Rainfall in the Riverina

Australia has one of the worlds most variable climates making it a challenge to describe a normal year.

Australia is surrounded by two of the world's largest oceans and these have a profound and ever changing effect on our weather. Like the rest of Australia, southern New South Wales has experienced wide variations in rainfall during the last century.

Climate records collected at New South Wales Department of Primary Industries (NSW DPI) Wagga Wagga since 1898 highlight the extremes we have experienced over the last hundred years in our region. Rainfall figures for several towns across southern NSW are used as examples, representing the region.

Average monthly rainfall

Average rainfall varies across NSW (see Table 1 and Figure 1), with summer rainfall a feature of northern NSW and winter rainfall more a feature in southern NSW.

The rainfall pattern in Table 1 and Figure 1 is the 'typical' distribution in southern NSW, and is considered to be a winter effective pattern. In the Riverina the distribution of rainfall is fairly even across each month of the year.

In the eastern Riverina (e.g. Tumut), the winter rainfall trend is slightly more definite (see Figure 1). Tumut has a low average 43 mm in February and a high 86 mm in August.

My Country by Dorothea McKellar

Verse 2

I love a sunburnt country, a land of sweeping plains,
Of ragged mountain ranges, of droughts and flooding rains.
I love her far horizons, I love her jewel-sea,
Her beauty and her terror- the wide brown land for me!

Verse 4

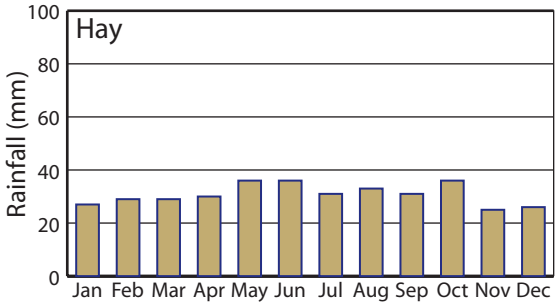
Core of my heart, my country! Her pitiless blue sky,
When, sick at heart, around us we see the cattle die -
But then the grey clouds gather, and we can bless again
The drumming of an army, the steady soaking rain.

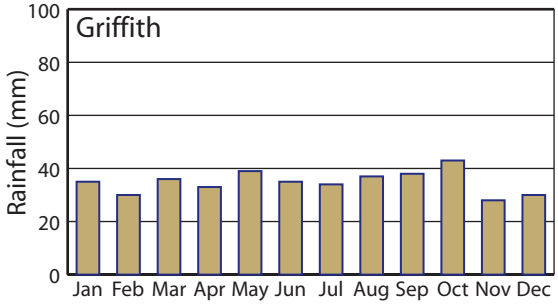
Summer storms during harvest add to the variability of Australia's rainfall.

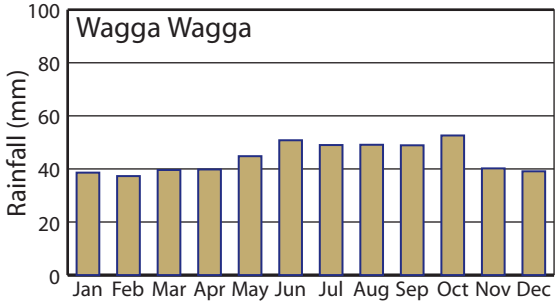
Photo: Di Holding.

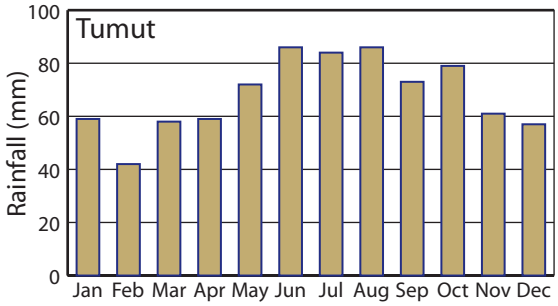
Table 1 Average monthly rainfall, and the lowest and highest recorded monthly rainfall for NSW DPI, Wagga Wagga.

Month	Monthly rainfall (mm)		
	Average	Lowest	Highest
January	38.6	0	190.8
February	37.3	0	183.4
March	39.6	0	219.7
April	39.8	0	189.9
May	44.8	0.5	172.7
June	50.8	6.0	190.5
July	49.0	4.6	122.4
August	49.1	3.6	130.8
September	48.9	4.3	137.9
October	52.6	0.5	183.1
November	40.2	0	166.2
December	39.1	0	194.1









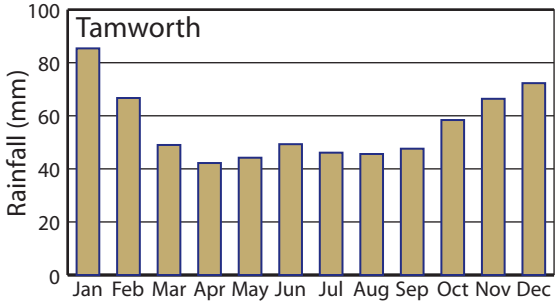


Figure 1 Average monthly rainfall for the New South Wales towns of Hay, Griffith, Wagga Wagga, Tumut and Tamworth.

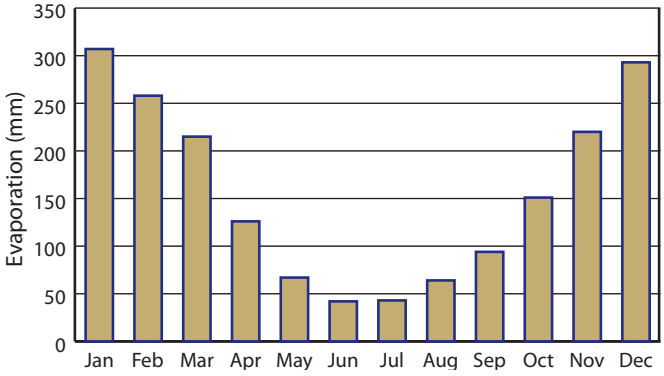


Figure 2 Average monthly evaporation at NSW DPI Wagga Wagga.

In comparison Tamworth (see Figure 1) in northern NSW has summer dominant rainfall, typical of northern NSW. In December and January average monthly rainfall peaks at 75 mm and 86 mm, respectively. In winter the average is 30 mm less (46 mm in July, 45 mm in August). On average, Tamworth has almost twice as much rain in summer than Wagga Wagga.

Although the averages appear quite uniform, in most years rainfall is far from evenly spread. There is often very heavy rain in February, for example, with lower than average falls for the rest of the year. While the total for the year appears 'normal', the cropping year may be

Measuring evaporation

Evaporation is measured, in millimetres of water, using an evaporation pan. It is an open pan of water and is covered with bird netting to stop birds and animals drinking from it. Evaporation is determined by measuring the amount of water required to refill the pan to a predetermined level.

Photo: Australian Bureau of Meteorology web site

very poor because the rain fell outside the crop growing period. 1994 is an example of this. NSW DPI Wagga Wagga recorded 135 mm in February, and less than 200 mm during the whole winter growing season (April-October).

Summer crops are too risky to grow in the region without irrigation because of the high evaporation rates (Figure 2) and irregular, stormy rainfall events in summer.

The great rains

Extremely wet years have occurred in no particular pattern, the last being 20 years ago (1983/84). Table 2 shows the occurrence of extremely wet years in several regional towns since 1900.

Wet periods affecting the whole region were recorded in 1916/17, 1931, 1955/56, 1973/74 and 1983/84. In these years every town in the region experienced excessive rainfall. Other wet periods were localised.

- The longest wet period for most areas of southern New South Wales was in 1916/17. This rainy time lasted for up to 34 months.
- Hay, Temora, Henty and Cootamundra have had ten 'wet' periods, while Lockhart, Griffith and Young have had eight. This highlights the local variability in rainfall.
- Around 30% of wet years were experienced region wide – five out of the 18 wet periods, while the remainder were localised events and were again variable in nature. For example, in 1920 only Hay had heavy rains with other towns recording slightly above average falls. In 1952 Temora, Henty, Young and Tumut were inundated while other places were recording a little above average.

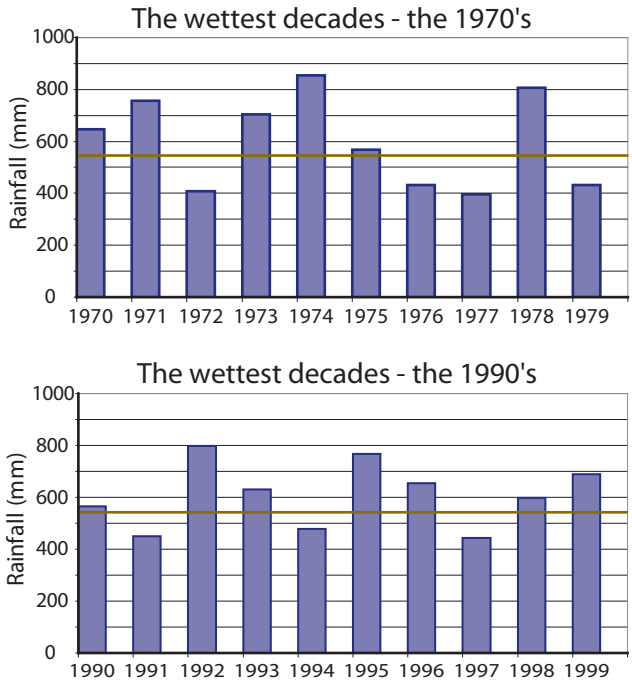


Figure 3 Annual rainfall for the two wettest decades on record at NSW DPI Wagga Wagga. The line equals average annual rainfall.

Some decades seem to have many wet years. The 1970s and the 1990s were like this. In the 1970s six out of ten years had much higher than average rainfall. In the 1990s, seven out of ten years were wetter than average at NSW DPI Wagga Wagga.

Table 2 Extremely wet years (indicated by shading) recorded at a number of southern New South Wales towns. (Extremely wet years are defined as the wettest 5% of years for each 12 month period. Source *Rainman*)

	1916/17	1920	1931	1933/34	1939	1949/50	1952	1955/56	1961/62	1968/69	1970/71	1973/74	1978	1983/84	1988/89	1992/93	1995/96	1999/2000
Hay	■	■	■					■		■		■		■	■	■		■
Binya	■		■			■		■				■		■		■		■
Narrandera	■		■		■			■			■	■		■	■	■		
Lockhart	■		■	■				■				■	■	■	■			
Wagga Wagga	■		■		■			■				■		■	■	■	■	
Temora	■		■			■	■	■		■		■		■	■	■		
Henty	■		■		■			■				■		■	■	■	■	
Young	■		■			■	■	■		■		■		■				
Cootamundra	■		■			■		■	■	■		■		■	■		■	
Tumut	■		■		■	■	■	■	■			■		■				

Floods

Significant floods are not always the result of heavy local rain. In fact, floods are often a product of heavy rain in the catchment area which then flows down the river system causing flooding along the way. The catchment area may be many kilometres from the areas that flood. The very wet years in our region have not always resulted in a big flood. Table 3 lists the years when major floods have travelled down the Murrumbidgee River system.

History of the weather station

On January 1 1898, the Wagga Wagga Experiment Farm, as it was known then, first started taking weather readings. The weather station was originally located near the current Charles Sturt University winery, on the other side of the hill to the present station.

At the original site the readings were manually read once a day. There is now an automatic weather station that takes readings multiple times each day, and downloads through a mobile phone to a computer link.

Flood waters can take between 19.5 hours and 50 hours to move from Gundagai to Wagga Wagga, and then another four to five days to move on to Narrandera. Hay is several days further away. These floods can be very damaging to all towns along the river system, no matter how long they take to get there.

Table 3 Major floods in the Murrumbidgee River system and maximum river height during the flood at Wagga Wagga.

Murrumbidgee River, Wagga Wagga		
Year	River height	
	metres	feet
July 1900	9.98	32
May 1925	10.11	33
June 1931	9.65	31
March 1950	10.13	33
June 1952	9.79	32
June 1956	9.58	31
August 1974	10.75	35
October 1975	9.58	31
July 1991	9.61	31

Measuring rain – manual weather station

Rainfall is measured, in millimetres of water, in a standard rain gauge at weather stations where people do the recordings. The rain that lands in the funnel is caught in the bucket and measured and emptied each day.

Ideally a rain gauge should be placed so that the lip of the gauge is 30 cm above ground level, in a clearing away from obstructions such as trees and buildings. The Australian Bureau of Meteorology specifies: a rain gauge should not be placed closer to an obstruction than four times the height of that obstruction. For example, if there is a 10 m high tree nearby, the rain gauge should be placed at least 40 m from it.

Photo: Australian Bureau of Meteorology web site

Measuring rain – automatic weather station

At automatic weather stations a 'tipping bucket' rain gauge is used to measure rainfall. The rain that lands in the funnel drips into one side of a double 'bucket' on a balance. Each bucket holds a specified amount of water. When one bucket fills, it over-balances, recording one 'unit' of rain, emptying itself, and the second bucket begins to fill.

Photo: Australian Bureau of Meteorology web site

Dry years and droughts

Dry years are a part of our landscape in Australia. Since records have been kept at NSW DPI Wagga Wagga, 54% of years have been below average rainfall. Hence, drier than average years are more common than wetter years.

We have had our fair share of extremely dry years, or drought. Drought years, in contrast to flood years, are the result of prolonged dry conditions in the local area. Droughts can affect a small area (e.g. a shire), or can affect a very large area (e.g. most of eastern Australia).

Table 4 indicates the periods of severe drought experienced in this region since 1900. As droughts vary in their length from place to place, average lengths have been used in this table.

There has been eight periods of severe drought during the last 105 years that affected the whole region — 1901/02, 1914, 1919/20, 1928/29, 1944/45, 1967, 1982/83, and 2002 onwards.

- The longest drought period was 1901/02 for most towns in the Riverina. This drought lasted for up to 38 months - three years of drought.
- Narrandera has suffered the most drought periods, 16 in the last 105 years.
- Tumut and Wagga have experienced the lowest number of drought periods, with ten.
- Droughts have not affected the western Riverina more than the higher rainfall eastern Riverina. Hay, in the west and Cootamundra and Henty further east all had 13 periods of drought.
- 35% (eight out of 23) drought periods were general, with 65% localised, and variable in the areas affected.
- There were 18 very wet periods in the last century and 23 drought periods.
- Towns that had the most wet periods didn't have fewer droughts.
- The great rains of 1983/84 were immediately after one of the worst droughts the region has experienced — the 1981/82 drought. Similarly the 1916/17 wet period followed another of the most severe droughts on record — 1914/15.

The 1900s and the 1940s were a very difficult period as shown in the Figure 4. Several droughts occurred back-to-back during these decades, a devastating time for the region's farmers.

Dust storms are part of a drought.

Photo: David Croft, NSW DPI.

Table 4 Extremely dry years (indicated by shading) recorded at a number of southern New South Wales towns. Extremely dry years are defined as the driest 5% of years for each 12 month period. (Source *Rainman*)

	1900	1901/02	1907	1912	1914/15	1919/20	1922/23	1926/27	1928/29	1933	1937/38	1940	1941/42	1944/45	1946	1957	1965	1967	1977/78	1979/80	1982/83	1985	2002 on
Hay		■			■	■	■	■	■		■	■		■				■	■		■		■
Binya		■			■	■	■	■	■			■	■	■		■		■			■		■
Narrandera		■	■		■	■	■	■	■		■	■	■	■	■	■		■			■		■
Lockhart	■	■	■	■	■	■			■		■	■	■	■				■			■		■
Wagga Wagga		■		■	■	■			■			■		■				■			■		■
Temora		■	■		■	■			■			■		■		■		■		■	■		■
Henty		■		■	■	■		■	■		■	■	■	■				■			■		■
Young		■			■	■			■			■		■		■		■		■	■	■	■
Cootamundra		■			■	■		■	■	■	■	■		■		■		■			■		■
Tumut		■			■	■			■					■			■	■			■		■

Dry decades

The 1900s (known as the Federation Droughts or the Great Drought period) and the 1940s were very dry periods with only two of the years in each period reaching above average rainfall in Wagga Wagga (see Figure 4). Eighty percent of years were below average rainfall.

Blowering Dam is one of many water storages in NSW which mitigate floods, secure domestic water, and supply and manage irrigation water supplies in our varied climate. The water level drops significantly during long periods of drought.

Photo: Gordon Murray, NSW DPI.

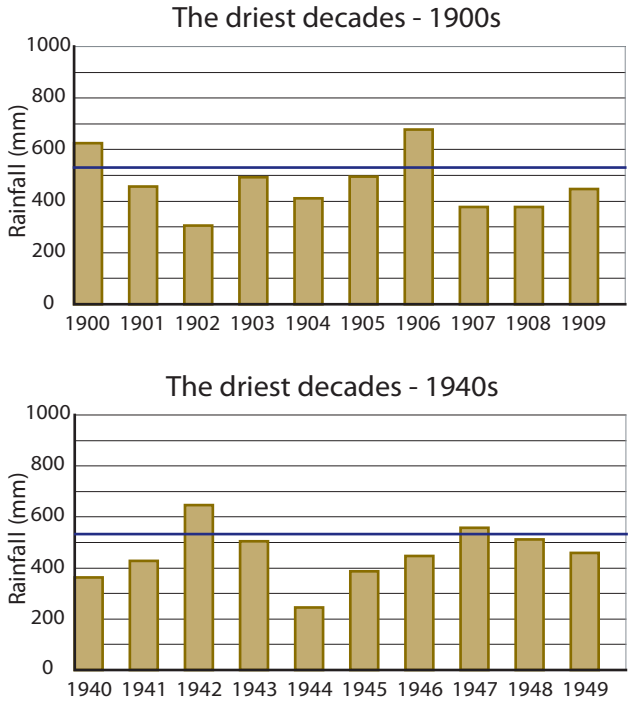


Figure 4 Annual rainfall for the two driest decades on record at NSW DPI Wagga Wagga. The line equals average annual rainfall.

Rainfall extremes in one decade

Some decades, such as 1910 to 1919, have had the wettest and driest of times all within a few years. In that decade 1914 was the driest year on record in Wagga Wagga with only 218 mm, 300 mm below the average. Just two years later in 1916, the second wettest year was recorded with 830 mm falling, 300 mm above the average.

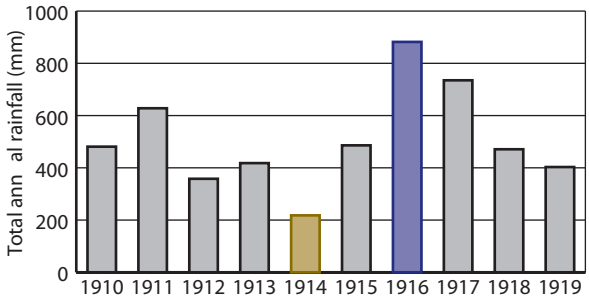


Figure 5 Annual rainfall for the decade 1910 to 1919 includes the driest, and the second wettest year on record at NSW DPI Wagga Wagga.

Recovery after drought

Recovery time can be defined as the first year after a drought period when at least average rainfall is recorded. This may not be the same as when the farming community and the region recover. This often takes much longer than just average rainfall in one season.

Looking at previous droughts we can see recovery has varied from receiving very good, above average rains the year following the drought, to taking longer than three years to reach average rainfall conditions (see Figure 6).

- In 40% of years the recovery was the first year after the drought.
- In 30% of years the recovery was the second year after the drought.
- In 30% of years it took three years or longer before there was average rainfall

Extended periods of drought

In the four years 2001 through to 2004, NSW DPI Wagga Wagga recorded well below average rainfall. In each of the four years, rainfall was at least 100 mm below the long term average. This is unprecedented. The four year period from 2001 to 2004 is the longest run of consecutive dry years since records at NSW DPI Wagga Wagga began.

Table 5 The wettest and driest year, the recorded rainfall (mm) for that year, the long term average annual rainfall, and the annual rainfall recorded in 2004 at a number of towns in the region. (Source *Rainman* and *CSIRO Griffith*).

Location	Wettest		Driest		Average 1898-2004	2004
	Year	Rainfall	Year	Rainfall		
Hay	1974	837	1940	157	368	281
Griffith	1956	700	1982	144	399	234
Narrandera	1956	917	1967	177	454	327
Lockhart	1974	1022	1967	217	481	413
Wagga Wagga	1956	918	1914	231	531	403
Temora	1956	978	1944	219	544	396
Henty	1974	1054	1967	227	592	495
Young	1950	1154	1982	247	658	487
Cootamundra	1956	1158	1944	203	623	488
Tumut	1956	1308	1967	340	817	758

Since 1898 we have experienced periods of up to three consecutive dry years. For example, the three years 1912 to 1914 were very dry. 1915 was only just below average and 1916 was well above average with over 800 mm falling. Again from 1944 to 1946 there was another run of very dry years, with 1947 and 1948 were average rainfall years.

As no two droughts are the same, it is difficult to make direct comparisons.

Wettest and driest years

Table 5 lists the wettest and driest years ever recorded for a number of towns in the region. Most records go back over 100 years. The average rainfall for each town is also given so you can see how extreme the worst years have been.

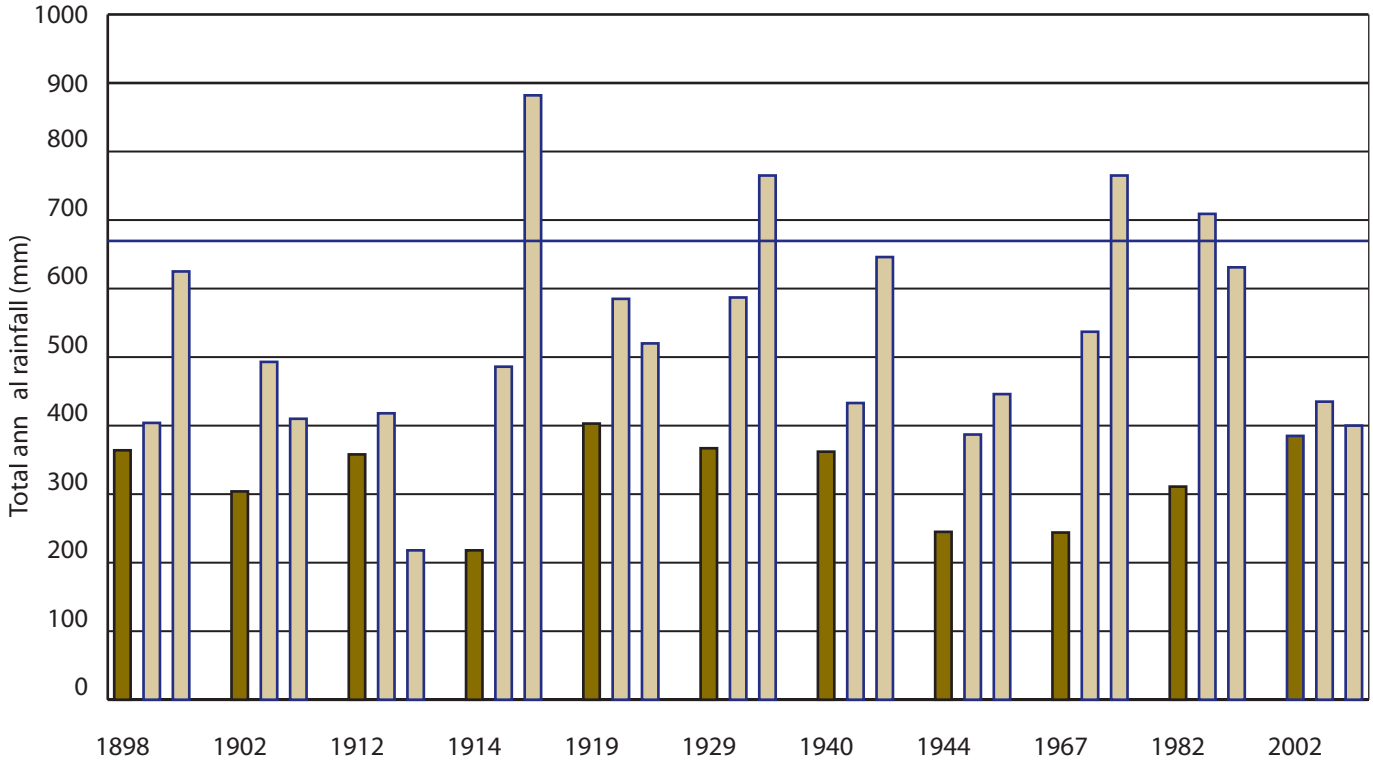


Figure 6 Total annual rainfall for significant drought years and two years following at NSW DPI Wagga Wagga.

Definition of some 'rainfall' terms

Average or mean: the arithmetic mean over a stated period of time. Determined by adding up the individual values and dividing by the number of values.

Average monthly rainfall: the average (or mean) of total monthly rainfall calculated over a period of years. The average monthly rainfall for April is calculated by adding up the total April rainfall for each year, then dividing this by the number of years, including those with zero rainfall.

Median: the value that half the records are greater than and half the records are less than. By placing all records in order of increasing value, then:

- if there is an odd number of records, the median is the middle value; or
- if there is an even number of records, the median is the average (or mean) of the two middle values.

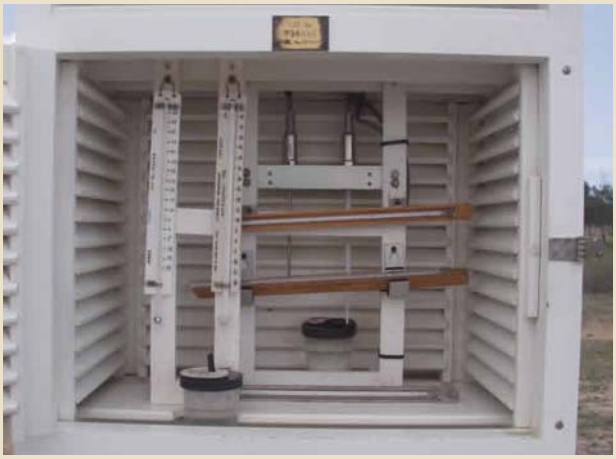
Median monthly rainfall: the median of total monthly rainfall over a period of years. The median monthly rainfall for April is calculated by placing all records in order of increasing value. The middle one (or the mean of the middle two) is the median. The median rainfall is often less than the average (or mean) as it is not as heavily influenced by extremely high but rare rainfall events.

Average annual rainfall: the average (or mean) of total rainfall for each of a number of years.

Evaporation: the amount of water that evaporates from an open body of water, recorded as millimetres of water over a period of time. It is measured using an evaporation pan (see page 2)

Extreme wet (or dry) period: defined as the wettest (or driest) 5% of years for any 12 month period. The 12 month period may not be a calendar year.

Measuring temperature - the Stevenson screen



Thermometers to measure temperature, including minimum, maximum, and wet bulb and dry bulb for relative humidity are located in a 'Stevenson Screen' situated 1.2 m above ground level. The screen protects the thermometers from direct sunlight but allows good air flow. A frost is defined as when the screen temperature drops below 2˚C.

Photo: Australian Bureau of Meteorology web site

The author

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Kerry has managed the weather station at NSW DPI Wagga Wagga since 1984. Her interest in the local climate and numerous requests for information encouraged her to compile this report.

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References:

Australian Rainman (Queensland Centre for Climate Applications)

The State Emergency Service

The Australian Bureau of Meteorology web site

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