Indian Ocean Climate Initiative
Informed Adaptation
GOVERNMENT OF WESTERN AUSTRALIA

How our river flows have changed

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Climate Note 7/05 (August) in a series outlining observed climate changes or variations over recent decades in south-west Western Australia.

How rainfall becomes streamflow

South-west WA has a temperate climate with hot, dry summers and cool, wet winters. Rainfall is highly seasonal with around 75% falling between May and September.

In south-west WA, average annual streamflow generally ranges from 3% to 20% of the rainfall. The majority of the rain is either evaporated or transpired by the vegetation. The remaining rain that strikes the ground typically infiltrates the soil and travels either to the groundwater or as sub-surface stormflow to the river. By late winter, some areas of soil become saturated and there is no further potential for infiltration so water travels to the river by direct overland flow. As the groundwater rises with increased recharge it too can contribute to the flow in our rivers. Of these three mechanisms of rainfall contributing to streamflow, direct overland flow occurs quickest while groundwater is the slowest to respond. As a result of the different travel times the flow observed in a river typically occurs after the rain has commenced and continues to flow for some weeks after the rain has stopped. The generation of streamflow from rainfall is shown in Figure 1.

The observed changes

Annual streamflow in south-west WA has generally been below the long-term mean annual flow for the last two decades. However, the reduction is variable over the south-west with the greatest change observed in the higher rainfall areas. This reduction in the annual flow appears as a gradual decline in the annual flow trend, as shown in Figure 2 for the Weld River, near Walpole, on the south coast.

Summary

The reduction in rainfall for south-west WA that has been observed since the mid-1970s has led to a greater reduction in streamflow. The main reason for the increased reduction in streamflow is the need for the rainfall to attain a threshold before streamflow is generated. This threshold, in many south-west rivers, is related to the large water storage capacity in the soil profile. The large soil water storage in the soil profile has meant not only lower streamflow volumes but also that rivers start flowing later and flow for less time than previously observed. This has reduced the water available for the environment and community. Research has indicated that, if the enhanced greenhouse effect causes further rainfall decrease in south-west WA, a higher percentage decrease in streamflow will occur, as observed since the mid-1970s.

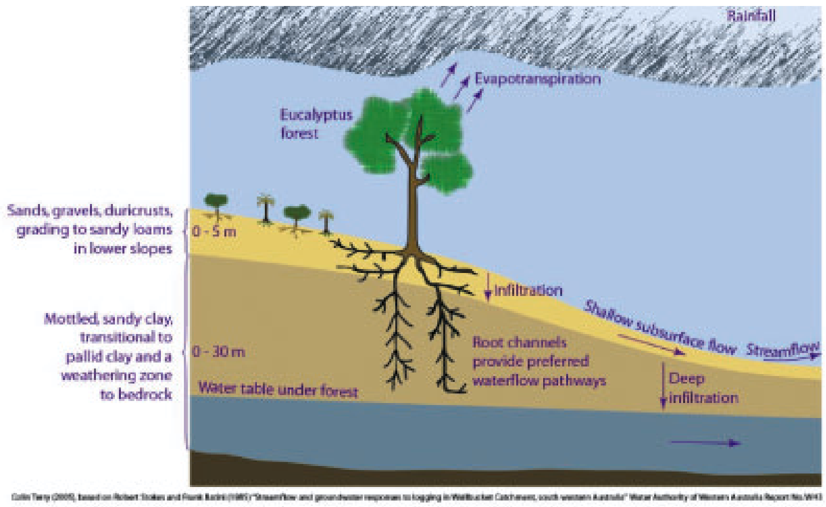

Figure 1: How rainfall becomes streamflow in south-west WA catchments.

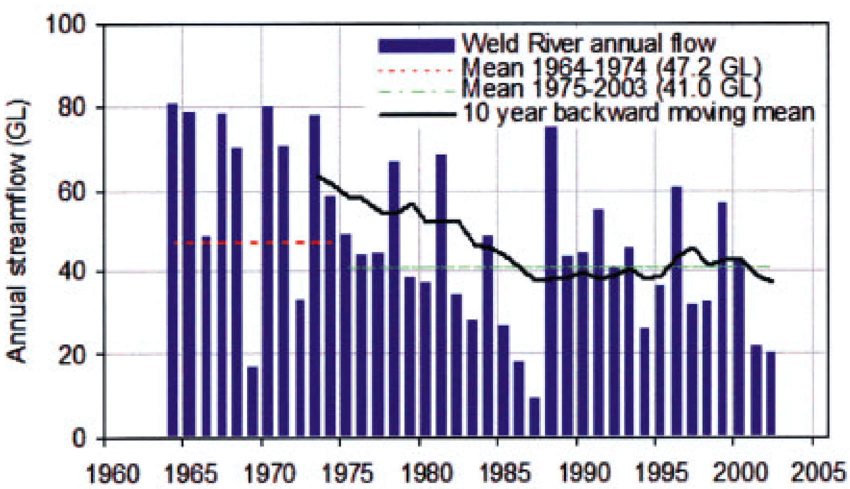

Figure 2: Variation in annual streamflow - high rainfall area of south-west WA.

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The changes are not just apparent in the annual flow data, there are also significant changes to the flows within a year at many rivers. Comparing the flow duration curves for a forested Darling Scarp catchment for the 24 years from 1952-1975 with the 24 years from 1976-1999 (Figure 3) shows that the river is dry more frequently in recent years. For example, prior to 1976 50% of days had a flow greater than 0.035 m^3s^{-1}. In comparison, since 1975 a daily flow of 0.035 m^3s^{-1} is only exceeded by 30% of days.

There are also changes to the monthly streamflow volumes (Figure 4). The greatest difference in the volumes occurs during winter and a slight shift in the peak flow month to later in the year is also observed.

Implications

The reduction in rainfall in the mid-1970s causing the lower and less frequent streamflows are likely to have major implications for the structure of rivers, instream ecology, riparian vegetation and stream salinity (see IOCI Climate Note 5/05). In addition, the surface water available for consumptive use has been considerably reduced for Perth and also for many country towns across south-west WA. This can be seen in the reduced total inflow into the reservoirs supplying Perth and integrated schemes. In this situation the reduction in streamflow has contributed to an approximate 50% decrease in total inflow from the long-term average, resulting from a 10-15% reduction in rainfall.

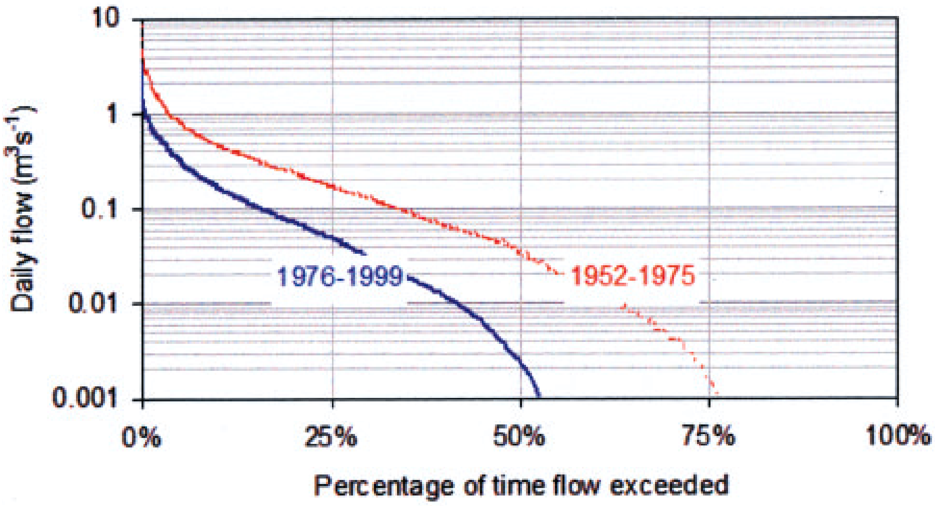

Figure 3: Change in daily flows for 1952-1975 compared with 1976-1999 for Yarragil Brook near Dwellingup.

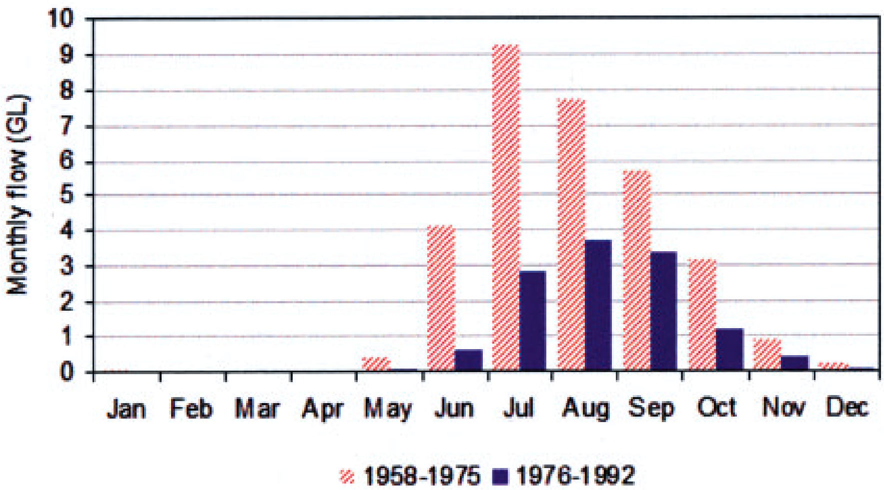

Figure 4: Comparison of the median monthly flows for the Harris River, near Collie, before and after 1976.

What can we say about the future?

The latest suite of climate change simulations also show that, even with the lowest greenhouse gas emission scenarios: south-west WA is projected to be drier and warmer later in this century, with increasing probability of 'dry everywhere' winter weather patterns and decreasing probability of 'wet' weather patterns.

However, part of the current rainfall reduction may be the result of natural multi-decadal variability and the rate of onset of further sustained rainfall and river flow reduction is uncertain.

Studies of a south-west catchment have shown that for a possible future climate scenario, in which rainfall was estimated to decrease by 11%, a 30% decrease of annual streamflow could be expected. The non-linearity between the change in rainfall and the reduction in streamflow highlights the sensitivity of south-west catchments to climate change.

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