1 Geography and climate

Geography of Australia

Position and area

Australia comprises a land area of about 7,682,300 km^2. The land lies between latitudes 10°41′south (Cape York) and 43°39′south (South Cape, Tasmania) and between longitudes 113°09′east (Steep Point) and 153°39′east (Cape Byron). The most southerly point on the mainland is South Point (Wilson's Promontory) 39°08′south.

The latitudinal distance between Cape York and South Point is about 3,180 km, while the latitudinal distance between Cape York and South East Cape, Tasmania, is 3,680 km. The longitudinal distance between Steep Point and Cape Byron is about 4,000 km.

1.1 AREA, COASTLINE, TROPICAL AND TEMPERATE ZONES, AND STANDARD TIMES

	Estimated area			% of total area		Standard times	
State/Territory	Total km^2	Total area %	Length of coastline km	Tropical zone	Temperate zone	Meridian selected	Ahead of GMT(a) hours
New South Wales	801 600	10.43	1 900	. .	100	150°E	10.0
Victoria	227 600	2.96	1 800	. .	100	150°E	10.0
Queensland	1 727 200	22.48	7 400	54	46	150°E	10.0
South Australia	984 000	12.81	3 700	. .	100	142°30′E	9.5
Western Australia	2 525 500	32.87	12 500	37	63	120°E	8.0
Tasmania	67 800	.88	3 200	. .	100	150°E	10.0
Northern Territory	1 346 200	17.52	6 200	81	19	142°30′E	9.5
Australian Capital Territory	2 400	.03	(b)35	. .	100	150°E	10.0
Australia	**7 682 300**	**100.00**	**36 735**	**39**	**61**	. .	. .

(a) Greenwich Mean Time. During daylight saving periods, an hour should be added to the times in this column. (b) Jervis Bay Territory.

Source: Bureau of Meteorology.

The area of Australia is almost as great as that of the United States of America (excluding Alaska), about 50% greater than Europe (excluding the former USSR) and 32 times greater than the United Kingdom. Tables 1.2 and 1.3 show the area of Australia in relation to areas of other continents and selected countries.

1.2 AREAS OF CONTINENTS

	Area '000 km^2
Continents	
Asia	44 614
Africa	30 319
North, Central America and West Indies	24 247
South America	17 834
Europe	10 600
Australia and Oceania	8 504
Total land mass excluding Arctic and Antarctic continents	**135 774**

Source: Encyclopedia Britannica and The World Book Encyclopedia.

1.3 AREAS OF SELECTED COUNTRIES

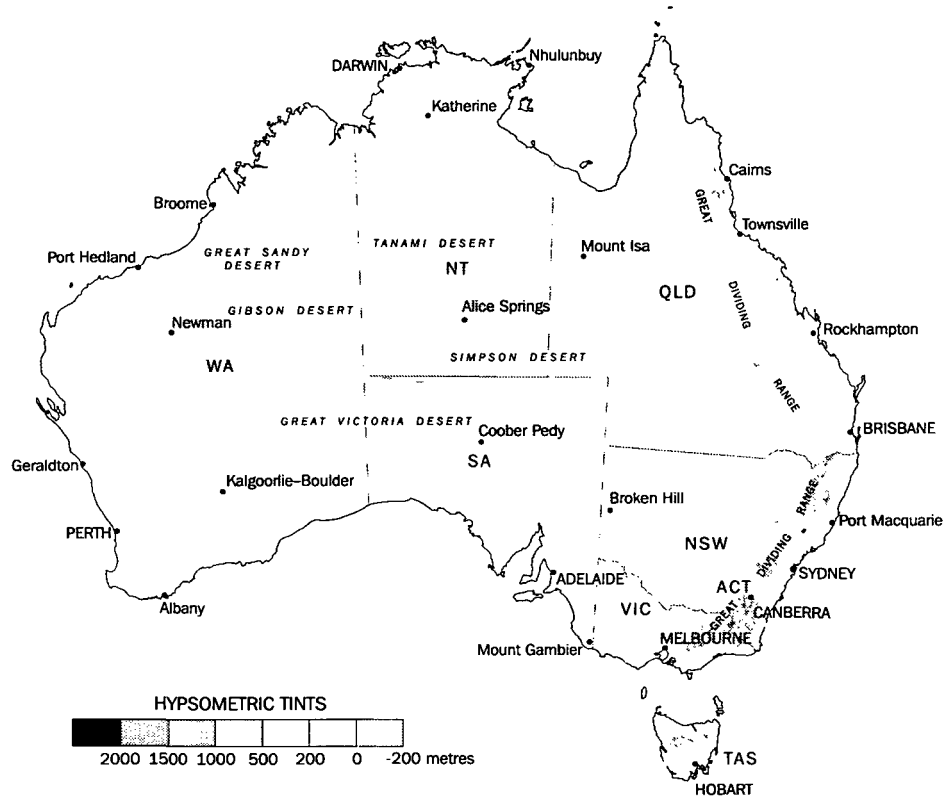
Continent/country	Area '000 km^2
Countries (seven largest)	
Russia	17 073
Canada	9 976
China	9 590
United States of America	9 363
Brazil	8 512
Australia	7 682
India	3 288
Selected other countries	
Belorus	208
France	544
Germany	357
Indonesia	1 919
Japan	372
Kazakhstan	2 717
Papua New Guinea	462
New Zealand	269
Ukraine	604
United Kingdom	244
Total land mass excluding Arctic and Antarctic continents	**135 774**

Source: Encyclopedia Britannica and The World Book Encyclopedia.

Landforms and their history

Australia is the lowest, flattest and, apart from Antarctica, the driest of the continents. Unlike Europe and North America, where some landscapes date back to 'only' 20,000 years ago, when great ice sheets retreated, the age of landforms in Australia is generally measured in many millions of years. This fact gives Australia a very distinctive physical geography. Map in 1.4 shows the major relief patterns of the Australian continent.

1.4 AUSTRALIA, Elevation



Source: AUSLIG 1996.

The continent can be divided into three parts:

- the Western Plateau;
- the Central Lowlands; and
- the Eastern Highlands.

The Western Plateau consists of very old rocks (some over 3,000 million years old), and much of it has existed as a landmass for over 500 million years. Several parts have individual plateau names (e.g. Kimberley, Hammersley, Arnhem Land, Yilgarn). In the Perth area, younger rocks along a coastal strip are separated from the rest by the Darling Fault escarpment. The Nullabor Plain is virtually an uplifted sea floor, a limestone plain of Miocene age (about 25 million years).

The Central Lowlands stretch from the Gulf of Carpentaria through the Great Artesian Basin to the Murray–Darling Plains. The Great Artesian Basin is filled with sedimentary rocks which hold water that enters in the wetter Eastern Highlands.

Much of the centre of Australia is flat, but there are numerous ranges (e.g. Macdonnels, Musgrave) and some individual mountains of which Uluru (Ayers Rock) is probably the best known. Faulting and folding in this area took place long ago, the area was worn to a plain, the plain uplifted and then eroded to form the modern ranges on today's plain. In looking at Uluru, one remarkable thing is not so much how it got there, but that so much has been eroded from all around, to leave it there. In the South Australian part of the Central Lowlands, fault movements are more recent, and the area can be considered as a number of blocks that have been moved up and down to

form a series of ranges (Mt Lofty, Flinders Ranges) and hills (such as the Adelaide Hills), with the down faulted blocks occupied by sea (e.g. Spencer Gulf) or lowlands including the lower Murray Plains.

The Eastern Highlands rise gently from central Australia towards a series of high plateaus, and even the highest part around Mt Kosciusko (2,230 metres) is part of a plateau.

There are a few younger faults and folds, such as the Lake George Fault near Canberra, and the Lapstone Monocline near Sydney.

Some plateaus in the Eastern Highlands are dissected by erosion into rugged hills, and the eastern edges of plateaus tend to form high escarpments. Many of these are united to form a Great Escarpment that runs from northern Queensland to the Victorian border. Australia's highest waterfalls (Wollombi on the Macleay, Wallaman Falls on a tributary of the Herbert, Barron Falls near Cairns, and Wentworth Falls in the Blue Mountains) all occur where rivers flow over the Great Escarpment. For most of its length the Great Divide (separating rivers flowing to Central Australia from rivers flowing to the Pacific) runs across remarkably flat country dotted with lakes and airstrips. In eastern Victoria, however, the old plateau has been eroded into separate High Plains (such as Dargo High Plain)

The present topography results from a long landscape history which can conveniently be started in the Permian, about 290 million years ago, when much of Australia was glaciated by a huge ice cap. After the ice melted, parts of the continent subsided and were covered with sediment to form sedimentary basins such as the Great Artesian Basin. By early Cretaceous times, about 140 million years ago, Australia was already so flat and low that a major rise in sea level divided it into three landmasses as the shallow Cretaceous sea spread over the land

In the following Tertiary times, Australia can be regarded as a landscape of broad swells varied by a number of sedimentary basins (Murray, Gippsland, Eucla, Carpentaria, Lake Eyre and other basins). These slowly filled up and some are now sources of coal or oil. The Eastern Highlands were uplifted about this time.

Throughout the Tertiary, volcanoes erupted in eastern Australia. Some individual volcanoes were the size of modern Vesuvius, and huge lava plains covered large areas. Volcanic activity continued up to a few thousand years ago in Victoria and Queensland. Australia's youngest volcano is Mt Gambier in South Australia, about 6,000 years old.

Between 55 and 10 million years ago Australia drifted across the surface of the earth as a plate, moving north from a position once adjacent to Antarctica. There have been many changes in the climate of Australia in the past, but oddly these do not seem to be due to changing latitude (associated with global scale plate movements). Even when Australia was close to the South Pole, the climate was relatively warm and wet, and this persisted for a long time despite changes in latitude. It was probably under this climate that the deep weathered, iron-rich profiles that characterise much of Australia were formed. Aridity only seems to have set in after Australia reached its present latitude, and the northern part was probably never arid.

Today a large part of Australia is arid or semi-arid. Sand dunes are mostly longitudinal and are aligned with dominant wind directions associated with the regular passage of high pressure cells (anticyclones). These 'highs' rotate anticlockwise and track at about 28°S in winter and 38°S in summer, resulting in predominantly south-east to easterly flows in the north and north-west to westerly flows in the south. Looking down from above, the south-east Trade Winds or 'Trades' would be those winds in the top right hand quarter of a hypothetical, stationary 'high' centred on the Australian continent.

The dunes are mostly fixed now. Stony deserts or gibber plains (covered with small stones or 'gibbers') are areas without a sand cover and occupy a larger area than the dunefields. Salt lakes occur in many low positions, in places following lines of ancient drainage. They are often associated with lunettes, dunes formed on the downwind side of lakes. Many important finds of Aboriginal prehistory have been made in lunettes. Despite the prevalence of arid conditions today, real aridity seems to be geologically young, with no dunes or salt lakes older than a million years.

The past few million years were notable for the Quaternary ice age. There were many glacial and interglacial periods (over 20) during this time, the last glacial period occurring about 20,000 years ago. In Tasmania, there is evidence of three different glaciations: the last glaciation,

one sometime in the Quaternary, and one in the Tertiary. On the mainland, there is evidence of only the last glaciation, and the ice then covered only 25 km^2, in the vicinity of Mt Kosciusko.

The broad shape of Australia has been influenced over long periods by earth movements associated with large tectonic processes. However, much of the detail has been carved by river erosion. A significant number of Australia's rivers, like the Diamantina River, drain inland. While they may be eroding their valleys near their highland sources, their lower courses are filling up with alluvium, and the rivers often end in salt lakes which are dry for most of the time. Other rivers reach the sea, and have dissected a broad near-coast region into plateaus, hills and valleys. Many of the features of the drainage pattern of Australia have a very long history, and some individual valleys have maintained their position for hundreds of millions of years. The salt lakes of the Yilgarn Plateau in Western Australia are the remnants of a drainage pattern that was active before continental drift separated Australia from Antarctica.

During the last ice age, sea level was more than 100 metres lower than it is today; the current outer reef area of the Great Barrier Reef would have been the coast at that time. The rivers tended to cut down to the lower level, especially towards the sea. When the sea level rose again, some of the lower valleys were drowned, making fine harbours — like Sydney Harbour — while others tended to fill with alluvium as the sea rose — making the typical lowland valleys around the Australian coast.

Coastal geomorphology is also largely the result of the accumulation of sediment in drowned coasts. In some areas, such as Ninety Mile Beach (Victoria) or the Coorong (South Australia), there are beaches made simply from this accumulation. In much of the east there is a characteristic alternation of rocky headland and long beach, backed by plains filled with river and marine sediments.

The offshore shape of Australia, revealed in isobath contours, results mainly from the pattern of break-up of the super-continent of which Australia was once a part. In some areas, such as the Great Australian Bight, there is a broad continental shelf bounded by a steeper continental slope. In other areas, like south-east New South Wales around Merimbula and much of the Tasmanian coastline, the continental shelf is very narrow, sometimes coming to within 20 nautical miles of the coast. The Queensland coast is bounded by a broad plateau on which the Great Barrier Reef has grown in only the last two million years. In South Australia the continental shelf is grooved by submarine canyons.

The Australian landforms of today are thus seen to result from long-continued processes in a unique setting, giving rise to typical Australian landscapes, which in turn provide the physical basis for the distribution and nature of biological and human activity in Australia.

Rivers and lakes

As can be inferred from the elevation and relief map (figure 1.4), the rivers of Australia may be divided into two major classes; those of the coastal margins with moderate rates of fall and those of the central plains with very slight fall. Of the rivers of the east coast, the longest in Queensland are the Burdekin and the Fitzroy, while the Hunter is the largest coastal river of New South Wales. The longest river system in Australia is the Murray–Darling which drains part of Queensland, the major part of New South Wales and a large part of Victoria, finally flowing into the arm of the sea known as Lake Alexandrina, on the eastern side of the South Australian coast. The length of the Murray is about 2,520 km and the Darling and Upper Darling together are also just over 2,000 km long. The rivers of the north-west coast of Australia, for example the Murchison, Gascoyne, Ashburton, Fortescue, De Grey, Fitzroy, Drysdale and Ord, are of considerable length. So also are those rivers in the Northern Territory, for example the Victoria and Daly, and those on the Queensland side of the Gulf of Carpentaria, such as the Gregory, Leichhardt, Cloncurry, Gilbert and Mitchell. The rivers of Tasmania have short and rapid courses, as might be expected from the configuration of the land.

There are many types of lake in Australia, the largest being drainage sumps from the internal rivers. In dry seasons these lakes finally become beds of salt and dry mud. The largest are Lake Eyre 9,500 km^2, Lake Torrens 5,900 km^2 and Lake Gairdner 4,300 km^2.

Other lake types are glacial, most common in Tasmania; volcanic crater lakes, predominantly in Victoria and Queensland; fault angle lakes, of which Lake George near Canberra is a good example; and coastal lakes formed by marine damming of valleys.

Climate of Australia

The island continent of Australia features a wide range of climatic zones, from the tropical regions of the north, through the arid expanses of the interior, to the temperate regions of the south

Widely known as 'The Dry Continent', the land mass is relatively arid, with 80% having a median rainfall less than 600 mm per year and 50% less than 300 mm (the average is 450 mm). Seasonal fluctuations can be large, with temperatures ranging from above 50°C to well below zero. However, extreme minimum temperatures are not as low as those recorded in other continents, probably because of the absence of extensive mountain masses to induce orographic cooling (which is in the order of –0.6°C/100 m increase in elevation) and because of the large expanse of relatively warm surrounding oceans

Although the climate can be described as predominantly continental, the insular nature of the land mass produces modifications to the general continental pattern.

Australia experiences many of nature's more extreme phenomena, particularly droughts, floods, tropical cyclones, severe storms and bushfires.

Climatic controls

The generally low relief of Australia is evident in the elevation and relief map (figure 1.4). Compared to other continents, Australia causes little obstruction to the atmospheric systems which control the climate. A notable exception is the eastern uplands which modify the atmospheric flow, sometimes causing the 'Easterly Dip' which is evident in some surface pressure charts.

In the winter half of the year (May–October) anticyclones, or high pressure systems, pass from west to east across the continent and may remain almost stationary over the interior for several days. These anticyclones may be 4,000 km wide and, in the Southern hemisphere, rotate anticlockwise. Northern Australia is thus influenced by mild, dry south-east winds (the Trade Winds or 'Trades'), and southern Australia experiences cool, moist westerly winds. The westerlies and the frontal systems associated with extensive depressions (lows, sometimes called extra-tropical cyclones) travelling over the Southern Ocean have a controlling influence on the climate of southern Australia during the winter season, causing rainy periods. Periodic north-west cloud bands in the upper levels of the atmosphere over the continent may interact with southern systems to produce rainfall episodes, particularly over eastern areas. Cold outbreaks, particularly in south-east Australia, occur when cold air of Southern Ocean origin is directed northwards by intense depressions having diameters up to 2,000 km. Cold fronts associated with the southern depressions, or with secondary depressions over the Tasman Sea, may produce strong winds and large day-to-day variations in temperature in southern areas, particularly in south-east coastal regions.

In the summer half of the year (November–April) the anticyclones travel from west to east on a more southerly track across the southern fringes of Australia directing easterly winds generally over the continent. Fine, warmer weather predominates in southern Australia with the passage of each anticyclone. Heat waves occur when there is an interruption to the eastward progression of the anticyclone ('blocking') and winds back northerly and later north-westerly. Northern Australia comes under the influence of summer disturbances associated with the southward intrusion of warm moist monsoonal air from north of the intertropical convergence zone, resulting in a hot rainy season. Southward dips of the monsoonal low pressure trough sometimes spawn tropical depressions, and may prolong rainy conditions over northern Australia for up to three weeks at a time.

Tropical cyclones are strong, well-organised low pressure systems of tropical origin where average surface winds are expected to reach at least gale force (speed equivalent of 34–40 knots) — gusts are usually 50% higher than the average (sometimes the definition of tropical cyclone includes surface pressure less than 1,000 hectopascals). Severe tropical cyclones reach at least Storm Force (57–65 knots) — the highest wind speed recorded in Australia was 259 km/h, which occurred with Cyclone Trixie (February 1975). Tropical cyclones develop over the seas where temperatures exceed 27°C around northern Australia in summer, between November and April. Interestingly, tropical cyclones do not usually form within 5° (or so) north or south of the Equator because the Coriolis Force associated with the rotation of the Earth is close to zero in this zone and this 'twist' is important

for cyclone formation. Their frequency of occurrence and the tracks they follow vary greatly from season to season. On average, about three cyclones per season directly affect the Queensland coast, and about three affect the north and north-west coasts. Tropical cyclones approaching the coast usually produce very heavy rain and high winds in coastal areas. Some cyclones move inland, losing intensity but still producing widespread heavy rainfall and, occasionally, moderate to severe damage.

The climate of eastern and northern Australia is influenced by the Oscillation (SO), a see-sawing of atmospheric pressure between the northern Australian/Indonesian region and the central Pacific Ocean. This Oscillation is one of the most important causes of climatic variation after the annual seasonal cycle over eastern and northern Australia. The strength of the SO is defined by the Southern Oscillation Index, which is a measure of the difference in sea level atmospheric pressure between Tahiti in the central Pacific and Darwin in northern Australia. At one extreme of the Oscillation, the pressure is abnormally high at Darwin and abnormally low at Tahiti. Severe and widespread drought over eastern and northern Australia generally accompanies this extreme. These conditions generally commence early in the year, last for about 12 months, and have a recurrence period of two to seven years.

The above extreme is generally immediately preceded or followed by the opposite extreme where pressures at Darwin are abnormally low and those at Tahiti are abnormally high. In this case, rainfall is generally above average over eastern and northern Australia.

The SO is linked to sea surface temperatures (SSTs) in the Pacific Ocean. Dry extreme SO years are accompanied by above normal SSTs in the central and/or eastern equatorial Pacific and vice versa. Dry extreme years are called El Niño years (El Niño is 'baby boy' in Spanish). Wet extreme years are called La Niña years (La Niña is 'baby girl'). Continuing research in the El Niño/La Niña phenomenon is revealing the connectivity between atmospheric circulation, sea surface temperatures, currents (surface as well as deep currents) and their interaction with the land masses.

Rainfall and other precipitation

Annual

The area of lowest rainfall is in the vicinity of Lake Eyre in South Australia, where the median annual rainfall is only about 100 mm. Another very low rainfall area is in Western Australia in the Giles–Warburton Range region, which has a median annual rainfall of about 150 mm. A vast region, extending from the west coast near Shark Bay across the interior of Western Australia and South Australia to south-west Queensland and north-west New South Wales, has a median annual rainfall of less than 200 mm. This region is not normally exposed to moist air masses for extended periods and rainfall is irregular, averaging only one or two days per month. However, in favourable synoptic situations, which occur infrequently over extensive parts of the region, up to 400 mm of rain may fall within a few days and cause widespread flooding.

The region with the highest median annual rainfall is the east coast of Queensland between Cairns and Cardwell, where Tully has a median of 4,048 mm (63 years to 1987 inclusive). The mountainous region of western Tasmania also has a high annual rainfall, with Lake Margaret having a median of 3,565 mm (76 years to 1987 inclusive). In the mountainous areas of north-east Victoria and some parts of the east coastal slopes there are small pockets with median annual rainfall greater than 2,500 mm.

The Snowy Mountains area in New South Wales also has a particularly high rainfall. The highest median annual rainfall for this region is 3,200 mm, and it is likely that small areas have a median annual rainfall approaching 4,000 mm on the western slopes above 2,000 metres elevation.

1.5 AREA DISTRIBUTION OF MEDIAN ANNUAL RAINFALL

Median annual rainfall (mm)	NSW(a) %	Vic. %	Qld %	SA %	WA %	Tas. %	NT %	Aust. %
Under 199	8.0	..	10.2	74.2	43.5	..	15.5	29.6
200–299	20.3	6.3	13.0	13.5	29.6	..	35.6	22.9
300–399	19.0	19.2	12.3	6.8	10.5	..	9.0	11.2
400–499	12.4	11.8	13.5	3.2	4.3	..	6.6	7.6
500–599	11.3	14.1	11.6	1.8	3.1	12.2	5.8	6.6
600–799	15.1	24.5	20.5	0.5	4.6	18.2	11.6	10.7
800–1 200	11.3	17.7	12.6	..	3.7	25.0	9.6	7.7
Above 1 200	2.6	6.4	6.3	..	0.7	44.6	6.3	3.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

(a) Includes Australian Capital Territory.

Source: Bureau of Meteorology.

Seasonal

As outlined earlier, the rainfall pattern of Australia is strongly seasonal in character with a winter rainfall regime in the south and a summer regime in the north.

The dominance of rainfall over other climatic elements in determining the growth of specific plants in Australia has led to the development of a climatic classification based on two main parameters. The parameters are median annual rainfall and seasonal rainfall incidence.

Evaporation and the concept of rainfall effectiveness are taken into account to some extent in this classification by assigning higher median annual rainfall limits to the summer zones than to the corresponding uniform and winter zones. The main features of the seasonal rainfall are:

- marked wet summer (the 'Monsoon') and dry winter of northern Australia;
- wet summer and relatively dry winter of south-eastern Queensland and north-eastern New South Wales;
- uniform rainfall in south-eastern Australia — much of New South Wales, parts of eastern Victoria and southern Tasmania;
- marked wet winter and dry summer of south-west Western Australia and, to a lesser extent, much of the remainder of southern Australia directly influenced by westerly circulation (sometimes called a 'Mediterranean' climate); and
- arid area comprising about half the continent extending from the north-west coast of Western Australia across the interior and reaching the south coast at the head of the Great Australian Bight.

Rainday frequency

A rainday occurs where more than 0.2 mm of rain falls in 24 hours, usually from 9 a.m to 9 a.m. the next day. The frequency of raindays exceeds 150 per year in Tasmania (with a maximum of over 200 in western Tasmania), southern Victoria, parts of the north Queensland coast and in the extreme south-west of Western Australia. Over most of the continent the frequency is less than 50 raindays per year. The area of low rainfall with high variability, extending from the north-west coast of Western Australia through the interior of the continent, has less than 25 raindays per year. In the high rainfall areas of northern Australia the number of raindays is about 80 per year, but heavier falls occur in this region than in southern regions.

Rainfall intensity

The values in table 1.6 represent intensities over only small areas around the recording points because turbulence and exposure characteristics of the measuring gauge may vary over a distance of a few metres. The highest 24 hour (9 a.m. to 9 a.m.) falls are listed in table 1.7. Most of the very high 24 hour falls (above 700 mm) have occurred in the coastal strip of Queensland, where a tropical cyclone moving close to mountainous terrain provides ideal conditions for spectacular falls.

The highest annual rainfalls are listed by State/Territory in table 1.8.

1.6 HIGHEST RAINFALL INTENSITIES

Station	Period of record	Years of complete records	Period in hours: 1 mm	3 mm	6 mm	12 mm	24 mm
Adelaide	1897–1991	91	69	133	141	141	141
Alice Springs	1951–1994	44	75	87	108	160	207
Brisbane	1911–1991	81	99	142	182	266	327
Broome	1948–1991	44	112	157	185	313	353
Canberra	1938–1990	45	40	57	67	76	120
Carnarvon	1956–1991	36	44	63	83	95	108
Charleville	1953–1992	35	42	66	75	111	142
Darwin (Airport)	1953–1994	42	89	160	214	260	291
Esperance	1963–1991	27	39	50	62	75	86
Hobart	1911–1991	81	28	56	87	117	168
Meekatharra	1953–1991	39	60	67	81	99	112
Melbourne	1873–1994	108	76	83	86	97	130
Mildura	1953–1993	41	49	60	65	66	91
Perth	1946–1991	45	31	43	52	77	97
Sydney	1913–1991	75	121	194	200	244	340
Townsville	1953–1992	39	94	168	235	296	319

Source: Pluviograph records in Bureau of Meteorology archives.

1.7 HIGHEST DAILY RAINFALLS(a)

State/Territory	Date	Amount mm
New South Wales		
Dorrigo (Myrtle Street)	21.2.1954	809
Lowanna (Yalamurra)	22.4.1974	662
Victoria		
Tanybryn	22.3.1983	375
Nowa Nowa (Wairawa)	11.3.1906	275
Queensland(a)		
Beerwah (Crohamhurst)	3.2.1893	907
Finch Hatton PO	18.2.1958	878
South Australia		
Motpena	14.3.1989	273
Nilpena	14.3.1989	247
Western Australia		
Roebourne (Whim Creek)	3.4.1898	747
Broome (Kilto)	4.12.1970	635
Tasmania		
Cullenswood	22.3.1974	352
Mathinna	5.4.1929	337
Northern Territory		
Roper Valley Station	15.4.1963	545
Angurugu (Groote Eylandt)	28.3.1953	513

(a) Bellenden Ker (Top Station) has recorded a 24 hour total of 960 mm from 3 p.m. to 3 p.m. on 3 and 4 January 1979. The standard daily rainfall period is 9 a.m. to 9 a.m.

Source: Bureau of Meteorology.

1.8 HIGHEST ANNUAL RAINFALLS

State/Territory	Station	Year	Amount mm
NSW	Tallowwood Point	1950	4 540
Vic.	Falls Creek SEC	1956	3 739
Qld	Bellenden Ker (Top Station)	1979	11 251
SA	Aldgate State School	1917	1 853
WA	Armadale (Jarrahdale PO)	1917	2 169
Tas.	Lake Margaret	1948	4 504
NT	Elizabeth Downs	1973	2 966

Source: Bureau of Meteorology.

Thunderstorms and hail

A thunderday at a given location is a calendar day on which thunder is heard at least once. The average annual number of thunderdays varies from 74 per year near Darwin to less than 10 per year over parts of the southern regions. Convectional processes during the summer wet season cause high thunderstorm incidence in northern Australia. The generally high incidence of thunderdays (40–60 annually) over the eastern upland areas is caused mainly by orographic uplift of moist air streams.

Hail, mostly of small size (less than 10 mm diameter), occurs with winter-spring cold frontal activity in southern Australia. Summer thunderstorms, particularly over the uplands of eastern Australia, sometimes produce large hail (greater than 10 mm diameter). Large hail capable of piercing light-gauge galvanised iron occurs at irregular intervals and sometimes causes widespread damage.

Snow

Generally, snow covers much of the Australian Alps above 1,500 metres for varying periods from late autumn to early spring. Similarly, in Tasmania the mountains are covered fairly frequently above 1,000 metres in these seasons. The area, depth and duration are highly variable. In some years, snow falls in the altitude range of 500–1,000 metres. Snowfalls at levels below 500 metres are occasionally experienced in southern Australia, particularly in the foothill areas of Tasmania and Victoria, but falls are usually light and short lived. In some seasons, parts of the eastern uplands above 1,000 metres from Victoria to south-eastern Queensland have been covered with snow for several weeks. In ravines around Mount Kosciusko (2,228 metres) small areas of snow may persist through summer, but there are no permanent snowfields.

Temperature

Average temperatures

Average annual air temperatures range from 28°C along the Kimberley coast in the extreme north of Western Australia to 4°C in the alpine areas of south-eastern Australia. Although annual temperatures may be used for broad comparisons, monthly temperatures are required for detailed analyses

July is the month with the lowest average temperature in all parts of the continent. The months with the highest average temperature are January or February in the south and December in the north (except in the extreme north and north-west where it is November). The slightly lower temperatures of mid-summer in the north are due to the increase in cloud during the wet season.

Average monthly maxima

In January, average maximum temperatures exceed 35°C over a vast area of the interior and exceed 40°C over appreciable areas of the north-west. The consistently hottest part of Australia in terms of summer maxima is around Marble Bar in Western Australia (150 km south-east of Port Hedland) where the average is 41°C and daily maxima during summer may exceed 40°C consecutively for several weeks at a time.

In July, a more regular latitudinal distribution of average maxima is evident. Maxima range from 30°C near the north coast to 5°C in the alpine areas of the south-east.

Average monthly minima

In January, average minima range from 27°C on the north-west coast to 5°C in the alpine areas of the south-east. In July, average minima fall below 5°C in areas south of the tropics (away from the coasts). Alpine areas record the lowest temperatures; the July average low is –5°C.

Extreme maxima

Temperatures have exceeded 45°C at nearly all inland stations more than 150 km from the coast and at many places on the north-west and south coasts. Temperatures have exceeded 50°C at some inland stations and at a few near the coast. It is noteworthy that Eucla on the south coast has recorded 50.7°C, the highest temperature in Western Australia. This is due to the long trajectory over land of hot north-west winds

from the Marble Bar area. Although the highest temperature recorded in Australia was 53.1°C at Cloncurry (Queensland), more stations have exceeded 50°C in western New South Wales than in other areas due to the long land trajectory of hot winds from the north-west interior of the continent.

Extreme maximum temperatures recorded at selected stations, including the highest recorded in each State/Territory, are shown in the following table.

1.9 EXTREME MAXIMUM TEMPERATURES

Station	°C	Date
New South Wales		
Bourke	52.8	17.1.1877
Wilcannia	50.0	11.1.1939
Menindee	49.7	10.1.1939
Victoria		
Mildura	50.8	6.1.1906
Swan Hill	49.4	18.1.1906
Queensland		
Cloncurry	53.1	16.1.1889
Winton	50.7	14.12.1888
Birdsville	49.5	24.12.1972
South Australia		
Oodnadatta	50.7	2.1.1960
Marree	49.4	2.1.1960
Whyalla	49.4	2.1.1960
Western Australia		
Eucla	50.7	22.1.1906
Mundrabilla	49.8	3.1.1979
Forrest	49.8	13.1.1979
Madura	49.4	7.1.1971
Tasmania		
Bushy Park	40.8	26.12.1945
Hobart	40.8	4.1.1976
Northern Territory		
Finke	48.3	2.1.1960
Jervois	47.5	3.1.1978
Australian Capital Territory		
Canberra (Acton)	42.8	11.1.1939

Source: Bureau of Meteorology.

Extreme minima

The lowest temperatures in Australia have been recorded in the Snowy Mountains, where Charlotte Pass (elevation 1,760 metres) recorded –23.0°C on 28 June 1994. Temperatures have fallen below –5°C at most inland places south of the tropics and at some places within a few kilometres of southern coasts. At Eyre, on the south coast of Western Australia, a minimum temperature of –4.3°C has been recorded, and at Swansea, on the east coast of Tasmania, the temperature has fallen as low as –5.0°C.

In the tropics, extreme minima below 0°C have been recorded at many places away from the coasts — as far north as Herberton, Queensland (–5.0°C). Even very close to the tropical coastline, temperatures have fallen to 0°C, a low recording being –0.8°C for Mackay.

1.10 EXTREME MINIMUM TEMPERATURES

Station	°C	Date
New South Wales		
Charlotte Pass	–23.0	18.6.1994
Kiandra	–20.6	2.8.1929
Perisher Valley	–19.5	23.7.1979
Victoria		
Mount Hotham	–12.8	30.7.1931
Omeo	–11.7	15.6.1965
Hotham Heights	–11.1	15.8.1968
Queensland		
Stanthorpe	–11.0	4.7.1895
Warwick	–10.6	12.7.1965
Mitchell	–9.4	15.8.1979
South Australia		
Yongala	–8.2	20.7.1976
Yunta	–7.7	16.7.1976
Ernabella	–7.6	19.7.1983
Western Australia		
Booylgoo Springs	–6.7	12.7.1969
Wandering	–5.7	1.6.1964
Tasmania		
Shannon	–13.0	30.6.1983
Butlers Gorge	–13.0	30.6.1983
Tarraleah	–13.0	30.6.1983
Northern Territory		
Alice Springs	–7.5	12.7.1976
Tempe Downs	–6.9	24.7.1971
Australian Capital Territory		
Gudgenby	–14.6	11.7.1971

Source: Bureau of Meteorology.

Heat waves

Periods with a number of successive days having a temperature higher than 40°C are relatively common in summer over parts of Australia. With the exception of the north-west coast of Western Australia, however, most coastal areas rarely experience more than three successive days of such conditions. The frequency increases inland, and periods of up to 10 successive days have been recorded at many inland stations. This figure increases in western Queensland and north-west Western Australia to more than 20 days in places. The central part of the Northern Territory and the Marble Bar–Nullagine area of Western Australia have recorded the most prolonged heat waves. Marble Bar is the only station in the world where temperatures of more than 37.8°C

(100°F) have been recorded on as many as 161 consecutive days (30 October 1923 to 7 April 1924).

Heat waves are experienced in the coastal areas from time to time. During 11–14 January 1939, for example, a severe heat wave affected south-eastern Australia: Adelaide had a record of 47.6°C on the 12th, Melbourne a record of 45.6°C on the 13th and Sydney a record of 45.3°C on the 14th.

The Kimberley district of Western Australia is the consistently hottest part of Australia in terms of annual average maximum temperature. Wyndham, for example, has an annual average maximum of 35.6°C.

Other aspects of climate

Frost

Frost can cause serious losses of agricultural crops, and numerous climatic studies have been made in Australia relating to specific crops cultivated in local areas.

Frost frequency depends on location and orography, and even on minor variations in topography. In simplified terms, location controls the extent to which the relatively warm ocean temperatures ameliorate those on land (often called 'continentality') and, on an even larger scale, location in this context means proximity to the Equator or to the cooler climates towards the south. Orography relates loosely to elevation (noting that an air parcel which is obliged to rise above a mountain range will cool (by expansion) about 0.6°C for each 100 metres it rises above sea level), and to topography. Topography influences frost on a much more local scale than the other factors. It does this through controlling 'cold air draining', which is a night time phenomenon where cool air 'flows' down hillsides and accumulates in low lying areas, occasionally causing 'frost hollows' with very low temperatures. The topographic effect is largely independent of the other factors and can happen anywhere in complex terrain under clear and calm weather conditions.

Frost hazard will be greatest in areas which are away from the immediate coast, are at relatively high elevations and have complex terrain which is conducive to cold air drainage.

The parts of Australia which are most subject to frost are the eastern uplands from north-eastern Victoria to the western Darling Downs in southern Queensland. Most stations in this region experience more than 10 nights a month with readings of 0°C (or under) for three to five months of the year. On Tasmania's Central Plateau similar conditions occur for three to six months of the year. Frosts may occur within a few miles of the coasts except in the Northern Territory and most of the north Queensland coasts.

Regions in which frosts may occur at any time of the year comprise most of Tasmania, large areas of the tablelands of New South Wales, much of inland Victoria, particularly the north-east, and a small part of the extreme south-west of Western Australia. Over most of the interior of the continent, and on the highlands of Queensland as far north as the Atherton Plateau, frosts commence in April and end in September. Minimum temperatures below 0°C are experienced in most of the subtropical interior in June and July.

The median frost period over the continent varies from over 200 days per year in the south-eastern uplands areas south of the Hunter Valley, to zero days in northern Australia. In the southern regions of the continent, the annual frost period generally decreases from about 100 days inland to below 50 days towards the coast. However, there are appreciable spatial variations depending mainly on local orography. In Tasmania the frost period exceeds 300 days on the uplands and decreases to 100 days near the coast.

The regions of mainland Australia most prone to heavy frosts are the eastern uplands and adjacent areas extending from Victoria through New South Wales to south-eastern Queensland. Stations above 1,000 metres in altitude in the southern parts of these uplands have more than 100 heavy frosts annually, and in the upland areas below 1,000 metres the annual frequency ranges from 100 to about 20. Over the remainder of southern Queensland, New South Wales and Victoria, although there are great spatial variations, the average annual frequency of heavy frosts typically ranges from about 20 inland to 10 towards the coast.

In Tasmania, uplands above 1,000 metres have more than 100 heavy frosts annually and, in neighbouring areas, the frequency is about 100 decreasing to 20 towards the coasts. Even some coastal stations have a relatively high frequency (Swansea, for example, has 16).

The southern half of Western Australia, the whole of South Australia, and the Alice Springs district of the Northern Territory experience heavy frosts. Differences in annual frequencies between places are great, but in general the frequency is about 10 inland decreasing towards the coasts. Some places average more than 20 heavy frosts annually, notably Wandering, Western Australia (22) and Yongala, South Australia (42). At Alice Springs the annual average frequency is 12.

Humidity

Australia is a dry continent in terms of the water vapour content or humidity of the air, and this element may be compared with evaporation to which it is related. Moisture content can be expressed by a number of parameters, of which the most commonly known is relative humidity. Relative humidity can be thought of as the relative evaporating power of the air; when the humidity is low, a wet surface, like our skin, can evaporate freely. When it is high, evaporation is retarded. People can feel this as discomfort or even stress as the body's ability to perspire (and hence cool) decreases with increasing relative humidity. The combination of high temperature and high humidity is potentially dangerous for people who are active in such conditions.

The main features of the relative humidity pattern are:

- over the interior of the continent there is a marked dryness during most of the year, notably towards the northern coast in the dry season (May–October);
- the coastal fringes are comparatively moist, although this is less evident along the north-west coast of Western Australia where continental effects are marked;
- in northern Australia, the highest values occur during the summer wet season (December–February) and the lowest during the winter dry season (June–August); and
- in most of southern Australia the highest values are experienced in the winter rainy season (June–August) and the lowest in summer (December–February).

Global radiation

Global (short wave) radiation includes that radiation energy reaching the ground directly from the sun and that received indirectly from the sky, scattered downwards by clouds, dust particles, etc.

A high correlation exists between daily global radiation and daily hours of sunshine. On the north-west coast around Port Hedland, where average daily global radiation is the highest for Australia (640 milliwatt hours), average daily sunshine is also highest, being approximately 10 hours. Sunshine is more dependent on variations in cloud coverage than is global radiation, since the latter includes diffuse radiation from the sky as well as direct radiation from the sun. An example is Darwin where, in the dry month of July, sunshine approaches twice that of the wet (cloudy) month of January, but global radiation amounts for the two months are comparable.

Sunshine

Sunshine here refers to bright or direct sunshine. Australia receives relatively large amounts of sunshine although seasonal cloud formations have a notable effect on its spatial and temporal distribution. Cloud cover reduces both incoming solar radiation and outgoing long wave radiation and thus affects sunshine, air temperature and other climatic elements on the Earth's surface.

Most of the continent receives more than 3,000 hours of sunshine a year, or nearly 70% of the total possible. In central Australia and the mid-west coast of Western Australia, totals slightly in excess of 3,500 hours occur. Totals of less than 1,750 hours occur on the west coast and highlands of Tasmania; this amount is only 40% of the total possible per year (about 4,380 hours).

In southern Australia the duration of sunshine is greatest about December when the sun is at its highest elevation, and lowest in June when the sun is lowest. In northern Australia sunshine is generally greatest about August–October prior to the wet season, and least about January–March during the wet season.

Cloud

Seasonal changes in cloudiness vary with the distribution of rainfall. In the southern parts of the continent, particularly in the coastal and low-lying areas, the winter months are generally more cloudy than the summer months. This is due to the formation of extensive areas of stratiform cloud and fog during the colder months, when the structure of the lower layers of the atmosphere favours the physical processes resulting in this type of cloud. Particularly strong seasonal variability of cloud

cover exists in northern Australia where skies are clouded during the summer wet season and mainly cloudless during the winter dry season. Cloud coverage is greater near coasts and on the windward slopes of the eastern uplands of Australia and less over the dry interior.

Fog

The formation of fog depends on the occurrence of favourable meteorological elements — mainly temperature, humidity, wind, and cloud cover. The nature of the local terrain is important for the development of fog and there is a tendency for this phenomenon to persist in valleys and hollows. The incidence of fog may vary significantly over distances as short as one kilometre.

Fog in Australia tends to be more common in the south than the north, although parts of the east coastal areas are relatively fog-prone even in the tropics. Incidence is much greater in the colder months, particularly in the eastern uplands. Fog may persist during the day, but rarely until the afternoon over the interior. The highest fog incidence at a capital city is at Canberra which has an average of 47 days per year on which fog occurs, 29 of which are in the period of May to August. Brisbane averages 20 days of fog per year. Darwin averages only two days per year, in the months of July and August.

Winds

The mid-latitude anticyclones are the chief determinants of Australia's two main prevailing wind streams. In relation to the west-east axes of the anticyclones these streams are easterly to the north and westerly to the south. The cycles of development, motion and decay of low-pressure systems to the north and south of the anticyclones result in diversity of wind-flow patterns. Wind variations are greatest around the coasts where diurnal land and sea-breeze effects are important.

Orography affects the prevailing wind pattern in various ways, such as the channelling of winds through valleys, deflection by mountains and cold air drainage from highland areas. An example of this channelling is the high frequency of north-west winds at Hobart caused by the north-west to south-east orientation of the Derwent River Valley.

Perth is the windiest capital with an average wind speed of 15.6 km/h; Canberra is the least windy with an average speed of 5.4 km/h

The highest wind speeds and wind gusts recorded in Australia have been associated with tropical cyclones. The highest recorded gust was 259 km/h at Mardie (near Onslow), Western Australia on 19 February 1975, and gusts reaching 200 km/h have been recorded on several occasions in northern Australia with cyclone visitations. The highest gusts recorded at Australian capitals were 217 km/h at Darwin and 156 km/h at Perth.

Droughts

Drought, in general terms, refers to an acute deficit of water supply to meet a specified demand. The best single measure of water availability in Australia is rainfall, although parameters such as evaporation and soil moisture are significant, even dominant in some situations Demands for water are very diverse, hence the actual declaration of drought conditions for an area will generally also depend on the effects of a naturally occurring water deficit on the principal local industries.

Since the 1860s there have been 10 major Australian droughts. Some of these major droughts could be described as periods consisting of a series of dry spells of various lengths, overlapping in time and space, and totalling up to about a decade. The drought periods of 1895–1903, 1958–68, 1982–83 and 1991–95 were the most devastating in terms of their extent and effects on primary production. The latter drought resulted in a possible $5 b cost to Australia's economy, and $590m in drought relief by the Commonwealth Government. The remaining major droughts occurred in 1864–66 (and 1868), 1880–86, 1888, 1911–16, 1918–20 and 1939–45

In this same period, several droughts of lesser severity caused significant losses over large areas of some States. They occurred in 1922–23 and 1926–29, 1933–38, 1946–49, 1951–52, 1970–73 and 1976.

South-eastern Australia (New South Wales, southern Queensland, Victoria, Tasmania and the settled parts of South Australia) contains about 75% of the nation's population, and droughts affecting this region have a markedly adverse impact on the economy. There have been eight severe droughts in south-eastern Australia since 1888, and these were

encompassed within the major Australian droughts specified previously, except for the severe drought in 1972–73. Drought definitions and the area of coverage and length of droughts, together with related information, may be obtained from *Year Book Australia, 1988*.

Floods

Widespread flood rainfall may occur anywhere in Australia, but it has a higher incidence in the north and in the eastern coastal areas. It is most economically damaging along the shorter streams flowing from the eastern uplands eastward to the seaboard of Queensland and New South Wales. These flood rains are notably destructive in the more densely populated coastal river valleys of New South Wales — the Tweed, Richmond, Clarence, Macleay, Hunter and Nepean–Hawkesbury — all of which experience relatively frequent flooding. Although chiefly caused by summer rains, they may occur in any season.

The great Fitzroy and Burdekin river basins of Queensland receive flood rains during the summer wet seasons. Much of the run-off due to heavy rain in north Queensland west of the eastern uplands flows southward through the normally dry channels of the network of rivers draining the interior lowlands into Lake Eyre. This widespread rain may cause floods over an extensive area, but it soon seeps away or evaporates, occasionally reaching the lake in quantity. The Condamine and other northern tributaries of the Darling also carry large volumes of water from flood rains south through western New South Wales to the Murray, and flooding occurs along their courses at times.

Flood rains occur at irregular intervals in the Murray–Murrumbidgee system of New South Wales and Victoria, the coastal streams of southern Victoria and the north coast streams of Tasmania.

Water resources

Rainfall, or the lack of it, is the most important single factor determining land use and rural production in Australia. The scarcity of both surface and ground water resources, together with the low rates of precipitation which restrict agriculture (quite apart from economic factors), has led to extensive programs to regulate supplies by construction of dams, reservoirs, large tanks and other storages.

The major topographical feature affecting the rainfall and drainage patterns in Australia is the absence of high mountain barriers. Australia's topographical features encompass sloping tablelands and uplands along the east coast Main Divide, the low plain and marked depression in the interior, and the Great Western Plateau.

Only one-third of the Australian land area drains directly to the ocean, mainly on the coastal side of the Main Divide and inland with the Murray—Darling system. With the exception of the latter, most rivers draining to the ocean are comparatively short but account for the majority of the country's average annual discharge. Surface drainage is totally absent from some arid areas of low relief.

Australia's large area (7.7 km^2) and latitudinal range (3,700 km) have resulted in climatic conditions ranging from alpine to tropical. Two-thirds of the continent is arid or semi-arid, although good rainfalls (over 800 mm annually) occur in the northern monsoonal belt under the influence of the Australian–Asian monsoon, and along the eastern and southern highland regions under the influence of the great atmospheric depressions of the Southern Ocean. The effectiveness of the rainfall is greatly reduced by marked alternation of wet and dry seasons, unreliability from year to year, high temperatures and high potential evaporation.

The availability of water resources controls, to a large degree, the possibility and density of settlement; this in turn influences the quality of the water through production and disposal of waste. Most early settlements were established on the basis of reliable surface water supplies and, as a result, Australia's population is concentrated along the coast, mainly in the comparatively fertile, well-watered east, south-east and far south-west.

As settlement spread into the dry inland grazing country, the value of reliable supplies of underground water was realised. Observations of the disappearance of large quantities of the rainfall precipitated on the coastal ranges of eastern Australia eventually led to the discovery of the Great Artesian Basin which has become a major asset to the pastoral industry. Development, however, has not been without costs. Significant environmental degradation and deterioration in water quality are becoming evident.

1.11 MAJOR GROUND WATER RESOURCES

State/Territory	Area of aquifers km²	Ground water resource: Major divertible resource: Fresh GL	Marginal GL	Brackish GL	Saline GL	Total GL	Abstraction during 1983–84 GL
New South Wales	595 900	881	564	431	304	2 180	242
Victoria	103 700	469	294	69	30	862	146
Queensland	1 174 800	1 760	683	255	144	2 840	962
South Australia	486 100	102	647	375	86	1 210	504
Western Australia	2 622 000	578	1 240	652	261	2 740	355
Tasmania	7 240	47	69	8	—	124	5
Northern Territory	236 700	994	3 380	43	10	4 420	24
Australia	**5 226 440**	**4 831**	**6 877**	**1 833**	**835**	**14 376**	**2 238**

Source: Australian Water Resources Council, 1987.

Permanent rivers and streams flow in only a small part of the continent. The average annual discharge of Australian rivers has been recently assessed at 397 teralitres of which 100 teralitres are now estimated to be exploitable on a sustained yield basis. This is small in comparison with river flows on other continents, as indicated in the following broad comparison of rainfall and run-off of the continents.

1.12 RAINFALL AND RUN-OFF OF THE CONTINENTS

Continent	Area km²	Average yearly rainfall mm	Run-off mm	Run-off km³	Run-off %
Africa	30 300 000	690	260	7 900	38
Asia	45 000 000	600	290	13 000	48
Australia	7 700 000	465	57	440	12
Europe	9 800 000	640	250	2 500	39
North America	20 700 000	660	340	6 900	52
South America	17 800 000	1 630	930	16 700	57

Source: Department of Resources and Energy, 1983.

In addition, there is a pronounced concentration of run-off in the summer months in northern Australia while the southern part of the continent has a distinct, if somewhat less marked, winter maximum.

Even in areas of high rainfall, large variability in flow means that, for local regional development, most streams must be regulated by surface storage. However, in many areas evaporation is so great that storage costs are high in terms of yield. Extreme floods also add greatly to the cost of water storage, because of the need for adequate spillway capacity.

The portion of run-off able to be diverted for use is very low compared with other continents, and results from the high variability of stream flow, high rates of evaporation and the lack of storage sites on many catchments. On an Australia-wide basis, only 21.5% of the divertible resource has currently been developed for use; much of the remaining resource is available in remote regions where development is impractical and uneconomic. In areas such as the Murray–Darling Division, where water is scarce, there are few resources not yet developed, and management is focusing on greater efficiency in water use.

Water resources are assessed within a framework comprising four levels:

- the total water resource is the volume of water present in the environment, measured as mean annual run-off for surface water, and mean annual recharge for ground water;
- the divertible resource is the portion of run-off and recharge which can be developed for use;
- the developed resource is the portion of the divertible resource which has been developed for use; and

- resource utilisation is a measure of the portion of the developed resource which is actually used.

Emphasis is given to the second level of assessment, the divertible resource, as the prime measure of the resource. The divertible resource is defined as the average annual volume of water which, using current technology, could be removed from developed or potential surface water or ground water sources on a sustained basis, without causing adverse effects or long-term depletion of storages.

1.13 SURFACE WATER RESOURCES

		Surface water resource							
				Major divertible resource					
State/Territory	Area km^2	Mean annual run-off GL	Mean annual outflow GL	Fresh GL	Marginal GL	Brackish GL	Saline GL	Total GL	Developed resource GL
New South Wales	802 000	42 400	37 200	16 900	—	—	—	16 900	7 970
Victoria	228 000	19 200	18 800	9 050	240	120	—	9 810	5 990
Queensland	1 730 000	159 000	158 000	32 700	—	—	—	32 700	3 840
South Australia	984 000	2 120	1 250	193	109	59	20	384	124
Western Australia	2 520 000	39 900	39 700	10 200	516	856	168	11 700	2 340
Tasmania	68 200	52 900	52 900	10 800	—	—	—	10 900	1 020
Northern Territory	1 350 000	81 200	79 200	17 700	—	—	—	17 700	59
Australian Capital Territory	2 400	549	549	175	—	—	—	175	106
Australia	**7 684 600**	**397 300**	**387 600**	**97 700**	**865**	**1 040**	**190**	**100 300**	**21 500**

Source: Australian Water Resources Council, 1987.

Australia's water resources are managed by a large number of resource management agencies, irrigation authorities, metropolitan water boards, local government councils and private individuals. State authorities dominate the assessment and control of water resources as, under the Commonwealth Constitution, primary responsibility for management of water rests with the individual State Governments. The Commonwealth Government is responsible for matters relating to its Territories, and participates indirectly through financial assistance or directly in the coordination or operation of interstate projects through bodies such as the Murray–Darling Basin Commission.

A description of the management, main storage and use of water resources across the States and Territories is contained in the chapter, *Water resources*, in the 1994 and earlier editions of *Year Book Australia*.

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