13 Environment

Introduction

This chapter presents information about Australia's environment and its interaction with society and the economy. Due to the complex nature of the topic and the vast amount of available information, not all aspects are covered here. As many other issues were discussed in previous Year Books, this year's chapter focuses on key areas of contemporary interest not addressed in previous Year Books, such as greenhouse gas issues, air quality and climate change, pollution abatement, environmental research and development, and environmental education and training. Also included are previously covered topics for which new information is now available, such as environmental indicators.

Environmental indicators

In 1992 the Organisation of Economic Cooperation and Development (OECD) established an Environmental Performance Review Program in order to evaluate the

13.1 OECD ENVIRONMENTAL INDICATORS

Indicator	Unit	Australia	Canada	USA	Netherlands	Sweden	UK	OECD
Carbon Dioxide (CO_2) emissions from energy use								
1991	Mill. t	283	435	5 035	193	56	608	10 439
CO_2 emissions from energy per capita	tonnes	16	16	20	12.5	6.5	10.5	12
Major protected areas 1990	'000 km^2	457	701	983	4	18	46	2 481.7
Protected areas (% of land area)	%	5.9	7.0	10.5	9.5	3.9	18.9	7.7
Scientific Reserves and National Parks	'000 km^2	296.0	268.0	204.0	0.1	6.0	n.a.	885.4
Wooded area								
1990	'000 km^2	1 060	4 533	2 946	3	280	24	10 311
1990 (% of land area)	%	13.8	49.2	32.1	9.9	68.1	10	33.2
Threatened species in species known, early 1990								
Mammals	%	12.3	6.2	10.5	28.8	19	45.2	n.a.
Birds	%	3.4	3.3	7.2	22.4	7.9	28.3	n.a.
Fish	%	0.4	4.4	2.4	79.4	4.0	12.2	n.a.
Reptiles	%	2.9	48.8	7.1	100	—	33.3	n.a.
Amphibians	%	5.0	21.4	3.6	62.5	46.2	33.3	n.a.
Vascular plants	%	4.7	1.4	0.5	7.6	8.2	9.5	n.a.
Hazardous waste								
Production 1990	'000 t	316	6 080	180 000	1 040	500	2 940	237 388
Per unit of GDP	kg/$US '000	1.1	11.4	31.6	4.3	3.8	3.3	15.8
Energy intensity — tonnes of oil equivalent (TOE) 1991								
per $US '000	tonnes	0.32	0.4	0.34	0.28	0.34	0.24	0.27
per capita	tonnes	5.2	7.8	7.7	4.6	5.7	3.8	4.8
Motor vehicles in use								
1981	million	7.3	13.2	155.8	4.8	3.1	17.3	336.1
1991	million	10	16.8	192.3	6.2	4	23.3	455.1
Car ownership								
1980	veh/100 persons	39	43	53	32	35	26	34
1991	veh/100 persons	45	48	58	37	43	34	42
Population								
1992	million	17.5	27.4	255	15.2	8.7	57.8	866.3
Population density								
1992	persons/km^2	2.3	2.8	27.2	406.6	19.3	236.2	26.9
GDP at 1985 prices and purchasing power parities (index 1980 = 100)								
1985	—	117	115	113	105	109	110	112
1992	—	140	132	132	125	118	126	135

Source: OECD Environmental Indicators 1995.

performance of member countries in implementing their domestic environmental policies and international commitments. Australia is due to be assessed by the OECD in 1997.

The OECD has developed a core set of indicators to be used in environmental performance reviews of member countries. There are three broad categories of indicator, based on the Pressure-State-Response framework: indicators of environmental pressure, which describe pressures from human activities exerted on the environment; indicators of environmental conditions, which describe the quality of the environment, and the quantity and quality of natural resources; and indicators of societal responses, which show the extent to which society is responding to environmental changes and concerns. Table 13.1 presents statistical information on indicators of environmental pressure prepared by the OECD, and shows a comparison of Australia with selected OECD countries and all OECD countries combined.

Compared to the other countries included in table 13.1, Australia is favourably placed in many aspects, including total area in scientific reserves and national parks, proportion of species threatened, hazardous waste generation, and population density. However, its per capita emission of carbon dioxide from energy use are higher than in many OECD countries.

National activities

Greenhouse response

One of the outcomes of the world environment conference in Rio de Janeiro in June 1992 was the establishment of the United Nations Framework Convention on Climate Change, which was a direct global response to the problem of climate change due to the enhanced greenhouse effect. Since the greenhouse effect is largely a consequence of human activities, it is expected that developed countries, whose past economic activities have been major contributors to greenhouse gases, will play a leading role in adopting greenhouse gas reduction measures. Australia is both a signatory to the convention, and a major player in developing response strategies and obligations for the 120 member countries. Since 1992 Australia has embarked on a number of greenhouse gas initiatives designed to meet its national policy objectives and international obligations. These initiatives include the *National Greenhouse Response Strategy* released in December 1992, *Greenhouse 21C, a plan of action for a sustainable future* released in March 1995, and *Greenhouse Challenge* which was launched in October 1995.

National Greenhouse Response Strategy

Measures to control greenhouse gas emissions are an integral component of Australia's National Strategy for Ecologically Sustainable Development. The *National Greenhouse Response Strategy (NGHRS)* was launched and signed by the Commonwealth Government and the State and Territory Governments, and approved by the Australian Local Government Association in 1992. The target is first to stabilise greenhouse gas emissions based on 1988 levels by the year 2000, then to reduce these emissions by 20% by the year 2005. The proviso to meeting this target is that Australia will not implement response measures that would have adverse impacts nationally, or on Australia's trade competitiveness, in the absence of similar action by major greenhouse producing countries.

The primary goal of the NGHRS is '...to contribute towards effective global action to limit greenhouse gas emissions and enhance greenhouse gas sinks to improve knowledge and understanding of the enhanced greenhouse effect; and to prepare for potential impacts of climate change in Australia.' The key elements of the strategy include

- a set of sectoral objectives and strategies guiding response measures;
- a phased plan of action for limiting greenhouse gas emissions, enhancing and conserving greenhouse gas sinks, and preparing for potential impacts of climate change;
- research and analysis to improve knowledge and understanding of the enhanced greenhouse gas effect;
- mechanisms for community involvement in the implementation and further development of the strategy;
- assignment of priorities to the response measures;
- a monitoring system for the programs;
- periodic review and continued development of the strategy.

As part of its commitment to limit greenhouse gas emissions, the Commonwealth Government is initiating a review of its national strategies and performance, which is expected to be completed in 1997. Among the areas targeted for special consideration are vegetation clearance controls, revegetation and farm forestry, changing agricultural patterns, forestry and reafforestation, as well as a review of the energy and transport sectors.

Greenhouse 21C

In March 1995 the Commonwealth Government announced *Greenhouse 21C*, an additional package of measures, including a $63m funding package, to its National Greenhouse Response Strategy. Greenhouse 21C aims to promote:

- cooperative agreement between government and industry for reductions in net greenhouse gas emissions;
- renewable energy initiatives, including research and development in renewable energy technology;
- economic reform in the energy sector (especially in the gas industry), and increased energy efficiency;
- a greenhouse information network;
- tree-planting programs to provide greenhouse sinks;
- environmental best practice in Commonwealth Government operations.

It has been projected that Greenhouse 21C will reduce growth in greenhouse gas emissions to about 3% above the stabilisation target level by the year 2000.

Greenhouse Challenge

In October 1995 the Commonwealth Government launched the *Greenhouse Challenge*, a program of cooperative agreement with industry to mitigate Australia's greenhouse gas emissions through cost effective industry initiatives such as improved energy and process efficiency, and by enhancing greenhouse gas sinks. A total of $9.7m has been allocated over four years to support the development and implementation of the program. The Greenhouse Challenge Office (jointly sponsored by the Department of Primary Industries and Energy, the Department of Industry, Science and Technology, and the Department of Environment, Sports and Territories) was set up to coordinate the program, and to work with industry in developing and implementing cooperative agreements. The office also works closely with State, Territory and local governments to facilitate the implementation of greenhouse gas abatement policies and measures. It is estimated that, when fully implemented, the program will lead to reductions of up to 15 million tonnes (15%) of greenhouse gas emissions annually by the year 2000.

Significant progress has been made since the beginning of the program, with agreements from companies in over 250 sites that account for just under 50% of the national total emissions from the industrial sector. The agreements have identified over 420 actions to reduce greenhouse gas emissions, including:

- use of new low energy cells in aluminium smelting processes;
- reduction of wastes going to landfills;
- increasing the number of tree plantations to act as CO_2 sinks;
- use of renewable energy alternatives;
- switching fuel sources to less potent greenhouse gases.

Initially, the focus is on the industrial and commercial sectors, which account for about 70% of Australia's energy-related CO_2 emissions. By taking part in the program, industry can make significant contributions to the national targets in the reduction of greenhouse gas emissions.

Recent information and updates on the Greenhouse Challenge are now available on the Department of Primary Industries and Energy's greenhouse directory on the Internet.

National Greenhouse Gas Inventory

A major requirement of the United Nations Framework Convention on Climate Change is the periodic publication by member states of a National Greenhouse Gas Inventory of emissions and sinks, using an internationally comparable methodology. Table 13.2 shows trends in emissions of selected greenhouse gases for 1990 and 1994. There was a general increase in emissions in some sectors, and a decrease in others, for all gases except CO_2 which showed an increase in emission levels in all sectors.

13.2 SELECTED GREENHOUSE GASES, Changes in National Emissions — 1990–94

	Unit	Energy	Transport	Fugitive fuel	Industry	Solvents	Agriculture	Landuse change and forestry(a)	Waste	All sectors
Carbon dioxide (CO_2)										
Net CO_2 emissions 1990	'000 t	202 162	60 460	3 845	6 655	—	—	121 668	—	**394 790**
Net CO_2 emissions 1994	'000 t	210 175	63 759	4 274	7 293	—	—	124 550	—	**410 051**
Average rate of CO_2 change	% per year	1.0	1.3	2.7	2.3	—	—	0.6	—	**0.95**
Methane (CH_4)										
CH_4 emissions 1990	'000 t	79.2	30.0	1 212.9	3 2	—	3 223.2	336.7	704.4	**5 589.7**
CH_4 emissions 1994	'000 t	87.1	25.8	1 217.9	3 7	—	3 140.8	335.2	766.9	**5 577.3**
Average rate of CH_4 increase	% per year	2.4	–3.7	0.1	3 8	—	–0.6	–0.6	2.1	**–0.1**
Nitrous oxide (N_2O)										
N_2O emissions 1990	'000 t	2.5	5.2	0.1	1 6	—	68.2	3 6	—	**81.2**
N_2O emissions 1994	'000 t	2.7	8.9	0.1	1 4	—	67.4	3.6	—	**84.1**
Average rate of N_2O increase	% per year	1.3	14.6	1.3	–3 8	—	–0.3	–0.2	—	**0.9**
Carbon monoxide (CO)										
CO emissions 1990	'000 t	857	5 199	7.3	—	—	12 042	6 638	—	**24 743**
CO emissions 1994	'000 t	932	3 522	7.7	—	—	10 583	6 596	—	**21 641**
Average rate of CO increase	% per year	2.1	–9.3	1.3	—	—	–3.2	–0.2	—	**–3.3**
Oxides of nitrogen (NOx)										
NOx emissions 1990	'000 t	865.9	479.9	1.3	—	—	906.2	121.4	—	**2 374.7**
NOx emissions 1994	'000 t	907.4	420.7	1.3	—	—	799.8	120.3	—	**2 249.5**
Average rate of NOx increase	% per year	1.2	–3.2	1.3	—	—	–3.1	–0.6	—	**–1.4**
Non-methane volatile organic compounds(b)										
NMVOC emissions 1990	'000 t	202.0	664.3	211.1	8.1	167.5	705.4	753.3	3.7	**2 715.5**
NMVOC emissions 1994	'000 t	22.3	522.1	232.8	9.9	166.4	620.0	748.2	4.0	**2 525.6**
Average rate of NMVOC increase	% per year	2.4	–5.8	2.5	5.1	–0.2	–3.2	–0.2	2.0	**–1.8**

(a) The 1990 value for emissions from forest and grassland conversion is used for all years to 1994, as an interim measure pending revision of the methodology. (b) NMVOC.

Source: National Greehouse Gas Inventory, 1988–94.

Table 13.3 outlines a range of policy options identified for reducing greenhouse gas emissions in Australia.

13.3 OPTIONS FOR REDUCTION OF GREENHOUSE GAS EMISSIONS

Factors	Options
Residential	
Lighting	Compact fluorescent lights to replace incandescents
Cooking	Microwave cooking, electric induction, improved gas
Water heating	Better tank insulation, low flow shower heads, pipe lagging, improved gas combustion, electronic ignition
Space heating	Building improvements including weatherisation and insulation, new solar efficient design, improved wood and electric heaters
Space cooling	Building improvements, technology improvements
Commercial	
Lighting	More efficient fluorescents, compact fluorescents, daylighting
Electric drive	High efficiency motors, ducting redesign
Space cooling	Building improvements, improved efficiency/operation of cooling technologies
Space heating	Building improvements, better furnace efficiency/operation
Water heating	Tank insulation, pipe lagging, gas combustion, ignition
Industrial	
Smelting	Intelligent controllers, heat recovery, increased scrap usage
Metal processing	Heater design, combustion control, heat recovery
Furnaces	Combustion efficiency and control, heat recovery
Steam	Pipe insulation, optimised distribution
Fluid heating	Better heat exchangers, efficient use, combustion efficiency
Drying	Combustion efficiency, better heat transfer, efficiency of intelligent controllers
Mechanical drives	Efficient motors, variable speed drives, optimal sizing, improved in-house wiring, optimisation of use
Aluminium	Electrode tuning, increased use of recycled material
Transport	
Cars	Improved fuel economy from downsizing, continuous gearing, electronic ignition, improved aerodynamics
Trucks	Better fuel ignition and gearing systems, fleet and dispatch control
Rail	Control systems, electric motor efficiencies
Mining	Improved efficiency in gas preparation, chilling, liquefaction, vehicle efficiency
Agriculture	More efficient farm vehicles, electric motors and processing equipment

Source: Deni Greene Consulting Services 1991 in ABS 1992, Australians and the Environment: Issues and Facts (4140.0).

Climate change research

Australia has high standing in the scientific world in the area of climate change research, especially in such aspects as climate variability and impact assessments, and in modelling the implications of climate change for Australia and the Asia–Pacific region. The 1996 Commonwealth Government Budget provides $6.2m in 1996–97 for climate change research, with a commitment for a further $14m over four years for national greenhouse gas research, related activities and implementation to support advancement in the science of climate change.

Australia is a member of and signatory to the United Nations Framework Convention on Climate Change and plays a key role in the Intergovernmental Panel on Climate Change (IPCC). In its Second Assessment Report released in July 1995, the IPCC noted significant scientific gains in understanding the science of climate change, and in separating the natural from the anthropogenic influences on the climate system, since the First Assessment Report in 1990. It found that despite uncertainties in a number of key areas, there was sufficient evidence to suggest that the human influence on global climate is realistic and discernible, and emphasised that urgent action must be taken, especially by developed countries, to limit and reduce the emissions of greenhouse gases. However, the report did not specify what level of concentration of greenhouse gases might constitute dangerous human interference in the climate system. Some countries, including Australia, argued that neither the science nor the assessment of impacts is yet sufficiently advanced to nominate a specific level.

Scenarios have been developed for changes to surface temperatures in Australia, depending on assumptions about CO_2 emissions, climate sensitivity to those emissions and the strength of regional responses to the size of emissions. Table 13.4 presents ranges of temperature increase by the years 2030 and 2070 resulting from a doubling in CO_2 concentration. Surface temperatures have been projected to increase by between 1.5 and 4.5 degrees centigrade in the event of a doubling in CO_2 emissions. Despite the uncertainties in the science, such scenarios have been used to assess Australia's vulnerability to future climate changes, and to develop options for responses and adaptation strategies.

13.4 SCENARIOS OF TEMPERATURE INCREASE

Region	2030 °C	2070 °C
Northern coast (north of about 25°S)	0.0–1.5	0–4
Southern coast (south of about 25°S)	0.5–2.0	1–5
Inland	0.5–2.5	1–5

Source: Commonwealth of Australia 1994, Climate Change: Australia's national report under the United Nations Framework Convention on Climate Change.

Environment programs

Australian Waste Database project

Australians generate vast amounts of wastes every year, which are a major source of pressure on the environment. In response to a growing need for the collection and reporting of information on waste generation and management, the National Waste Database (NWD) project was initiated by the Environment Protection Agency and the Cooperative Research Centre for Waste Management and Pollution Control. The project aims to establish a database on waste generation, which can be used as a monitoring system of waste minimisation policies by Commonwealth and State environmental and waste management agencies and other organisations. Part of the project's objectives includes the establishment of a nationally agreed classification system for various categories of wastes, and a protocol for sampling and characterising urban solid wastes.

The NWD has two major components: solid wastes, comprising non-hazardous wastes from municipal, commercial, industrial, building and demolition activities, and hazardous wastes, mostly liquid industrial wastes which are precluded from disposal through the sewerage system or municipal waste landfills, and therefore require special disposal facilities such as a treatment plant. The hazardous waste database is part of the proposed National Pollutant Inventory (NPI). Hazardous wastes are the focus of this section.

The management and disposal of hazardous wastes in Australia presently fall under the jurisdiction of the State and Territory Governments. There is no uniform national legislation for the disposal of hazardous wastes, although a number of Acts relating to pollution control exist. Available data on hazardous wastes relate to monitored or manifested wastes, that is, wastes transported from the generator to a central treatment site.

The volumes of manifested hazardous wastes generated by industry in Sydney in 1990–94 are shown in table 13.5. Wastes disposed of on site and radioactive wastes are not included in the NWD. Manufacturing produces the highest amount of hazardous wastes, contributing 59% of the total volume.

13.5 MANIFESTED HAZARDOUS WASTES GENERATED ANNUALLY BY INDUSTRY, Sydney — 1990–94(a)

Waste	Agriculture(b) kl	Mining kl	Manufacturing kl	Electricity, gas and water kl	Construction kl	Wholesale, retail trade kl
Plating and heat	—	—	742	—	—	54
Acids	—	56	5 744	97	—	90
Alkalis	—	9	6 457	66	6	416
Inorganic chemicals	67	166	2 921	57	14	616
Reactive chemicals	—	—	180	8	—	3
Paint — organic sludges	—	—	8 052	1	21	499
Organic solvents	—	—	3 077	6	2	319
Pesticides	—	—	106	—	—	1
Waste oil	11	21	7 298	228	282	2 077
Textiles	—	—	441	—	—	—
Putrescible	—	—	7 945	181	1	769
Wash-waters	—	55	5 904	276	45	2 290
Inert	—	—	395	7	—	46
Organic chemicals	—	1	1 949	9	2	41
Bags etc.	—	—	13	—	—	2
Immobilised	—	—	4 560	—	2	3
Miscellaneous	—	84	1 675	1 424	955	1 155
Total(c)	78	393	57 460	2 362	1 330	8 381

Waste	Accommodation and hospitality kl	Transport and storage kl	Communication services kl	Finance, insurance, property, business services kl	Health and community services kl	**Total kl**
Plating and heat	3	1	12	17	—	**830**
Acids	—	4	28	194	—	**6 212**
Alkalis	—	67	9	2 345	—	**9 375**
Inorganic chemicals	—	12	53	103	22	**4 032**
Reactive chemicals	—	3	—	25	—	**220**
Paint — organic sludges	—	3	7	175	—	**8 759**
Organic solvents	—	23	223	452	—	**4 102**
Pesticides	—	—	—	10	—	**118**
Waste oil	4	124	3 661	2 922	—	**16 628**
Textiles	—	20	—	38	—	**500**
Putrescible	—	1	109	3 659	—	**12 665**
Wash-waters	56	118	126	1 418	1	**10 290**
Inert	—	2	1	57	—	**507**
Organic chemicals	—	21	15	7 085	—	**9 122**
Bags etc.	—	—	—	25	—	**40**
Immobilised	—	—	2	206	—	**4 773**
Miscellaneous	—	2 797	223	277	722	**9 312**
Total(c)	63	3 195	4 466	19 011	745	**97 485**

(a) Average over five years. (b) Includes forestry and fishing. (c) Excludes oily wastes and greasy wastes which are hazardous, but which are controlled by a separate manifest system.

Source: Australian Waste Database Project 1994.

Air quality

Australian guidelines for air quality are based not on the usual notion of transparency of the atmosphere, but on considerations of what is optimal for human health. The responsibility for monitoring air quality and assessing impacts on human health rests with State and Territory agencies, which currently limit their activities to:

- 'urban airsheds' or major metropolitan areas surrounding most capital cities;
- selected regional and industrial areas;
- some areas around major sources of emissions.

The number of air quality monitoring stations in Australia and the parameters monitored are indicated in table 13.6. Only 5% of the country is covered by the existing network of air quality monitoring stations. For the remaining 95%, the major concerns relate to sulphur dioxide from industrial point sources like coal power stations, heavy metals such as lead from ore processing, particulates from forestry and agricultural activities, pesticides from aerial spraying, and roadside emissions from motor traffic in rural areas.

13.6 ROUTINELY MONITORED AIR QUALITY INDICATOR SITES — 30 June 1995

Location	O_3	CO	NO_2	SO_2	Visibility	TSP(a)	Lead	Dust	PM10(b)	PM2.5(b)	Fluoride	PAH(c)	VOCs(d)	Airtrak
Adelaide	2	1	2	1	2	9	9	—	—	—	—	—	—	—
Brisbane	8	1	9	3	4	—	5	11	—	—	—	—	—	2
Broken Hill	—	—	—	—	—	3	3	27	—	—	—	—	—	—
Cairns	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Canberra	2	2	2	—	2	5	5	—	—	—	—	—	—	—
Cape Grim	1	1	—	1	—	—	1	—	1	1	—	—	—	—
Central Tablelands	—	—	—	—	—	2	—	10	—	—	—	—	—	—
Gladstone	—	—	3	2	2	—	—	—	2	—	—	—	—	—
Hobart	—	—	—	—	—	(e)	(e)	—	—	—	—	—	—	—
Hunter Valley	—	—	—	4	—	20	—	194	—	—	14	—	—	—
Illawarra	—	—	—	8	—	9	2	60	—	—	—	16	—	—
Kalgoorlie	—	—	—	11	—	—	—	—	—	—	—	—	—	—
Latrobe Valley	2	—	2	2	2	—	—	—	—	—	—	—	—	—
Launceston	—	—	—	—	—	(e)	—	—	—	—	—	(e)	—	—
Mackay	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Mt Isa	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Newcastle	2	1	11	10	—	9	7	15	2	—	12	18	—	—
Perth (incl. Kwinana)	9	3	11	6	6	3	3	—	4	6	—	—	2	2
Port Augusta	—	—	—	(e)	—	(e)	—	—	—	—	—	—	—	—
Port Pirie	—	—	—	(e)	—	(e)	(e)	—	(e)	—	—	—	—	—
Port Phillip Region	11	5	9	7	10	5	5	—	1	—	—	—	3	—
Rockhampton	—	—	—	—	—	2	—	—	—	—	—	—	—	—
Southern Tablelands	—	—	—	—	—	—	—	11	—	—	—	—	—	—
Sydney	13	8	11	4	8	4	4	10	6	—	—	—	—	1
Townsville	—	—	—	—	—	—	—	6	2	—	—	—	—	—
Wollongong	2	4	2	2	2	4	5	17	1	—	—	3	—	—
Whyalla	—	—	—	—	—	(e)	(e)	—	—	—	—	—	—	—

(a) Total suspended particulates. (b) TSP include all particles from the smallest up to 50mm in diameter: within this range are sub-categories of those less than 10mm in diameter, known as PM10 and those smaller than 2.5mm known as PM2.5. (c) Polycyclic Aromatic Hydrocarbons. (d) Volatile organic compounds. (e) Monitored but number of monitors not specified.

Source: Australia — State of the Environment Report, 1996.

Table 13.7 is a summary of Australian urban and regional air quality. It shows that, although breaches of the guidelines are common, there is a general improvement in the concentration of most pollutants. Major air pollutants and their sources are indicated in table 13.8. Motor vehicles are the main source of emissions in cities, accounting for 82–89% of all carbon monoxide, 41–50% of hydrocarbons, and 54–80% of oxides of nitrogen.

13.7 URBAN AND REGIONAL AIR QUALITY

Pollutant	
	AREAS OF MOST SIGNIFICANCE
Ozone	Primarily Melbourne and Sydney.
Nitrogen dioxide	With heavy traffic.
Sulphur dioxide	Near metal ore processing.
Carbon monoxide	Areas with heavy traffic, wood fires.
Total suspended particulates (TSP or PM10)(a)	Areas with heavy traffic, mining and industrial areas, biomass burning (including wood fires).
Lead	Lead point sources and motor vehicles.
Fluoride	Aluminium smelters and ceramics works.
	MEASURED LEVELS
Ozone	Occasional breaches of guidelines.
Nitrogen dioxide	Occasional breaches in large cities.
Sulphur dioxide	Substantial breaches of guidelines near some sites.
Carbon monoxide	Some breaches.
Total suspended particulates(a)	Some breaches.
Lead	Some substantial breaches.
Fluoride	Breaches, often in buffer zones.
	TRENDS
Ozone	Signs of improvement may be the result of meteorological variability.
Nitrogen dioxide	No clear trends.
Sulphur dioxide	Some improvements due to better controls for specific plants.
Carbon monoxide	Slight improvement in most cities.
Total suspended particulates(a)	General improvements.
Lead	Steady improvement in urban areas.
Fluoride	General gradual improvements.
	OTHER COMMENTS
Ozone	Potentially growing problem in Brisbane and Perth as populations increase rapidly.
Nitrogen dioxide	—
Sulphur dioxide	Potential for pressure for new sources in future.
Carbon monoxide	Measured levels sensitive to monitor siting.
Total suspended particulates(a)	TSP not as well related to health effects as PM10 or PM2.5(a).
Lead	Motor vehicles declining in importance as lead emissions decrease.
Fluoride	Vegetation protection.

(a) Particles are monitored and reported in size-related categories. Total suspended particulates (TSP) include all particles from the smallest up to 50mm in diameter: within this range are sub-categories of those less than 10mm in diameter, known as PM10 and those smaller than 2.5mm known as PM2.5.

Source: Australia — State of the Environment Report, 1996.

13.8 SOME MAJOR AIR POLLUTANTS AND EMISSIONS

Pollutant	Source
Carbon monoxide	Mainly produced from fossil fuel combustion sources. The car is the main contributor of this pollutant.
Sulphur dioxide	Emitted from sources such as coal burning, oil combustion and some industrial processes.
Oxides of nitrogen	Produced from processes in air, oil and water such as lightning and soil biological processes. Can also be produced from sources such as fossil fuel combustion, biomass burning, cultivated soils and intensive use of fertilisers. Nitrogen oxide also contributes for the greenhouse effect and depletion of stratospheric ozone.
Lead	One of the most significant pollutants, owing to its toxic nature, particularly its effects on young children. Sources include petrol engines, lead smelters, refineries, combustion of recycled sump oil and battery manufacture.
Air toxics	Includes pollutants known to cause or suspected of causing long term health effects in humans. Many air toxics are either volatile organic compounds or metallic compounds that could affect health following long-term exposure at very low concentrations.
Particulate matter (particles)	Particles of various sizes suspended in the air can reduce its clarity. These particles may include sea salt, sulphate from sea salt and SO_2 emissions, carbon from combustion processes, silica from soil and pollen.
Ozone	Tropospheric ozone is a secondary air pollutant, formed in the process of photochemical reactions among other chemicals.
Fluoride	Recognised as one of the traditional pollutants because of its effects on vegetation and livestock. Has a limited effect on the human body. Major sources are industrial processes, such as aluminium smelting, phosphate fertiliser production and brick and glass making.
Greenhouse gases	A number of trace gases which have a significant effect on the radiative energy balance of the earth's atmosphere. Includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide and chlorofluorocarbons and their substitutes.

Source: Australians and the Environment (4601.0).

National Strategy for Ecologically Sustainable Development (NSESD)

Sustainable development refers to development that aims to meet the basic needs of the present without compromising the ability of future generations to meet their own needs. The concept of ecologically sustainable development was developed at the United Nations Stockholm Conference in 1972, although the idea only gained international prominence in the last few years. In Australia the *National Strategy for Ecologically Sustainable Development (NSESD)* was endorsed by Heads of Government in 1992, following extensive consultation with all community sectors. The first report on implementation of the strategy was issued in December 1993. An Intergovernmental Committee for Ecologically Sustainable Development (ICEDSD) was established to monitor the performance of the NSESD.

The core objectives of the NSESD are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations;
- to protect biological diversity and maintain essential ecological processes and life-support systems.

In order to achieve ecologically sustainable development, four key areas of the environment need to be sustained: biodiversity, ecological integrity, natural capital, and social integrity. Biodiversity refers to the variety of species, populations, habitats and ecosystems. Australia has diverse flora and fauna, some unique to the continent. Ecological integrity pertains to the general health and resilience of natural support systems and their ability to withstand stresses such as climate change. Natural capital refers to stocks of fresh water, productive soils, forests, sub-soil assets and other resources. Social integrity relates to the resilience of social and cultural systems to development processes.

Waste disposal

Compared to other OECD countries, Australia has a relatively high production of solid waste, second only to the United States in per capita production of municipal waste. Landfill is the main form of waste disposal. This is due to the relatively low cost of landfills, and availability of land in many areas. However, in some cities the establishment of new landfills is becoming a major problem for municipal authorities due to increasing scarcity of open land, and growing community opposition. Table 13.9 shows the life expectancy of current landfill sites in Australian capital cities. Most of the current municipal landfills are expected to fill up within 10–15 years.

13.9 LIFE EXPECTANCY OF SELECTED CURRENT LANDFILL SITES

	Year expected to reach capacity(a)
Sydney	n.a.
Melbourne	(b)2000+
Brisbane	2016
Adelaide	—
North and central regions	(c)2003 (2009)
South regions	(d)2016 (2020)
Perth	2007
Tasmania	n.a.
Darwin	2026
ACT and Queanbeyan	2005–07

(a) Estimates taken at different times, on basis of existing landfill sites. (b) Usually only licensed for five to seven years at a time. (c) Best case scenario based on 8% reduction for five years and 0% reduction thereafter.

Source: Department of Commerce and Trade Western Australia 1990; Waste Recycling and Processing Service 1994; ACT Department of Urban Services 1995, unpub.; Department of Environment and Natural Resources SA 1995; Darwin City Council 1996, unpub.; Brisbane City Council 1996, unpub.; Wallwork and Joy 1993.

Landfills are a major source of pollution. Solid waste decomposes to produce acidic leachate and methane which can contaminate the air, land, surface and ground water systems. Table 13.10 shows an estimate of municipal solid wastes taken to landfill sites in Australia in 1989–90, and the net methane emissions from those sites. Total municipal solid waste amounted to an estimated 14.7 million tonnes, and methane 1.3 million tonnes. Another common problem with landfill sites is noxious odours which permeate the surrounding air.

Incineration is an alternative method of waste disposal, especially in remote communities where the costs of landfills and waste disposal services are prohibitive. Nationally, incineration accounts for only 1% of total municipal solid waste disposal, which is significantly low compared to other countries (table 13.11).

13.10 METHANE PRODUCED(a) BY LANDFILL SITES — 1989–1990

State	Municipal solid waste to landfill '000 t	Net methane emissions '000 t
NSW	5 462	517.3
Vic.	3 508	284.1
Qld	1 909	211.9
SA	1 478	139.2
WA	1 605	125.2
Tas.	285	27.0
NT	102	9.7
ACT	314	29.8
Australia	**14 663**	**1 344.3**

(a) These are estimates and may not reflect actual totals.

Source: DEST 1994, National Greenhouse Gas Inventory 1988 and 1990.

13.11 PROPORTION OF MUNICIPAL SOLID WASTE INCINERATED, Various Countries

Country	Municipal solid waste incinerated %
Singapore	85
Denmark	65
Sweden	55
France	42
Netherlands	40
Germany	30
Australia	<1

Source: Australia, Parliament 1994.

Pollution abatement and control techniques

In order to minimise the impact of their activities on the environment, many Australian industries and other groups now adopt pollution abatement and control measures, either through compliance with Government legislation or through economic incentives. Economy-wide statistics on industry actions are not available at present. The information presented in table 13.12 is limited to the mining industry, and shows the proportion of establishments within the mining sector undertaking selected pollution abatement and control techniques in 1994. The coal industry adopting dust and noise control measures. Its treatment of waste water is second only to that of the oil and gas industry. The metal ore

industry has the highest proportion of establishments using ventilation and cleaning exhaust gases to control dust and other noxious substances.

13.12 ESTABLISHMENTS USING POLLUTION ABATEMENT AND CONTROL TECHNIQUES, By Industry — 30 June 1994

Techniques	Coal %	Oil and gas %	Metal ore %	Other mining %	Services to mining %	**Total mining %**
CONTROL OF DUST AND OTHER SUBSTANCES EMITTED INTO THE AIR						
Protective activity	73	18	58	47	26	**46**
Ventilation	56	18	68	28	26	**40**
Application of water	98	27	92	92	48	**77**
Application of chemicals	41	9	22	20	6	**19**
Cleaning of exhaust gases	40	36	44	16	14	**25**
Other	9	—	6	4	2	**4**
No method used	—	—	1	—	3	**1**
No dust/substances emitted into the air	1	55	3	6	35	**15**
CONTROL OF NOISE LEVELS FOR EMPLOYEES AND/OR THE ENVIRONMENT						
Silencers	83	64	74	64	47	**64**
Protective equipment	95	82	94	90	59	**85**
Erection of noise barriers	48	27	54	48	17	**38**
Modification of buildings	41	27	24	35	9	**25**
Limitations on hours of operations	30	—	19	52	20	**30**
Other	10	18	5	4	3	**5**
No method used	—	—	1	1	1	**1**
No method required	4	18	2	2	25	**10**
TREATMENT OF WASTE WATER						
Mechanical treatment technology	70	73	62	52	25	**49**
Biological treatment technology	38	36	22	4	5	**14**
Advanced treatment technology	12	18	12	2	2	**6**
Other	15	9	14	8	4	**9**
No method used	4	—	5	3	2	**3**
No waste water produced	14	18	19	36	66	**38**
TREATMENT OF HAZARDOUS WASTES						
Physical treatment	19	—	26	3	4	**11**
Chemical treatment	6	18	16	2	3	**6**
Thermal treatment	5	36	5	—	1	**3**
Biological treatment	1	—	2	—	1	**1**
Conditioning of radioactive wastes	—	—	2	—	1	**1**
Other	7	18	15	3	6	**8**
No method used	4	—	4	1	4	**3**
No hazardous waste produced	68	45	47	93	84	**75**

Source: Mining Technology Statistics, Australia (8413.0).

Land and soil conditions

Changes in land cover 1788–1993

Land cover is a generic term used to describe the physical state of the land surface, which includes vegetation, soil, water and artificial structures. Being the interface between the earth's crust and the atmosphere, it influences the flow of energy and materials between the two systems. Changes in land cover affect a wide range of physical processes including the energy, water and nutrient cycles and balances.

Australia's natural vegetation cover has undergone considerable changes since European settlement in 1788. Almost 9% of the continent was covered by forests. Woodlands and open woodlands each covered 21%, shrublands 40%, and grasslands 7%. Less than 1% of the total land was unvegetated.

By the late 1980s only 5% of Australia was forested, 140,000 km^2 having been cleared for

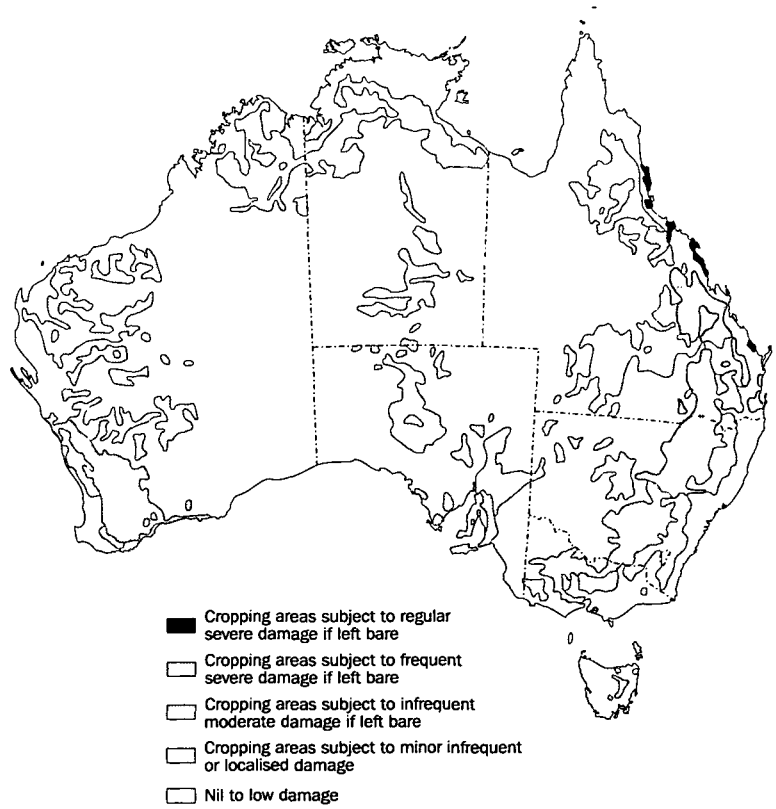
grazing and crop production, and a further 175,000 km^2 converted to woodland or open woodland. The original area of woodland declined from 21% to 14%, mainly due to clearing for pasture and cropping. Grasslands nearly doubled in area, from 7% in 1788 to 16% in the 1980s. The last major clearing for agriculture is believed to have occurred in the 1970s, although annual clearing rates over the past 10 years are also considered to be in excess of 5,000 km^2.

Rapid expansion and intensification of cropping and grazing, commercial forestry, mining, development of transport infrastructure and urbanisation have led to considerable restructuring of the Australian landscape, such that areas of high wilderness quality are now restricted to arid lands and the 'wet-dry' tropics.

Soil conditions

Australian soils are generally characterised by low organic matter, poor surface structure, and a large proportion of clay content. In the arid zone, large areas are covered by soils formed on aeolian sands. Changes in soil structure due to land use are among Australia's most serious forms of land degradation. These changes occur in a number of ways, including losses of organic matter associated with regular tillage, exposure of wet soil to stress caused by machinery or stock, and by exposing bare soil to intensive rainfall. The effects of a decline in soil structure include reduced porosity and permeability leading to waterlogging, excessive run-off and soil erosion, reduced root vigour which affects nutrient and water uptake, and yield decline.

13.13 AREAS THAT EXPERIENCE DAMAGE, Wind Erosion



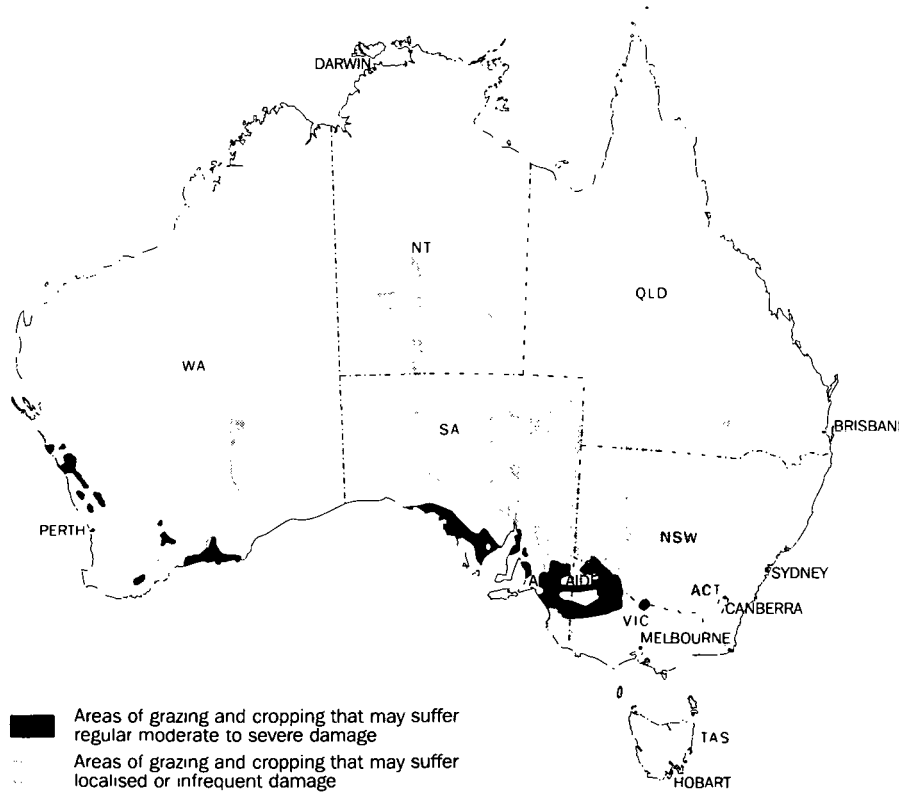
Source: AUSLIG 1992 in ABS 1996 (4606.0).

Soil erosion is a naturally occurring process, but certain management practices exacerbate the problem, resulting in large scale removal of topsoil in many parts of the country. It has beenestimated that soil erosion in Australia has increased 10–100 times in the last 100 years within agricultural areas.

Water erosion is the most common cause of land degradation in Australia. Map13.13 shows areas that are most susceptible to this process. Maintenance of plant cover, reduced tillage, strip cropping, and contour banks are common land management techniques used to protect the soil from accelerated water erosion.

Map 13.14 shows major areas that are most susceptible to wind erosion in Australia. These include some of the agricultural areas, and the sandy soils of southern, western, and central Australia. Land management practices used to minimise wind erosion include maintenance of vegetation, and using windbreaks to reduce surface wind speeds.

13.14 AREAS THAT EXPERIENCE WATER EROSION DAMAGE



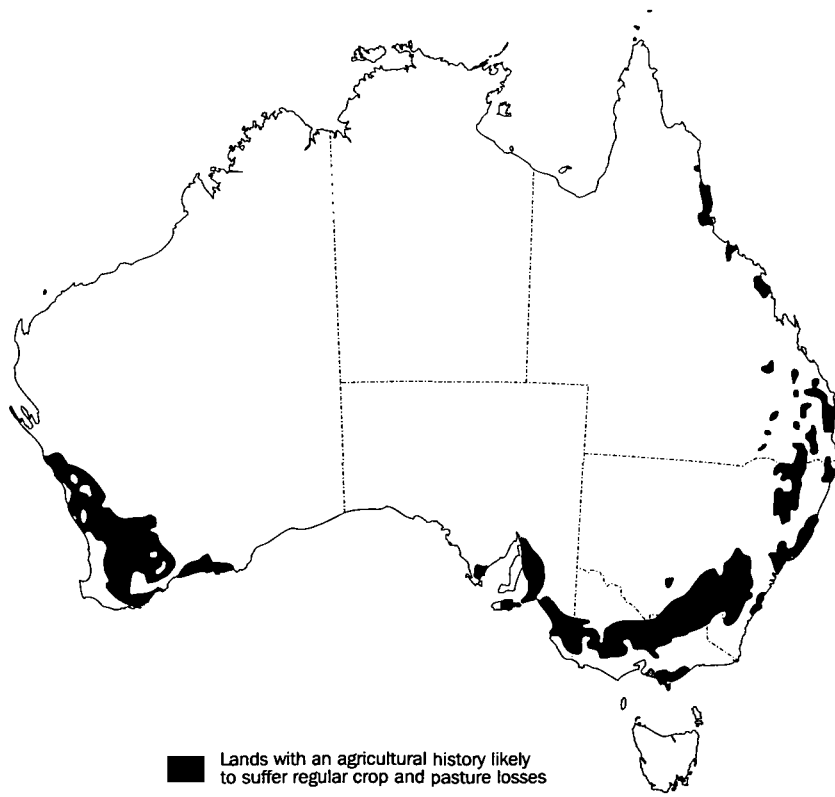
Source: AUSLIG 1992 in ABS 1996 (4606.0).

Soil acidity and salinity are other contemporary environmental problems in Australia. Although many of the continent's acidic soils are naturally occurring, there is increasing concern about those soils that show accelerated acidification. Map 13.15 shows areas that experience induced soil acidity. Many of these are found in the cropping and grazing areas. Widespread

clearance of deep rooted perennial vegetation, replaced by shallow rooted annual crops and pastures, has led to significant modifications of the hydrological cycle in many areas. The net result is a rise in the water table, bringing dissolved salts to the soil profile. These salts concentrate on the surface following evaporation, causing scalds and seepages.

Map 13.16 shows areas affected by salinity in Australia in 1992. In Western Australia alone an estimated 1.6 million hectares, or 9% of the area of cleared agricultural land in the State, are salinised. Estimates of dryland salinity in the Murray–Darling Basin, South Australia, and Victoria stand at 200,000 hectares, 400,000 hectares and 150,000 hectares respectively. Similar estimates for New South Wales and Queensland stand at 20,000 hectares and 10,000 hectares respectively.

13.15 AREAS OF INDUCED ACIDITY



Source: AUSLIG 1992 in ABS 1992 (4140.0)

13.16 AREAS AFFECTED BY SALINITY

Source: AUSLIG 1992 in ABS 1992 (4140.0).

Water

Australia is often described as the dry continent, with most of its land mass classed as arid or semi-arid. About 80% of the country receives median rainfall of less than 600 mm, while 50% receives less than 300 mm. Approximately 65% of the continent's mean annual run-off occurs in the northern Drainage Divisions. About 32% of Australia's land mass produces virtually no run-off. This low percentage run-off is due to a combination of high evaporation rates, low and variable rainfall, and low relief of most of the land mass.

Compared to other habitable continents, Australia has the least amount of water in rivers and the smallest areas of permanent wetlands. Table 13.17 shows Australia's surface water resources by Drainage Division in 1987. There are 12 major Drainage Divisions and 245 river basins. The largest Drainage Division is the Murray–Darling, which drains about one-seventh of the entire land mass and supports 30–40% of the nation's resource-based industries (including half of the sheep and crops, one-quarter of the diary and beef, and three-quarters of the irrigated field crops). Within the Lake Eyre, Bullo–Bancannia, and Western Plateau Drainage Divisions average evaporation is nearly five times the average rainfall.

13.17 SURFACE WATER RESOURCES, By Drainage Division

Drainage Division	Area km²	Mean annual runoff Gl	Mean annual outflow Gl
North–East Coast	451 000	83 900	83 900
South–East Coast	274 000	41 900	41 900
Tasmania	68 200	52 900	52 900
Murray–Darling	1 060 000	24 300	12 200
South Australian Gulf	82 300	877	767
South–West Coast	315 000	6 670	6 600
Indian Ocean	519 000	3 960	3 840
Timor Sea	547 000	80 700	80 700
Gulf of Carpentaria	641 000	92 500	92 500
Lake Eyre	1 170 000	6 310	—
Bulloo–Bancannia	101 000	1 090	—
Western Plateau	2 450 000	1 580	—
Total	**7 680 000**	**397 000**	**375 000**

Source: Australian Water Resources Council (AWRC) 1987.

13.18 MAJOR GROUNDWATER RESOURCES OF DRAINAGE DIVISIONS

Drainage Division	Area of Aquifers(a) km²	Fresh Gl	Marginal Gl	Brackish Gl	Saline Gl	Total Gl
North–East Coast	114 250	1 260	464	185	94	2 000
South–East Coast	71 660	760	699	353	50	1 860
Tasmania	7 240	47	69	8	—	124
Murray–Darling	908 500	782	594	435	349	2 160
SA Gulf	2 500	—	74	10	1	85
South–West Coast	328 000	466	415	260	78	1 220
Indian Ocean	487 400	22	241	174	71	508
Timor Sea	328 900	617	1 980	161	57	2 820
Gulf of Carpentaria	340 250	721	1 180	16	11	1 930
Lake Eyre	834 030	81	382	125	31	619
Bulloo–Bancannia	90 100	28	27	41	4	100
Western Plateau	1 706 700	44	746	64	90	944
Total	**5 219 530**	**4 828**	**6 871**	**1 832**	**836**	**14 370**

(a) Includes surficial, sedimentary and fractured aquifers.

Source: AWRC 1987.

Groundwater is an important resource in Australia, providing about 80% of the total annual water supplies. About 600 communities nation wide depend entirely on groundwater for their domestic water needs. Australia's available groundwater resources in 1987 are shown in Australian Gulf Drainage Division extracted the greatest amount of available groundwater (66%). In 1984 Australia used about 16% of the total groundwater available.

Irrigation accounts for nearly 70% of the total annual water consumption in Australia (table 13.20). The domestic sector is the second largest consumer of water (12%), most of which is used in outdoor activities (table 13.21). Average water consumption in capital cities varies from 263 kilolitres per year in Sydney to 500 kilolitres per year in Darwin.

13.19 GROUNDWATER EXTRACTED IN 1983–84, By Drainage Division

Drainage Division	Available Resource Gl	Extracted Gl	Resource used %
North–East Coast	2 000	586	29
South–East Coast	1 860	437	24
Tasmania	124	5	4
Murray–Darling	2 160	501	23
South Australian Gulf	85	56	66
South–West Coast	1 220	296	24
Indian Ocean	508	52	10
Timor Sea	2 820	15	1
Gulf of Carpentaria	1 930	95	5
Lake Eyre	619	172	28
Bulloo–Bancannia	100	15	15
Western Plateau	944	9	1
Total	**14 370**	**2 238**	**16**

Source: AWRC in ABS 1992 (4140.0).

13.20 MEAN ANNUAL WATER USE, By Drainage Division(a)

Drainage Division	Unit	Pasture	Crops	Horticulture	Irrigation Total
North–East Coast	Gl	70.5	803.0	92.2	966.0
South–East Coast	Gl	711.0	137.1	176.0	1 024.0
Tasmania	Gl	45.9	46.8	4.0	96.7
Murray–Darling	Gl	4 119.3	2 438.1	1 090.0	7 649.0
South Australian Gulf	Gl	28.2	2.4	45.0	75.6
South–West Coast	Gl	168.0	23.5	75.1	267.0
Indian Ocean	Gl	0.1	1.7	6.8	8.7
Timor Sea	Gl	19.6	45.6	5.1	70.3
Gulf of Carpentaria	Gl	16.6	44.9	12.7	74.2
Lake Eyre	Gl	<1.0	3.3	<0.1	3.0
Bulloo–Bancannia	Gl	—	—	—	—
Western Plateau	Gl	—	<1.0	0.4	0.5
Total	**Gl**	**5 180.0**	**3 550.0**	**1 510.0**	**10 240.0**
Proportion of total	%	35.5	24.3	10.3	70.1

		Urban and industrial					
Drainage Division	Unit	Domestic	Industrial	Commercial	Total	Rural	Total
North–East Coast	Gl	353.0	147.0	41.3	541.0	149.0	1 660.0
South–East Coast	Gl	747.0	386.0	228.0	1 360.8	144.1	2 530.0
Tasmania	Gl	33.0	23.2	9.9	66.1	11.4	174.0
Murray–Darling	Gl	225.5	55.1	46.7	327.0	1.0	8 660.0
South Australian Gulf	Gl	141.0	23.7	34.1	199.0	37.9	313.0
South–West Coast	Gl	211.0	74.0	96.9	382.0	30.0	679.0
Indian Ocean	Gl	24.4	17.4	5.9	47.7	7.8	64.1
Timor Sea	Gl	23.1	12.5	6.0	41.5	16.3	128.1
Gulf of Carpentaria	Gl	14.8	38.0	4.3	57.0	113.0	245.0
Lake Eyre	Gl	10.1	4.0	4.6	18.7	113.2	135.0
Bulloo–Bancannia	Gl	0.2	0.3	—	0.5	17.5	18.0
Western Plateau	Gl	8.8	9.4	2.8	21.0	17.6	40.7
Total	**Gl**	**1 790.0**	**790.0**	**481.0**	**3 061.0**	**1 340.0**	**14 600.0**
Proportion of total	%	12.3	5.4	3.3	20.9	9.2	100.0

(a) Includes water from both reticulated and self-extracted sources.

Source: AWRC 1987.

13.21 AVERAGE HOUSEHOLD WATER CONSUMPTION, Australian Capital Cities — 1993–94

Capital city	Average household consumption Kl/year	Average rainfall mm	Outdoor use %
Sydney	263	1 227	30
Melbourne	270	656	38
Brisbane	430	1 149	n.a.
Adelaide	265	451	56
Perth	330	869	42
Darwin	500	1 659	45
Canberra	400	625	55

Source: Australia — State of the Environment Report, 1996.

Environment research and development

According to the Australian Science and Technology Council, Australia presently lacks the data and the knowledge base that are required for a comprehensive assessment of the quality of its environment, and to evaluate the environmental consequences of the past, present and future activities of its people. Without this information it is also impossible to adequately evaluate its national policies and strategies for ecologically sustainable development. However, research and data collection on environmental issues have increased considerably over the past few years. Table 13.22 shows the distribution of resources on environmental research and development in Australia by both the public and private sectors.

Expenditure and human resource input into environmental research and development were greater than, for example, those on defence research and development.

In addition to the formal research networks, a large number of volunteer organisations are also involved in data gathering and environmental monitoring activities. These include, for example, the Bureau of Meteorology's volunteer observers program with about 6,000 volunteers nation-wide, and the Saltwatch and Ribbons of Blue programs which monitor salt levels in local water supplies, the Waterwatch scheme, and numerous Landcare groups.

13.22 RESOURCES DEVOTED TO RESEARCH AND DEVELOPMENT — 1992–93

	Government		Non-government		Total	
	$m	person years	$m	person years	$m	person years
Defence	201.3	2 104	137.7	429	339	2 533
Economic development	1 005.7	10 853	2 911.2	29 920	3 916.9	40 773
Society	165.7	2 587	588.2	11 701	753.8	14 288
Advancement of knowledge	90	816	745.4	14 124	835.4	14 940
Environment						
Environmental knowledge	140	1 393	98	1 919	237.9	3 312
Environmental aspects of economic development	115.5	1 136	56.7	880	172.2	2 016
Environmental management and other aspects	25.6	299	27.9	376	53.6	675
Total environment	281.1	2 829	182.6	3 174	463.7	6 003
Total	**1 743.8**	**19 188**	**4 565.1**	**59 350**	**6 308.8**	**78 538**

Source: Research and Experimental Development, All Sector Summary, Australia (8112.0).

Environment education and training

Australia is also in the process of broadening its understanding of the continent's complex environment and its interactions with human activities, through education and training. In 1993–94 government organisations spent $72.6m for the advancement of knowledge in the natural sciences, technologies and engineering, and another $7.4m in education and training. In addition, private non-profit organisations spent about $132m and $8m for the respective purposes.

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