Precipitation and Flooding in a Warmer Climate

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Extended Abstract

Flooding is one of the costliest natural disasters around the world and with a warming climate flooding expected to increase as a result of increases in precipitation (Seneviratne et al., 2012). However predicting changes to extreme precipitation and flooding is difficult due to the number of factors affecting flood risk in a future climate. These include changes to not just extreme precipitation intensities, but the pattern of extreme storm events as well as catchment specific conditions such as the wetness state prior to a storm event. Here, we examine the influence changes in temperature have on historical precipitation and flood records to gain an insight into what we might expect in a future warmer climate. The work presented here is based on published work in Wasko and Sharma (2017b).

While there has been improvements in modelling precipitation extremes, climate models remain limited in their ability to predict precipitation change (Stephens et al., 2010). As a result, historical relationships of precipitation and temperature remain an active area of research (Wasko and Sharma, 2014; Westra et al., 2014). Although there is disagreement over whether these should be used due to the fact they aggregate over a wide range of climate dynamics (Wasko et al., 2015), there is evidence to show that they do explain most of the variability in rainfall (Wasko and Sharma, 2017). Indeed historical changes in precipitation are well correlated to temperature (Lenderink and Attema, 2015).

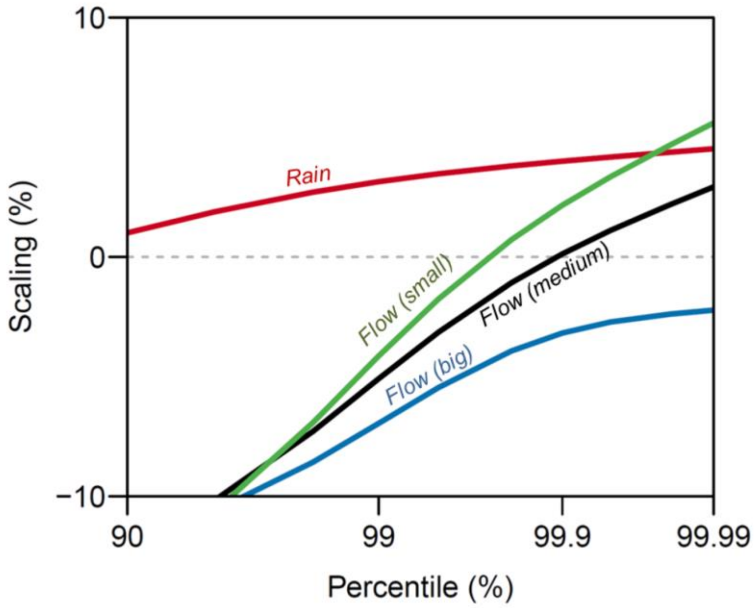

Figure 1. Precipitation and streamflow scaling with exceedance percentile demarcated on catchment area for South East Australia. Streamflow scaling is stratified on catchment size.

For a region of south-west Australia approximately the size of Victoria independent streamflow (GRDC, 2015) and rainfall events (Menne et al., 2015) were identified and the daily peak from each event was matched to the coincident temperature from a daily gridded temperature (Berkeley Earth, 2015). Data for 116 flow stations from a range of catchment sizes and 4349 precipitation stations was standardised on the mean, aggregated, and then binned on 2°C temperature bins. An extreme value distribution was fitted in each bin to data above the 99th percentile and a linear regression was fitted to the computed extreme percentiles in each bin for the temperature range 10-20°C. The slope of the resultant linear regression was used to calculate the relationship between precipitation and temperature and streamflow and temperature, termed scaling. Below the 99th percentile the empirical percentiles were used. This was repeated for a range of percentiles and range of catchment sizes. Small catchments were less than 1 000 km^2, large catchments were greater than 1 000 km^2, while medium catchments is just an aggregation of all the catchments.

The scaling results are presented in Figure 1 after Wasko and Sharma (2017b). The results show that only for the most extreme cases and the smallest of catchments does the flow scaling match the precipitation scaling. In most cases, for the less extreme percentiles, we generally see decreasing flow trends with increasing temperatures despite a clear increase in precipitation. There are several assumptions present in this analysis; for example, rainfall must translate through the catchment to the catchment outlet attenuating the flow – but aggregating to longer durations did not change the results.

The analysis presented suggests that it is actually changes in initial moisture that may be dominating changes in flooding in a warmer climate. Finally, if these relationships with temperature were to hold in a future warmer climate, the results suggest greater flooding, particularly for short durations and in urban catchments.

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