other living organisms. Motor vehicles are the dominant source of air waste in most Australian cities. In the case of Melbourne in 1990, winter week-day emissions from motor vehicles were responsible for 73 per cent of nitrogen oxide, 70 per cent of carbon monoxide, 40 per cent of volatile organic compounds, 11 per cent of sulfur dioxide and 11 per cent of particulates emitted (Carnovale *et al*., 1991). The energy sector is the largest contributor to greenhouse gas emissions in Australia. Within this sector, motor vehicles contribute 18 per cent, which is close to twice that of industry, making them the single largest end-use source of greenhouse gases. (Electricity generation is by far the highest primary source) (NGGIC, 1994). No one has yet undertaken a full assessment of greenhouse gas emissions resulting from vehicle manufacture and road construction.

Photochemical smog (produced by nitrogen oxides and volatile organic compounds reacting in the presence of sunlight) has become a major problem in cities. It is related to particular climatic conditions (see the box on page 5-25). Although new vehicle technology is helping to reduce levels of smog, projections are that it will increase unless the growth in motor vehicle use is curtailed. The airsheds of Sydney, Melbourne, Brisbane and Perth are showing constraints to any further growth in photochemical smog — principally toxic, tropospheric ozone.

Carbon dioxide emissions from the production and use of energy in Australia are estimated to have increased by nearly eight per cent between 1987–88 and 1990–91. Most of this increase occurred in electricity generation, which is predominantly sourced from coal and accounts for 48 per cent of energy-sector carbon dioxide emissions. Petroleum products account for 34 per cent and natural gas 13 per cent (ABARE, 1993). In 1990, carbon dioxide accounted for 73 per cent, methane 23 per cent, nitrous oxide three per cent and other emissions one per cent of total greenhouse gases (NGGIC, 1994). (Note, the National Greenhouse Gas Inventory (NGGI) does not include chlorofluorocarbons (CFCs) which are strong greenhouse gases. These are better known as substances that deplete beneficial, stratospheric

The airsheds of Sydney, Melbourne and Perth are near capacity for motor vehicle emissions

ozone. They are separately controlled under the Montreal Protocol) (see Chapter 5). Methane emissions associated with coal-mining in particular are estimated to have increased substantially in the three-year period, due to a 22 per cent increase in black coal production (ABARE, 1993).

Australia's high dependence on fossil fuels to generate electricity means that electricity generation is the major source of greenhouse gas emissions. Activities inside urban areas are the chief users of that electricity, although electricity generation occurs mainly outside or on the fringe of major urban areas. Of the greenhouse gas emissions from energy production, about two-thirds are from activities in urban areas. In total, urban areas account for about 40 per cent of Australia's greenhouse gas emissions. Chapter 5 deals with the principles determining greenhouse effects in detail.

For the Sydney airshed, EPA NSW (1993) lists manufacturing industry as an important source of carbon dioxide and the main source of volatile organic compounds and sulfur dioxide. It also contributes significantly to the quantity of suspended particulates in the Sydney airshed (see Table 3.40).

Domestic air waste comes mainly from home heating (wood, gas, oil and briquettes) and incineration of waste. Compared with those of transport, industry and electricity generation, its contribution to global and regional atmospheric waste is minor, although it may result in localised concentrations of particulates and other respiratory irritants. Most large city local authorities in Australia now ban domestic waste incineration in backyards and are moving to regulate solid fuel heating.

Waste heat and noise

The end products of all energy use are dissipated in the form of chemical emissions and in the mechanical processes of waste heat and noise. Some industrial processes and all power plants produce waste heat that is generally cooled in nearby water bodies and often affects aquatic systems.

Waste heat from all energy-using processes in a city can cause the 'urban heat island effect' which traps air waste like a dome over a city. The most obvious way to alleviate this is by minimising energy inputs, although it is also possible to reduce waste heat by using it for co-generation of electricity and by using heat pumps.

Noise is becoming an increasingly important issue in the management of Australian settlements. The many sources of civic noise disturbance include aircraft, road and rail traffic, industry, entertainment venues, intruder alarms, domestic animals and, of course, human social behaviour itself. A recent report (AURDR, 1995a) describes the undesirable effects of noise:

- amenity effects — sleep interference, annoyance
- health effects — hearing impairment, tension, headaches and fatigue may contribute to cardiovascular and digestive system ailments
- communication effects — interference with business and social communication, reduction in enjoyment of activities

A number of Australian studies point to the size of the problem, as the following examples show.

- In a national survey, 40 per cent of respondents claimed that noise interfered with listening or sleep, with traffic noise being the main source (Hede *et al.*, 1986).
- More than nine per cent of Australians are subject to 'excessively high' levels (>68dB(A)) of noise, with 39 per cent subject to 'undesirable' levels (>58dB(A)) (Brown, 1993).
- Of people exposed to environmental noise in New South Wales, 73 per cent were affected by road traffic, 17 per cent were affected by aircraft, six per cent were affected by rail and four per cent were affected by industry (EPA NSW, 1993).

Noise can be a political issue, as the conflict over the third runway at Sydney Airport demonstrates.

Table 3.42 Summary

Element of the environment/Issue	State	Adequate Info.	Response	Effectiveness of response
Big Cities Rapid growth and sprawl of suburbs.	Sprawl continuing but there is an increasing trend towards re-urbanisation.	✓✓✓	Urban consolidation programs, 'Better Cities', user pays on new infrastructure, PM's Urban Design Task Force.	Too early to assess. Models for re urbanisation not yet mainstream.
Dominance of car-based planning in new suburbs.	Airshed limitation and urban runoff difficulties in all big cities, together with growing congestion and noise from transport.	✓✓	'Better Cities' and PM's Urban Design Task Force.	Good demonstrations, good policy options outlined, but little integration to transport providers and planners in mainstream. No national approach to public transport.
Improving livability in an equitable way.	Comparatively high levels of livability. Poverty tends to be local and may be increasing and moving further outwards.	✓✓✓	Innovation programs, transfer payments and the social wage for broad equity goals; employment schemes and local government development program for local variations.	Generally effective but globalisation of the economy is causing increased differences in livability (pockets of poverty) which are not yet targeted.
Reducing resource inputs.	High consumption of energy, water and land with much lower levels in older inner suburbs. No data on building materials.	✓	Energy Management Program, Energy Card, ethanol subsidy, fleet fuel efficiency goals, water demand management and appliance efficiency.	Building energy and vehicle energy programs not mandatory and not effective yet. Water efficiency programs beginning. Energy, water and land use planning not sufficiently integrated. No building material programs.
Reducing waste outputs.	Comparatively high levels of waste.	✓	'Cleaner production', ISO 14000, Motor Vehicle Emissions Program, Greenhouse 21C, strategies on water quality, waste minimisation and recycling, pollution inventory.	Cleaner production occurring, vehicle emissions improving but insufficient in itself without travel demand management, Greenhouse 21C strategy just beginning, strategies on waste are presently voluntary and not universally applied.
Coastal Areas Rapid growth exceeding provision of services.	Insufficient social, economic and environmental services.	✓✓	Coastal development studies, coastal management program and State of Marine Environment Report.	A few demonstrations of integrated planning but mostly little change yet.
Unsustainable land use planning.	Degrading coastal environment, loss of biodiversity and social amenity.	✓	Regional development plans and organisations, local government development program, coastal planning.	Unsustainable patterns are still accelerating.
Livability and metabolism issues.	Reduced livability (especially high unemployment and benefit holders) and worse metabolism in comparison to cities.	✓	Regional development plans and organisations, local government development program.	Unsustainable patterns are still accelerating.
Small inland towns Declining population (and economic viability) associated with major regional environmental problems.	Reduced capacity for environmental rehabilitation.	✓✓✓	Regional development plans and organisation, local government development program, landcare programs and employment programs.	Effectiveness of programs diminished by economic decline.
Livability and metabolism issues.	Reduced livability and higher metabolic flows than in cities due to lower scale efficiencies, services and markets.	✓✓	Regional development plans and organisation, local government development program, landcare programs and employment programs.	Effectiveness of programs diminished by economic decline.
Remote settlements Fly-in/fly-out for mining towns (and pastoral areas).	Population decline and lack of service provision in remote areas by mining companies limits human impacts but minimises settlement development.	✓	Encouragement from government.	Growing ecotourism pressures may require greater need for government services in remote settlements.
Rapid increase in indigenous communities and outstations raises land management issues.	Indigenous claims on land increasingly being recognised and necessity for joint management of adjacent public land.	✓	Native title legislation and proposed social justice package; regional agreements and joint ventures.	Just beginning-Examples of successful joint management exist.
Livability and metabolism issues.	Low livability in all remote settlements especially in indigenous communities with severe health problems. Some related metabolism problems exist, eg, firewood shortage, and lack of water/waste systems.	✓✓✓	National policies on health, housing and education target indigenous needs with special measures.	Long term effectiveness depends on continuity of special measures.

Response

Improving sustainability in Australian settlements implies reducing resource inputs and waste outputs while improving livability (see Fig. 3.2). Such change occurs as a result of education, regulation, innovation in socio-technical systems and the use of appropriate economic incentives. This section examines existing and potential responses.

The most positive changes in attitude from the point of view of future movement towards a sustainable pattern of Australian human settlements, are:

- the widespread acknowledgment among Commonwealth, State and local government bodies of the importance of ESD goals for settlements
- the recognition in government and private sector reports that Australian communities need to implement major reforms in the design, location and resource flow aspects of their settlements
- acceptance at all levels — from international agreements through to industry and community perspectives — that developmental and environmental goals need not necessarily conflict
- a tentative but growing appreciation by industry in general that they need to include environmental accounting in their corporate and business plans, recognising both market forces and social responsibilities
- the high degree of positive support in Australian settlements for environmental goals, as measured by public opinion polls and by the evidence of people's participation in environmental issues (see Chapter 10)

Despite this, the state of Australia's human settlements falls well short of the environmental goals described for them and of our international commitments. Increasing per capita use of resources, increasing population numbers and patchy implementation of the economic, legislative, social and technological innovations necessary to ameliorate the environmental impact of the settlements all contribute to this state.

Program and policy responses and their effectiveness

Table 3.42 summarises a number of current programs and policy responses, along with some comments on their effectiveness. The focus is on the Commonwealth Government and its initiatives, but in most cases other levels of government, industry and the community jointly share the responsibility. Much is happening and much is still required. The programs are a mixture of positive, inadequate and uncertain responses.

Positive programs

Three positive programs appear to be the most significant:

- 'Better Cities' is a $1000 million program that is demonstrating integrated solutions to Australian settlements by re-urbanising old industrial sites, focusing suburbanisation in new subcentres and revitalising regional centres. It involves innovative transit, new water management, toxic land remediation and improved community-oriented design.
- Australian urban and regional development review — a three-year project — provides a comprehensive opportunity for Australian settlements to be reassessed and prepared for the next century.
- Cleaner production — a major initiative of the Commonwealth EPA — provides a best-practice clearing house and demonstrations in 10 top companies on how to reduce metabolic flows and create more wealth.

The planned Homebush Olympic Village is designed to reduce metabolic flows, and have high human livability.

Inadequate programs

In three other areas, this chapter suggests the level of response is not effective.

- Coastal development requires comprehensive, integrated strategies for preventing the excesses of recent developments. Authorities have not yet implemented recommended strategies (RAC, 1993; Zann,1995).
- Fuel efficiency regulations lag behind other countries. Australia's inability to keep up with fuel efficiency trends overseas is due to a desire not to lose the local motor vehicle manufacturing industry with its medium- to heavy-vehicle niche. If we do not impose stricter regulations on new vehicles, then gains can only come from stronger regulations on older vehicles plus more effort to reduce the need for travel or to use other transport modes.
- Public transport and integrated planning are inadequate. The critical role of transport in shaping settlements has been highlighted. A greater role for the Commonwealth in public transport (particularly in demonstrating new technologies such as light rail and demand-

responsive systems) has been suggested (AURDR, 1994). We also need integrated planning of settlements. Most of these initiatives have come through 'Better Cities' and are not yet part of the Commonwealth approach to transport funding which remains single-purpose road funding.

Uncertain programs

Many other programs have uncertain potential to improve settlements' livability while reducing their metabolic flows. Three examples are listed here.

- According to the Hilmer report (ICICPA, 1993) lower prices for electricity, gas and water are likely, if its recommendations are implemented. However, this will probably lead to increased consumption of these resources, unless full cost accounting is used in pricing, and/or measures are taken on more efficient and innovative delivery of end-use services. Transport (road funding) is yet to be treated under this framework.
- Many national strategies have been developed, such as waste minimisation and recycling, water quality, transport planning, ESD, biodiversity, greenhouse, landcare, tourism, rangeland management, housing and energy management. Virtually all are based on educational and voluntary processes. Such programs would be more effective if supported by regulation and economic incentives. Such measures can be used to achieve both environmental and livability goals. The new hypothecated tax on airport noise remediation shows that there is popular support for measures that can demonstrate improvements in both environmental and livability indicators.
- The Prime Minister's Urban Design Task Force (1994) picks up many of the themes discussed here. It is as yet uncertain how governments will deal with these issues.

Two questions are critical to all these responses in Australian settlements: where geographically should governments be focusing their attention? And, how can infrastructure help to ensure these different settlement types (and areas within them) become more sustainable?

Development constraints and opportunities

Large settlements have more efficient metabolic flows than small ones because of better infrastructure and services made possible by.economies of scale, as well as the wealth and expertise of big cities. They also have higher standards of living. Thus there is a net increase in metabolic flows and loss of livability if people move from big cities to small towns.

This, however, should be balanced against some of the real constraints on large Australian cities since in some areas they can reach capacity constraints before small settlements. An example is Sydney's scale problems associated with photochemical smog, sewerage and waste water. The effect of the latter on the Hawkesbury–Nepean catchment is illustrated in the box on page 3-50.

A city like Sydney has substantial problems coping with any extra growth, and so, if it is to grow in a sustainable way, planners need to carefully assess these capacity constraints. However, the recent dispersal of Sydney's growth to other parts of Australia may lead to an overall loss in ESD benefits. Indeed, some areas — particularly the new coastal developments — suffer obvious deprivations.

Large cities have relatively low metabolic flows in their compact areas, where land use is more efficient and less car-dependent. Levels of livability appear to vary little between these areas and dispersed ones, although this is less certain in regard to social amenity issues than to health. Livability varies far more between particular privileged and underprivileged parts of the city, within both compact and dispersed areas. Targeting these 'pockets of poverty' for development would be justified on both equity and ESD grounds.

Both suburbanisation and re-urbanisation can occur in ways that help to minimise metabolic flows and improve livability. Where the emphasis has been on the development of nodal/information subcentres with compact, mixed-use activities, then such centres have improved the local economy. They have also created a less resource-intensive urban form. The redevelopment of Fremantle provides an example of re-urbanisation with sensitivity to the city's heritage qualities. The subcentre is also a growing local economy and has one-third of the transport fuel use of new subcentres (Campbell and Newman, 1989). Similar nodal developments can occur throughout our cities.

Dispersed coastal development in Australia appears to involve high metabolic flows with more obvious environmental damage due to the sensitivity of the area and the speed of growth outstripping the capacity of poor infrastructure and services. The standards of livability of the coastal areas also appear to be reduced. However, individuals trade off this reduced livability (fewer services and opportunities) for the cheaper land and personal environmental amenity — which in turn is threatened by the scale of the development process. Restricting dispersed development along Australia's coast has been highlighted as a priority in many Commonwealth and State reports.

Inland settlements are mostly declining, unless they are tourist centres or have absorbed the functions of surrounding smaller towns. Many are caught in the spiral of declining investment, and often have inadequate technologies for water and waste management. Strategies for improving the local economy as well as the environment are therefore closely linked.

One important option for inland towns within a 100-km radius or so of a large city is to link them to the city by fast rail. This has been attempted in Melbourne, with links to Ballarat. If a journey to the city takes less than one hour, the town becomes

a viable centre to help absorb growth that exceeds the city's capacities. It is not certain whether this 'exurbanisation' strategy leads to net environmental gains. State of the environment reporting could assist with this evaluation.

Remote indigenous communities have low metabolic flows but suffer significant livability problems. Some are exceeding their settlements' capacity to supply, for example, firewood and basic sanitation. These problems are due to a complex range of social and economic factors, including the rapid growth of the settlements since the 'return to country' movement began, frequently allied with indigenous peoples' lack of any real title to the land. The result has been a lack of basic infrastructure.

Sustainable infrastructure plans and indicators

Provision of infrastructure and services helps shape the pattern of settlements — both the internal structure of the city and the extent and type of regional development. Governments are responsible for regulating infrastructure and services and often provide much of the funding.

The Commonwealth Government has announced that it will require sustainable infrastructure plans on all new development requiring an input of Commonwealth funds. Such plans may become standard practice in urban development. The National Housing Strategy Background Paper 15 provides a checklist for achieving ESD goals in urban development (Newman *et al*., 1992).

State of environment reporting can inform the application of sustainable infrastructure plans. Some suggestions follow.

Large growing cities

Most new investment in infrastructure and services takes place in the large cities. As described earlier, three simultaneous processes seem to be occurring: re-urbanisation, suburbanisation and exurbanisation. There is much discussion in Australia on the merits of these processes and how they relate to the environment. State of the environment indicators can inform sustainable infrastructure plans which provide a way of enhancing the processes in a more sustainable way.

Re-urbanisation

Re-urbanisation can improve the settlement environment and amenity by using under-utilised urban infrastructure and providing more people with a low-energy, low-water-use lifestyle. However, it can also mean development that overstretches infrastructure and can be insensitive in design and impact on the local community.

The Commonwealth Government program 'Better Cities' is designed to demonstrate how the re-urbanisation process can produce more efficient, socially just and ecologically sustainable urban development. Australian cities are moving rapidly towards a post-industrial form based on the processing of information and provision of services. Government demonstration projects outlined in Better Cities are designed to assist in this transition. Many demonstrations are dense housing developments on abandoned industrial land in inner areas, and most are designed to bring more people to use the many existing services of these areas. Analysis of one such project in East Perth, for example, showed some $121 million in savings on infrastructure and transport in just 1000 dwellings and 100 workplaces, as well as considerable savings in fuel and greenhouse gases (Kenworthy and Newman, 1992).

The new 'Sprinter' trains connect Ballarat to Melbourne enabling the city to be reached in less than one and a half hours.

State of the environment reporting can be used to monitor such demonstrations. Where benefits are revealed, this can provide the basis to redirect public subsidies to developments of this type.

Suburbanisation

This will probably remain as the dominant urban development process over the next 20 years unless significant disruptions (such as a world oil crisis) occur. The 'Better Cities' development of integrated urban villages around the extended Gold Coast railway is designed to show how suburbanisation can become more sustainable. State of the environment reporting might encourage more developments of this type: for example, to prevent development in sensitive areas; to ensure adequate densities are integrated to the infrastructure; to provide more water-sensitive design; and to facilitate development of the nodal/information city with the development of subcentres.

Exurbanisation

This chapter has highlighted the unsustainability of development occurring on the urban fringe and along the coast of non-metropolitan areas. The strategy outlined above — of providing inland country towns within 100 km or so of major capital cities with a fast rail service — may do little

but feed the continued growth of dispersed land uses that cause much larger metabolic flows and reduced livability due to inadequate planning and services. However, a rail service can lead to land development that is more compact and integrated to good infrastructure and services, particularly environmental technology. State of the environment reporting can help assess whether these types of developments lead to a more sustainable use of infrastructure.

Transport/information infrastructure planning

Most governments recognise the critical role that transport infrastructure plays in shaping the city. However, the emphasis has been on providing high-capacity roads to fringe and coastal areas — a major and continuing force behind the development of these areas. That kind of infrastructure planning needs to be monitored, perhaps using state of the environment indicators.

As part of its Greenhouse 21C statement, the Commonwealth Government committed itself to requiring transport impact statements for commercial, industrial and residential type infrastructure projects with Commonwealth funding. This will ensure transport and land use planning are fully coordinated in relevant projects by assessing all options and impacts at the planning stage. Thus, planning can be guided by state of the environment indicators such as those developed here.

A more significant role for the Commonwealth in new public transport infrastructure in Australian cities has been suggested (AURDR, 1994) for two reasons.

Firstly, public transport is critical in the shaping of urban form. Urban designers like those on the Prime Minister's task force are calling for a more transit-oriented form. Road-based development has led not to compact subcentres but to the kind of dispersed land use that is now under question.

Secondly, disadvantaged areas in particular need new public transport infrastructure. The new 'pockets of poverty' in Australian cities are sometimes well away from the traditional good transit services like rail lines. Such areas are very poorly provided with public transport and yet residents are often without cars (Social Justice Research Program into Locational Disadvantage, 1994).

Despite this growing awareness at the Commonwealth level, a major program of expansion is occurring in Australian cities, mostly by the States, in the provision of new high-capacity roads rather than new public transport. It ignores the already-heavy car dependence shown in this report. The consequent investment of many billions of dollars of public money has not been evaluated in terms of environmental indicators. For example, it will be extremely difficult to explain how such investment can meet international commitments on reducing greenhouse gas emissions or most of the other indicators suggested in this report.

Although most governments are aware of the effect of transport infrastructure on cities, the same cannot be said about information infrastructure. The need for Australian cities to fully participate in the global information system (for economic, social and environmental reasons) points to the need for information superhighway infrastructure and training in its use. This can be part of the solution to the 'pockets of poverty'. Environmental indicators can help monitor the ecological sustainability of new transport and information infrastructure.

Affordable housing

This report has highlighted the growing poverty of some pockets of Australian cities. It has found strong ESD and economic arguments as well as social justice reasons, for focusing development in these areas. Critical to that revitalisation is the provision of diverse and affordable housing near to shops and services such as good public transport infrastructure. 'Better Cities' has demonstrated that it can be done with housing that is compact, integrated with urban services and without the stigma of 1960s public housing.

Rouse Hill development area — integrated water management

The Hawkesbury–Nepean River is Sydney's major river system. Because of its mixture of agricultural, urban and recreational uses, it has come under pressure from increases in nutrient flow, turbidity, pollutants and algal growth. Water quality in much of the Hawkesbury–Nepean exceeds New South Wales EPA goals for nutrients, algal growth, suspended solids and faecal coliforms. At present, the rivers receive treated sewage effluent from about 10 per cent of Sydney's population — a pressure that is likely to grow with the Hawkesbury–Nepean catchment being the focus for much of Sydney's urban development over the next 10 to 15 years.

One place earmarked for future urban development is the Rouse Hill area, which is planned ultimately to accommodate about 235 000 people. To avoid further stressing the Hawkesbury–Nepean system, the Sydney Water Corporation has developed an integrated water management strategy that seeks to combat urban development 'side effects' caused by stormwater run-off, sewage effluent and untreated waste water.

The strategy aims to minimise impacts on the Hawkesbury–Nepean through:

- integrated management of water supply, waste water and drainage
- management of run-off via constructed wetlands, litter and silt traps, detention basins and grassed stormwater floodways
- tertiary sewage treatment, including nutrient stripping and disinfection
- recycling of tertiary-treated water for gardens and toilets
- mandatory installation of water-efficient appliances

The Rouse Hill strategy is a move towards a more sustainable infrastructure plan for water management but there is little to suggest a more sustainable transport infrastructure.

Social and economic infrastructure

Alleviating poverty has been shown in this report to be an integral part of providing sustainable settlements with good human and physical environments. Thus, state of the environment reporting appropriately monitors the impact of education, community services and employment programs aimed at reducing the fundamental problem of structural unemployment, as well as physical infrastructure. These social infrastructure items can also be part of sustainable infrastructure plans.

Provincial towns

While many older industries have been phased out of the big cities, a simultaneous move of process industries to smaller provincial towns has been occurring (Beer, *et al*., 1994). These moves are receiving increasing help from governments in terms of financial incentives and regulatory procedures. The process enables many industries to improve their technology as well as reducing their land and operating costs, although it could also be a way that unsustainable industries receive subsidies and reduce environmental assessment.

State of the environment reporting can help monitor the ecological sustainability of industrial processing in regional towns.

Coastal areas

This chapter has drawn attention to the rapid growth pressures being experienced by coastal areas. The data suggest that a large part of this growth is not sustainable economically or environmentally. Managing further coastal development is not as easy as drawing new lines on maps. We need to understand the processes driving it.

In Sydney, the expansion of the urban area through suburbanisation is now limited by the land that is available. New suburbs, like Rouse Hill, are constrained to carry out expensive environmental mitigation (see the box opposite), which pushes up the price of housing in standard subdivisions to levels beyond the reach of average families — creating an extra pressure to re-urbanise. Global economic pressures are encouraging high-income groups to locate in core and inner areas. If re-urbanisation does not proceed quickly enough to provide for that housing demand, then the price of houses and land in core and inner areas will also grow well beyond the reach of average families. This pincer movement in suburbanising and re-urbanising areas means that many families are fleeing the high prices of Sydney.

The preferred location for such families appears to be in small towns along the coast in New South Wales and Queensland, thus fanning the major environmental concerns outlined above. Not only are the metabolic resource flows high, but the coastal land being subdivided and the associated water areas are some of the most ecologically sensitive in Australia. The need to reduce this pressure on the coast raises obvious responses, which include reduced population growth, greater re-urbanisation, stronger planning controls and investment in better infrastructure and services to mitigate the direct ecological problems.

Demonstration model of a remote area community ablution block with low-water-use toilet, wood and solar water heating, shower, hand-pumped washing machine and photovoltaics for electricity, if required.

Each State (coordinated at the Commonwealth level) can scrutinise coastal areas more closely by monitoring sustainable infrastructure plans. Such monitoring can help determine where further coastal developments result in net economic and environmental gains.

Declining rural areas

The economic processes that have led to the decline of rural industries are well documented. Governments have provided financial assistance in many forms, but the economic forces are not likely to change. So, continuing decline is likely in many of those areas based on traditional products unless industries diversify. The Commonwealth Government has an active regional development program designed to halt rural decline.

Unfortunately, a vicious circle is operating here, in that the smaller the population becomes, the greater the need for cross-subsidies by governments to provide postal, education and transport services. The winding down of these services has cut into the range of job opportunities essential to the maintenance of the small town communities that once flourished in declining rural areas (Holmes, 1994).

New infrastructure is often seen as out of the question for such declining towns but, as with the urban 'pockets of poverty', it will be important not to neglect such areas for environmental as well as social and economic reasons.

Maintaining and expanding regional infrastructure and services is an essential part of reversing further rural decline. To help areas diversify economically, governments can use state of the environment reporting and sustainable infrastructure plans to guide regional economic development.

Remote areas

All remote settlements have heavy subsidies for infrastructure and services. The special allocations for establishing indigenous communities as they 'return to country' is part of a long tradition of assisting remote areas. Previous subsidies to remote areas for other development were given for a range of social and political reasons such as defence and long-term economic development goals.

The increasing costs to governments and the private sector of providing infrastructure and services is the main reason why mining settlements are increasingly fly-in/fly-out.

This report has highlighted the plight of many indigenous communities. It has shown that their levels of social amenity and health are well below those regarded as normal by the rest of Australia. If government reduces the investment in infrastructure in remote areas, conditions are unlikely to improve, rather they will probably deteriorate further. At the same time, the need for development of a greater economic base for remote indigenous communities is also apparent. We need to encourage the participation of these communities in remote-area growth industries such as mining, tourism, land management, farming of native species and the application of innovative technologies. State of the environment reporting can be used to monitor environmental flows and livability, including basic health standards, in these communities.

Settlement capacity

Ehrlich's formula for assessing carrying capacity is based on population, per capita consumption (lifestyle) and technology (efficiency) (Ehrlich *et al.*, 1977). Human settlements need to fit within a global and local ecological carrying capacity as they seek to manage their metabolic flows of resources and wastes. Global capacity is increasingly being defined by United Nations conventions for wastes like greenhouse gases or hazardous wastes, as well as by the global marketplace for resources like oil or timber. Local carrying capacity refers to resources like water or land and wastes like sewage, stormwater or photochemical smog.

Capacity for each settlement needs to be assessed. For many global resources and wastes, national and international policies that constrain the ability of settlements to expand in their usage will be increasingly significant — for example, the United Nations Framework Convention on Climate Change which Australia ratified in 1992. For local resources, the state of the environment reporting process can help settlements to monitor indicators and institute policies for living within constraints.

The policy responses outlined above tend to be those dealing directly with government agencies that manage resources such as land, water, waste and transport. But many other arenas can also significantly affect settlements. These include:

- population growth
- lifestyle choices that affect per capita consumption and are influenced by media, education and other forces
- the extent to which Australia can develop technological innovation that is both more sustainable and appropriate for our settlements

This report has highlighted capacity problems for each Australian settlement type. State of the environment indicators can help provide the necessary data to evaluate these capacity issues.

- Large cities — airshed capacities for photochemical smog, watershed capacities for stormwater and treated sewage as well as land development and water extraction impacts.
- Coastal areas — capacities to absorb land development on the sensitive border between land and water and also those of near-shore estuarine and marine environments to absorb waste.
- Smaller inland towns — watershed capacities and the effects on limited inland river flow.
- Indigenous communities — capacities for firewood, water and sewage and the basic infrastructure that can enable livability to improve.

Conclusion

The Commonwealth Government (in many cases in cooperation with the other spheres of government) has established a large number of initiatives covering many important environmental issues in human settlements. These have made progress in some areas. However, Australian settlements continue to grow in their metabolic flows and while livability is generally high, it is not shared equally. Potential ghettos are emerging in the big cities, although nothing like those in the United States. New coastal settlements appear to be growing at an unsustainable rate. Some inland towns, by contrast, are in sharp decline. Indigenous settlements clearly have the severest livability inequities.

This response section has gathered suggestions on how Australian settlements can reduce their metabolic flows while improving their livability. A significant portion of these initiatives require a holistic approach, and therefore a wide range of government agencies and other organisations need to adapt or consider their principles and implications. This will particularly apply to state of the environment reporting for human settlements as it crosses so many different areas of responsibility. Nationwide state of the environment approaches and guidelines, and more cooperative processes between the different levels of government, will be necessary to remove some of the impediments to addressing environmental issues in Australian settlements.

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