THE WEATHER'S DIFFERENT THESE DAYS — BUT WHAT DOES 'DIFFERENT' MEAN?

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Talking about the weather, my older neighbours in northwest Tasmania often say something like this:

> *When we were growing up years ago on the farm, we'd get rain for weeks on end. Now there's rain for a day or two, then long sunny spells.*

If they're right, then rainfall patterns have changed dramatically in recent years. But in what way? When it gets wet, are rainy spells really shorter than they used to be? Are the sunny spells longer? How about the rainfall totals? If today's rainy spells are shorter, do they 'compensate' by delivering as much rain as the longer rainy spells of past years?

In this article I explore these questions using long-term daily rainfall records from a single northwest locality, Burnie. Before I begin, I offer two disclaimers.

The first is that I don't hope to convince either believers or skeptics with numbers. There are always possible rejoinders like It *was different where I grew up* and *Don't go by Bureau of Met figures, a lot of the time they're way off*. And the old reliable *You can prove anything with statistics*.

The second has to do with the nature of memory. It isn't a clock-like record of what we experience. Memory is more like a set of beads that can be threaded together in different ways, some of them non-chronological. For example, I remember my first decade in Tasmania, the 1970s, as being very wet. As it happens, decade-by-decade rainfall summaries for the State are consistent with those memories. But the figures don't *validate* my memories, which are just undated mental pictures of a small number of wet days (small relative to the 3652-day total for the decade).

Conversely, facts cannot *invalidate* memories. People remember what they remember. Learning that a memory is incorrect doesn't automatically erase the memory or make it any less convincing.

OBVIOUS TRENDS

My working dataset is daily rainfall at Burnie over the 64 years from 1945-2008 (see Appendix for data treatment, and why I picked Burnie), and to smooth the variation I've used five-year moving averages. The most obvious overall trend is that Burnie has been getting less rain since the beginning of the 1980s (Figure 1). The average annual rainfall for the last 32 years of the period was only 85% of the average for the first 32 years.

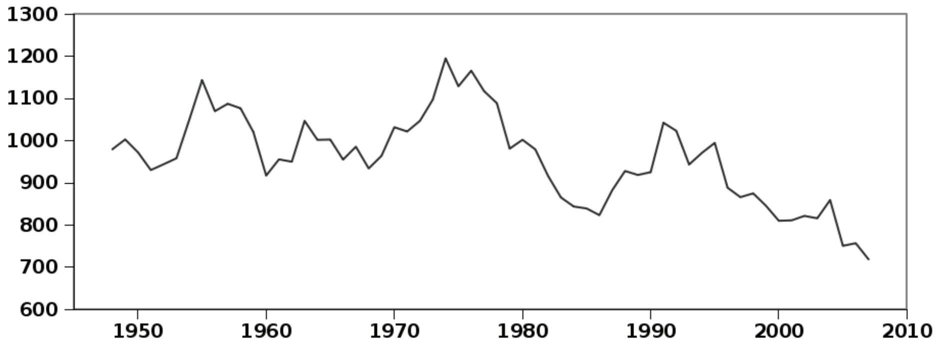

Figure 1. Five year moving average of annual rainfall (mm) at Burnie, 1945-2008.

This recent decline in rainfall is associated with a drop in the number of raindays (Figure 2), i.e. days when rain is recorded (see Appendix).

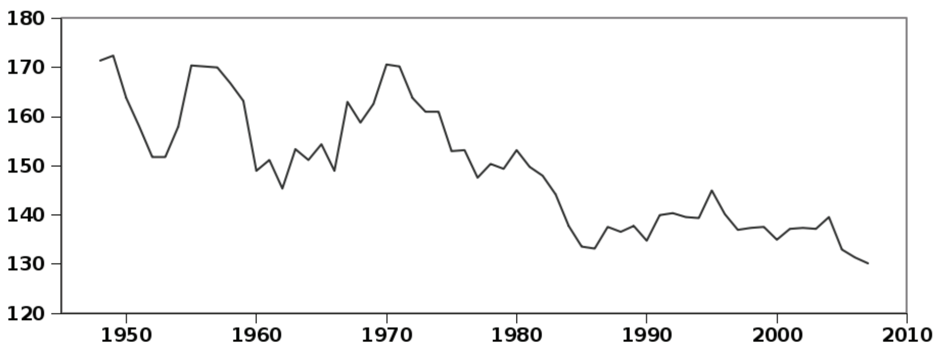

Figure 2. Five year moving average of number of raindays per year at Burnie, 1945-2008.

The decline in raindays largely explains the drop in annual rainfall. As shown in Figure 3, there hasn't been a parallel decline in the average fall per rainday, which is a rough measure of rainfall intensity.

Note, however, the downward trend over the last 10 years or so (Figure 3). That's largely explained by a drop in the falls on the days of highest rainfall. Figure 4 shows this trend for the 10 heaviest one-day falls each year. These 10 days account, on average, for one-third of Burnie's annual rainfall, and in 1965, 1982 and 1997 they contributed just over 40% of the year's total.

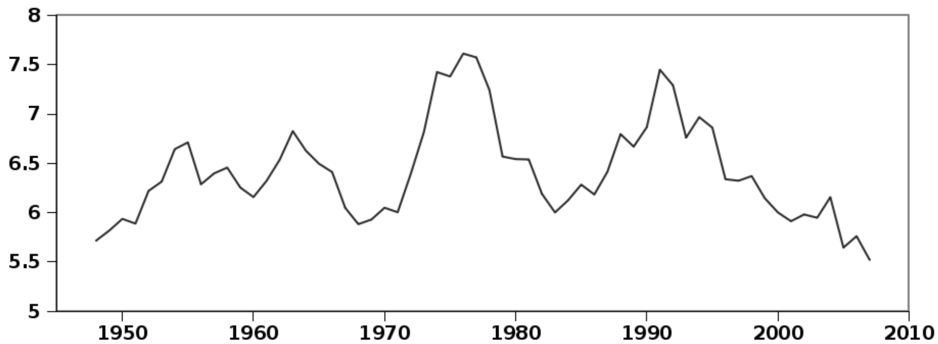

Figure 3. Five year moving average of mean fall per rainday (mm/day) at Burnie, 1945-2008.

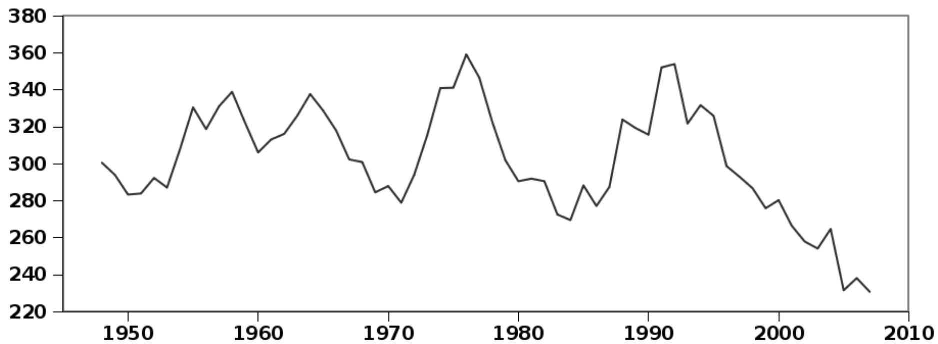

Figure 4. Five year moving average of 10 heaviest one-day falls (mm) each year at Burnie, 1945-2008.

NOT-SO-OBVIOUS TRENDS

So far I've shown that Burnie's rainfall pattern has indeed changed in recent years. It rains on fewer days per year, and it doesn't bucket down the way it used to on heavy-rainfall days.

However, we haven't yet looked at the *sequence pattern* of rainfalls, i.e. the lengths and distributions of rainy spells. To make the analysis a little easier, I'll arbitrarily define a 'rainy spell' as seven or more raindays in a row.

There were 197 such rainy spells at Burnie in the 64 years, the longest being a 19-day wet in 1946. Has the *length* of individual rainy spells changed over the years?

Yes, a bit, as shown in Figure 5. The average rainy spell in the first half of the 64-year period lasted 9.1 days, compared to 8.6 days in the second half. The decline in *number* of rainy spells per year has been much more dramatic (Figure 6), dropping from an average of 3.8 per year in the first 32 years to 2.2 per year in the second 32 years.

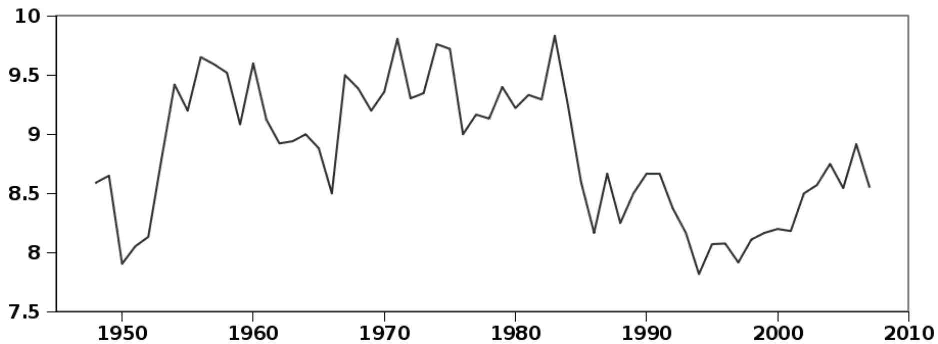

Figure 5. Five year moving average of mean length of 'rainy spells' (in days) at Burnie, 1945-2008.

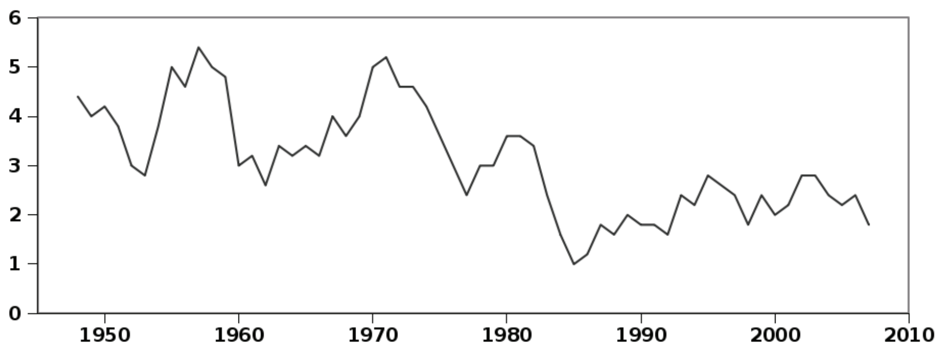

Figure 6. Five year moving average of number of 'rainy spells' per year at Burnie, 1945-2008.

We now have another change in rainfall pattern. In recent years there have been fewer long, continuous stretches of raindays, and the stretches have been a little shorter. But these figures don't tell us how rainy periods have been distributed through the year. A month of on-off rain is a wet month, even if it doesn't contain any 7-day-plus rainy spells. To look more closely at rainday distribution, I moved a 30-day window through the year, one day at a time, and totalled up the raindays within that window. I arbitrarily define a 'wet window' as a 30-day period in which there were at least 21 raindays, in any order.

As shown in Figure 7, ‘wet windows’ have been much less frequent at Burnie since the early 1980s.

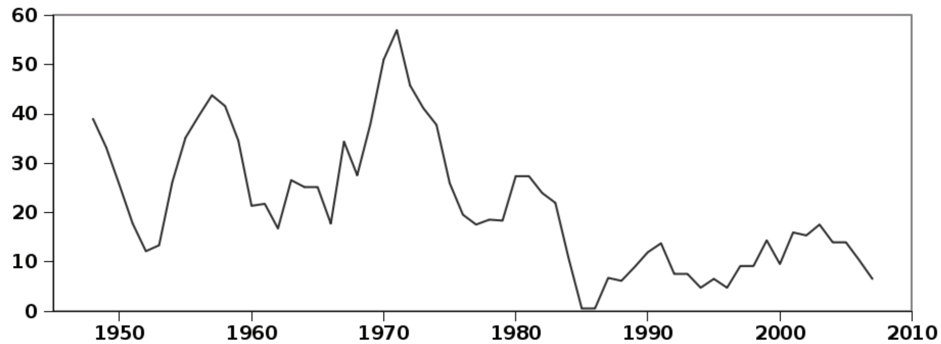

Figure 7. Five year moving average of number of ‘wet windows’per year at Burnie, 1945-2008.

Broadly speaking, we could say that it rains less these days and less often. The ‘often’ in that sentence can be gauged in still another way. Consider a string of days on which rain was either recorded (‘rain’) or not (‘fine’). There are four possible transitions from one day to the next: fine-fine, fine-rain, rain-rain and rain-fine. Now imagine a year in which there was only one long, continuous rainy period of 180-odd days, i.e. half the year. In that year there would be a single fine-rain transition (as the rainy spell began) and a single rain-fine transition (as the spell ended). All the other 360-odd transitions would be fine-fine or rain-rain.

At the other extreme, imagine a year in which rain and fine days alternated monotonously: rain-fine-rain-fine-rain-fine-etc. In such a year there would be 180-odd fine-rain transitions, the same number of rain-fine transitions, and no rain-rain or fine-fine transitions at all.

Does it rain more ‘often’ in the first imagined year or the second? In both years it rains on 180-odd days, but I’d suggest that in the second case we’d *perceive* the rain as falling more often. We could cope with six months of continuous rain by planning around it, but rain every second day would be a serious nuisance. We might wait patiently for the end of a six-month rainy spell which we knew lasted just six months. I don’t think we’d wait as patiently in the second imagined case. We’d soon be saying *I wish it wouldn’t rain so often*.

The number of fine-rain transitions per year might be seen as a 'psychological' index of raininess. Interestingly, this measure hasn't noticeably trended over the past 64 years (Figure 8).

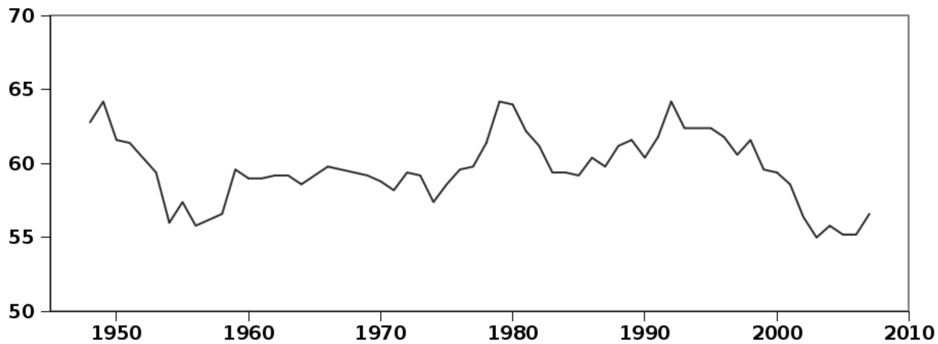

Figure 8. Five year moving average of number of fine-rain transitions per year at Burnie, 1945-2008.

SUMMING UP

There is a *lot* of variation in rainfall data. It's hard to detect rainfall trends unless variations are smoothed, as I've done here using a five year moving average. Even when trends are detected, it may not be obvious when they begin or end, or how strong they are. Nevertheless, I think I've shown in the analysis above that the old-timers are right. Not only is less rain falling these days at Burnie, but the intensity and sequence of rainfalls have also changed in detectable ways. There are also likely to be trends in the seasonality of rainfall, but I'll leave that study to other meteorological hobbyists!

APPENDIX: DATA TREATMENT

Daily rainfall records in digital form were obtained from the Tasmanian office of the Commonwealth Bureau of Meteorology. I chose Burnie (Round Hill) because it has a long run of records up to the present, and relatively few gaps: only 266 days out of 23376 in 1945-2008 (99% complete).

The gaps are of two kinds. 'Accumulation' gaps are periods when the rainfall observer recorded the total amount of rain that had accumulated in the gauge over the preceding few days. 'No record' gaps are periods when the rainfall station wasn't attended (e.g. over the Christmas holidays) and rainfall wasn't accumulated.

Conveniently for analysis, all of the 122 accumulation and 144 no-record gap days at Burnie can be filled using data from Elliott Research Station, 14 km to the southwest. Elliott is wetter than Burnie, however (1190 mm annually vs. 955 mm), which means the gap-filling has to be done a little judiciously. I first cleared the Burnie and Elliott histories of all accumulation and no-record days. This left 19736 days in 1945-2008 for which both stations had records. On 16635 of those days (84%), Burnie and Elliott agreed that it was a rainday or that it was not a rainday. Of the days when rain was recorded at Elliott but not at Burnie, 72% were falls of 0.5 mm or less. I therefore filled the Burnie gaps this way: (1) no rain at Elliott or 0.5 mm or less, no rainday at Burnie; (2) >0.5 mm at Elliott, rainday at Burnie.

For calculating yearly rainfall totals I used uncorrected Elliott data in the Burnie gaps. The possible inflation over the true (unknown) Burnie totals would have to be very small, as the gaps are only 1% of all days and occur mainly in the low-rainfall months of December and January.

The Bureau of Meteorology defines a day of rain as one on which at least 0.2 mm, not solely attributable to frost, fog or dew, has accumulated in the rain gauge by 9 am. To ensure consistency through the 64-year dataset, I defined a 'rainday' as a day on which at least 0.3 mm had accumulated.

Year-by-year analysis would have been complicated if rainy spells regularly occurred over New Year. Fortunately, they didn't. The only 'bridging' rainy spell was in 1971-72, and I ignored this bridge when calculating numbers and lengths of spells per year.

The 30-day window analysis, of course, doesn't respect year-ends. I assigned windows overlapping the year-end to either the old or new year by majority rule of days. In the 15-15 day case, the window was assigned to the old year.

The analyses reported here were done and graphed on a spreadsheet (Gnumeric under Linux). For ease in exploring time series data such as the pattern of rain/no-rain days, I converted the numbers to strings of characters and analysed the resulting text. For example, if we call a no-rain day '0' and a rainday '1', the sequence for the 366 days in 1948 is:

1110010010010000000000010000000000111100110010011111000011011111000
11111000000001000000010000000000001111101000001000000010101011011100
0111111100011111111101000011111000001111001001111111001101111110000
0001111101101101111110110000011101111111010011100111111101100011000
0111111100101101100011110111111111100011110100011110110000110000000
0011000101111010110011110000000111010

This string can easily be searched in a text editor for isolated sets of seven raindays, which would appear as 011111110 (there were four such sets in 1948). There are also scripts (e.g. in perl) for tallying selected substrings within a string.

Finally, I am very grateful to meteorologist Ian Barnes-Keoghan for helpful comments on an early draft of this article. All analytical and other errors are, of course, my own.