From Drought to Flood: The Life Cycle of Drought

Abraham Gibson, Danielle Verdon-Kidd, Greg Hancock and Garry Willgoose
The University of Newcastle, Australia
abraham.gibson@uon.edu.au

Introduction:

This work aims to identify how droughts begin, propagate through a catchment, and are terminated by flood, using the Millennium Drought Period (1994-2010) as an example. Understanding and quantifying these processes is crucial to developing better drought policy.

Figure 1: Methods

A drought record from 1908-2015 was created using the Standard Precipitation Index (SPI) and Surface Water Supply Index (SWSI) for a 1200 km^2 area in Eastern Australia (Figure 1). Presented here is a case study of the 1994-2010 period.

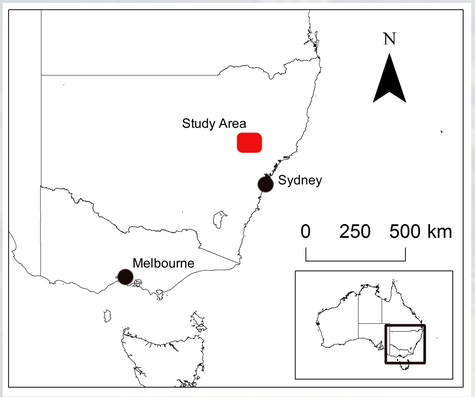


Figure 2: The Drought Record

Drought periods, such as the Millennium Drought Period, were found to be periods of low rainfall interspersed with near – normal to wet conditions. Drought periods were defined as a period of six or more months of index value < -1.

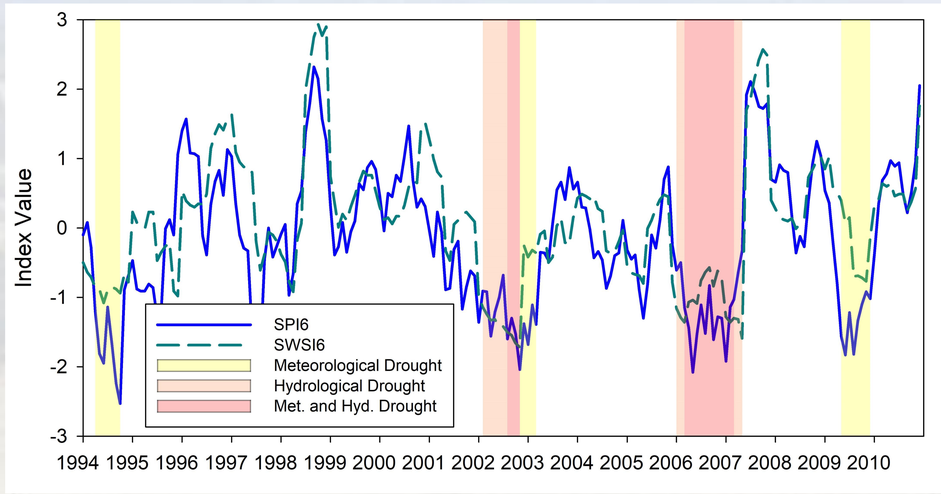


Figure 3: Drought Onset

Drought onset was slow and linked to both the El Niño Southern Oscillation and Indian Ocean Dipole being in their dry phase. This figure shows the rate of change in SPI6 and SWSI6 in the six months leading to drought onset and the six months following. This is for all the droughts in the record, with the dark line being the median.

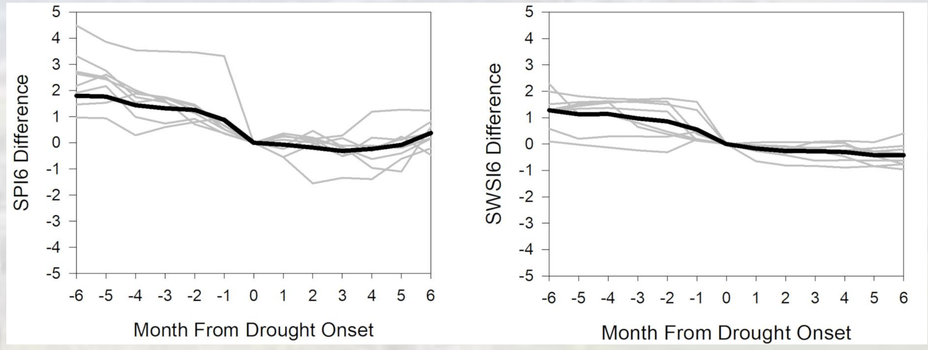


Figure 4: Drought Propagation and Recovery

In-situ soil moisture and remote sensed vegetation data showed a decline during the drought periods. They however recovered quickly when drought-breaking rain fell. This is shown in the below anomalies.

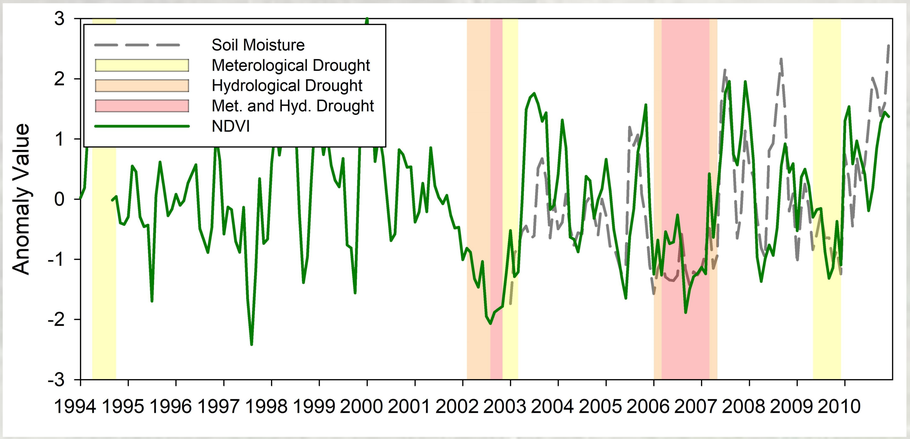
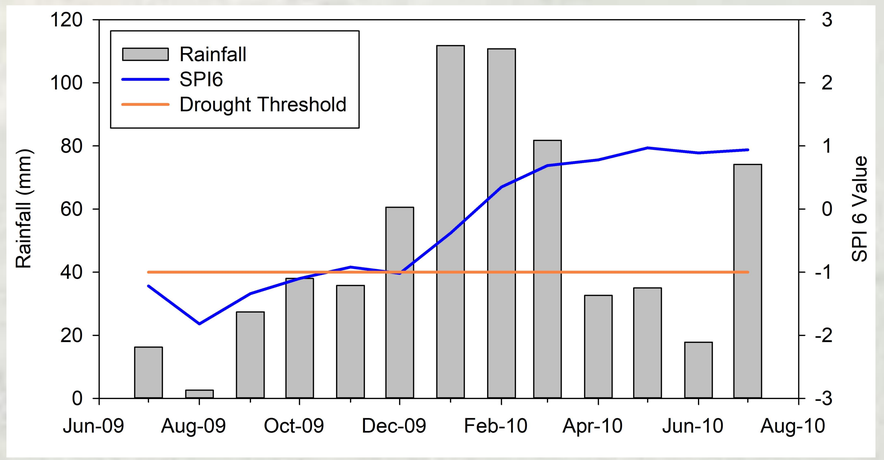


Figure 5: Drought Termination

Drought termination was abrupt and linked to synoptic-scale events and flooding. In 2010 for example, the Millennium Drought termination only resulted in minor flooding for the study area, but very severe flooding in other areas of Eastern Australia.



Conclusions:

Multiple indicators are required to monitor drought from onset to cessation.
Early warning systems can be developed using the state of ocean-atmosphere drivers.
On-ground impacts can be measured using rainfall, streamflow, vegetation and soil moisture data.
Termination is abrupt and linked to synoptic-scale events, bringing large amounts of rain and flood.

The full drought record can be found in: Gibson, A. J., Verdon-Kidd, D. C., Hancock, G. R., & Willgoose, G. (2020). Catchment-scale drought: capturing the whole drought cycle using multiple indicators. *Hydrology and Earth System Sciences, 24*(4), 1985-2002. doi: 10.5194/hess-24-1985-2020

References
Rudiger, C., Hancock, G., Hemakumara, H. M., Jacobs, B., Kalma, J. D., Martinez, C., . . . Willgoose, G. R. (2007). Goulburn River experimental catchment data set. *Water Resources Research, 43*(10), 10. doi: 10.1029/2006wr005837
Verdon-Kidd, D. C., Scanlon, B. R., Tong, R. C., & Fernando, D. N. (2017). A comparative study of historical droughts over Texas, USA and Murray-Darling Basin, Australia: Factors influencing initialization and cessation. *Global and Planetary Change, 149*, 123-138. doi: 10.1016/j.gloplacha.2017.01.001