How extreme south-west rainfalls have changed

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Climate Note 6/05 (August) in a series outlining observed climate changes or variations over recent decades in south-west Western Australia.

Summary

South-west WA can experience extreme rainfall in winter with frontal systems and in summer with tropical storms.

In the mid-1970s in south-west WA there was a shift to consistently drier conditions (see IOCI Climate Note 5/05) for annual and seasonal rainfall. Research sponsored by IOCI suggests that both natural climate variability and the enhanced greenhouse effect have played a role. However, it is much more difficult to determine if there has been a shift in extreme rainfall. At the relatively frequent level of extreme events, such as less than a one-in-10 year annual maximum rainfall event (20-60mm recorded at various locations), observed statistics give us some insight, but for extremes at the rare or disaster level, there is very little understanding at this point in time.

The data for many rainfall stations in the south-west indicate that larger storms do not appear as often now in winter, but the magnitude of annual winter maxima is not significantly changed. There are also observations that summer rainfall events (one-in-10 year) are typically random and have not altered significantly over the last 100 years.

Continuing research by IOCI is building our understanding of factors driving these changes, but projections of change in rare events are perhaps only able to be investigated by modelling studies at the very edge of our current capability in climate science.

Trends in rainfall events

Many studies have shown that winter rainfall events are less frequent (see Figure 1). Figure 2 shows the total mm of rainfall for June and July (per year) for the early period 1949-1975, compared to the later period. It is obvious that, although the majority of rain days fall in the category less than 10 mm, the big drop in total rainfall is in the medium intensity range, between 10 and 40 mm.

Trends in rainfall extremes

Common and uncommon extremes

Observable trends in extreme rainfall are limited to common-place extremes around the one-in-10 year event level or less. Changes of extreme rainfall at rare and disaster level are not statistically observable. Such changes could only be inferred by climate modelling which, at this stage, has insufficient skill for the task. The following trend observations are therefore confined to more common events.

Winter extremes

The long-term trend in maximum one-day winter rainfall is far more subtle than observed for summer rainfall totals at a number of stations across south-west WA (see, for example, Figure 3a). Previous studies show that there was a reduction in storm events associated with the post 1970s decrease in total winter rainfall and in the frequency of high winter rainfalls less than the one-in-10 year return level, but there was no observed reduction of note in more extreme winter rain events.

The more recent 1950-2000 trends in the maximum five-day rainfall total in each season at stations across south-west WA show no clear upward or downward trend in any season for most stations. However, there are indications that some spatial variations may exist and further IOCI research will reveal the existence of any consistent patterns.

Summer extremes

The year-by-year sequence of summer one-day maxima (Figure 3b) shows more frequent extreme rainfall events since 1970.
The major summer events in the south-west include 1955 and 1982, while 1999 and 2000 were major summer events in the Moore River and Avon River catchments.

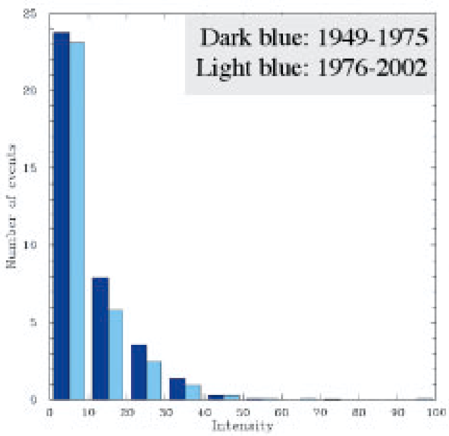

Figure 1: Perth Airport June and July - Average number of rainfall days per year in 10 mm intensity bands for two epochs.

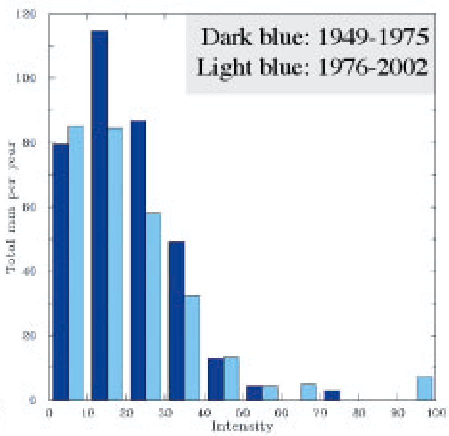

Figure 2: Perth Airport June and July - Total rainfall per year in 10 mm intensity bands for two epochs.

There is not enough conclusive evidence to make any judgements as to whether or not these recent summer events are related to enhanced greenhouse conditions or the change in atmospheric circulation observed since 1975.

Extremes and climate change

The most recent climate scenarios for south-west WA all indicate a drying trend in annual winter rainfalls over recent decades (IOCI Climate Note 5/05). Rising atmospheric temperatures on the other hand imply that the atmosphere will have an increasing trend in moisture-carrying capacity, and most computer models therefore simulate an increase in extreme daily rainfall as a broad global trend. This can occur even in the presence of an annual drying trend but is not evident in winter rainfall for south-west WA at this time.

Linkages and implications

Research sponsored by IOCI has been seeking a cause for the abrupt decline of winter rainfall. Broadly the change has been linked with observed changes in atmospheric circulation, most likely driven both naturally and by the enhanced greenhouse effect (IOCI Climate Note 4/05). However, research seeking more specific and predictively useful linkages is also taking place.

Winter flooding, one of the prime consequences of extreme rainfall events, is not just the result of one or two day rainfall events, but is also heavily influenced by the antecedent conditions (how wet the catchment is before the storm event). The major winter flood of 1964 is considered a one-in-50 year flood event, but was the combination of two very wet winter months and then a one-in-20 year rainfall event. Antecedent wetness is generally lower since the rainfall decrease of the mid-1970s and this would have a negative effect on flood magnitudes of all frequencies.

Change in climate extremes has potential to impact on the natural environment, the built environment and society. At shorter term return periods, for which some statistical observations are given above, the changes are relevant to a design of many small scale elements of infrastructure and to the function of some environmental processes. At the rare or disaster level of rainfall extremes provision of information useful for adaptation to climate change is most difficult at the present time and is likely to remain so for many years.

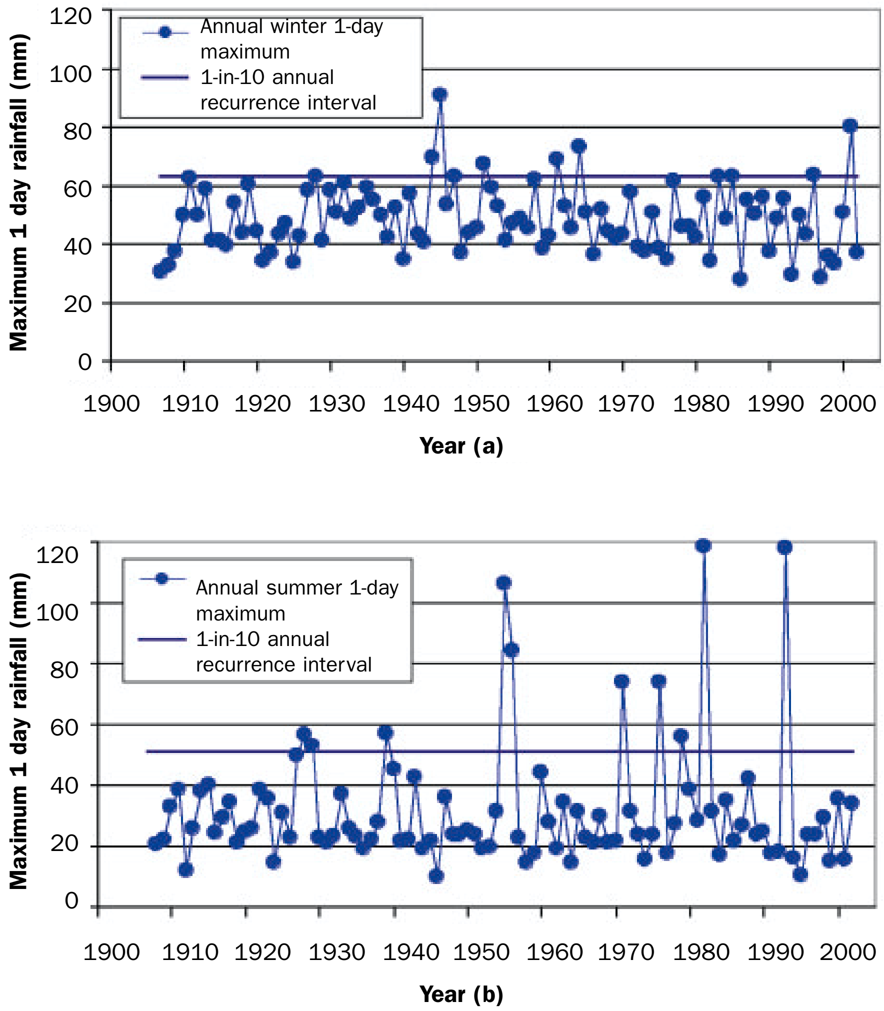

Figure 3: Yearly one-day maxima for (a) winter and (b) summer - Collie Post Office (009 628). (Where winter represents six months from April and summer represents six months from November based broadly on the rainfall mechanisms of winter frontal systems compared to summer storms.)

What can we say about the future?

Climate change projections indicate that rainfall totals will decline in south-west WA. On a global scale it is likely that extreme events will become more common as air temperatures rise with enhanced greenhouse conditions. Extreme rainfall projections for regional locations such as south-west WA, are not yet clear. Given the uncertainty in both magnitude and probability of extreme events it will always be difficult to separate natural climate variability from climate change as causative influences. Integrating climate and hydrologic models will be a necessary part of endeavours to understand the likely impact of climate change on extreme rainfall events.

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