Understanding and managing drought in Australia – What do we know? What do we need to know?

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“Established” drought definitions

- **Meteorological drought**: refers to the extent and severity of drought in terms of deficits in precipitation from average conditions, possibly combined with increased potential evapotranspiration.
- **Soil moisture (or agricultural) drought**: is a deficit of soil moisture (mostly in the root zone), and typically refers to a reduction in the availability of soil moisture to support vegetation growth (usually crop or pasture growth, hence the terms soil moisture drought and agricultural drought are often used interchangeably).
- **Hydrological or water resources drought**: implies a departure in surface or sub-surface water supplies from average conditions.
- **Socioeconomic drought**: refers to the impacts of one or more of the other types of drought on humans/communities and/or the economy and is defined based on social expectations, perceptions and other impacts (e.g. employment levels, income and debt levels, mental and physical health).

Factors that cause or contribute to droughts

- Large-scale ocean-atmospheric climate processes (ENSO, IPO etc)
- Precipitation deficits (or absence of extreme rainfall events)
- Evapotranspiration, temperature and wind
- Soil moisture deficits
- Land-surface feedbacks
- Others…??

Challenges, questions…

- Confusion between cause and impact in drought research and literature…..are established definitions ok? or not?
  - All droughts are different, caused or exacerbated by different factors…..how to deal with this when doing attribution?
- Problems with monitoring and forecasting drought onset, duration, ending, spatial extent, severity etc.
  - Opportunities with AWRA-L, GA's data cube??
- Problems with existing drought risk estimates (based primarily on the instrumental record and assumptions of stationarity)
  - How best to use paleoclimate info?….and how to deal with uncertainties?
  - How best to use GCMs /RCMs?….and how to deal with uncertainties?
- How best to use emerging info date sources (e.g. radar, remote sensing, reanalysis, GIS tools etc)?
- Interactions between drought and other hazards (e.g. bushfire, heatwaves, lack of floods/storms)
  - Is drought in Australia changing and if so where, when, how, why?
- Others….??

Thank you…

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From Van Loon (2015) - Hydrological drought explained, WIREs Water, doi: 10.1002/wat2.1085

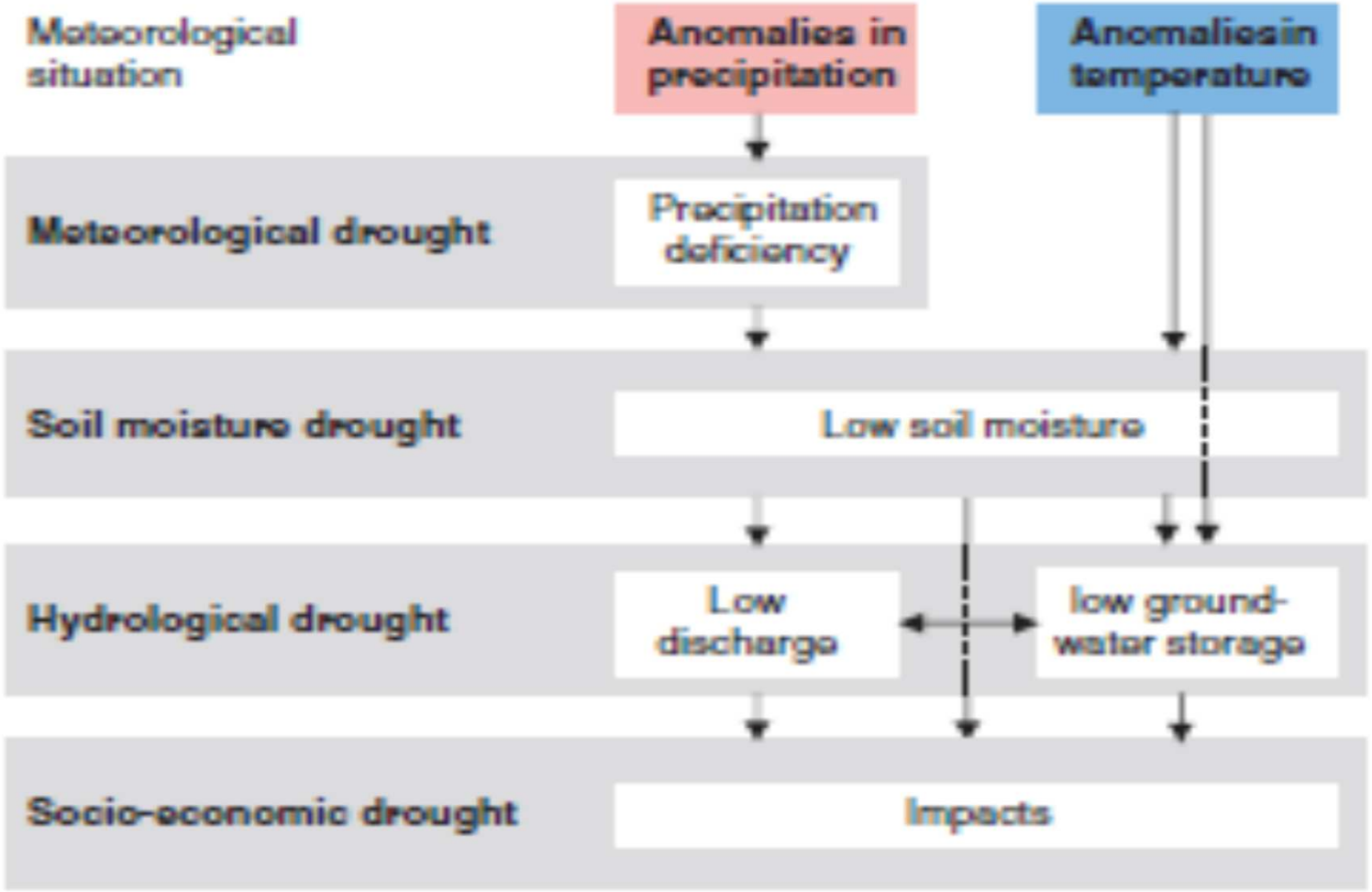


FIGURE 2 | Scheme representing different categories of drought and their development. (Derived from Peters,[53] Van Loon,[54] Stahl[55]).

Problems with “established” drought definitions

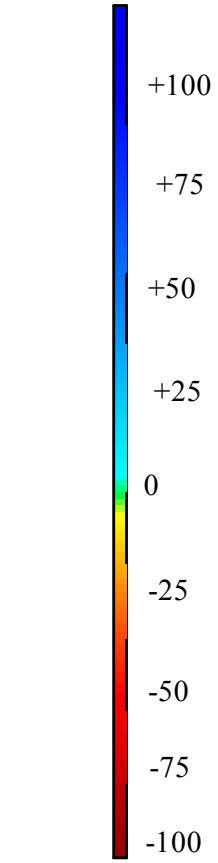
- Van Loon (2015): “droughts should not be confused with low flow, aridity, water scarcity or desertification”
- Similarly, while droughts are related to heat waves and bushfires, given that they may coincide or interact such that one exaggerates the impacts or increases the risk of the other, droughts are unique as they are usually only noticed months or years after they have started
- Once a drought is occurring it will typically last at least a year (compared with days for the other hazards)
- Currently have very limited ability to tell when a drought will terminate (whereas we know other hazards typically do not persist for more than a week)
- Unlike any other natural hazard drought definitions and categorisations introduce confusion between causes, risks and impacts (e.g. we do not talk about agricultural floods or socioeconomic cyclones)
  - This creates problems when attempting to attribute drought to various potential causal mechanisms and also for drought monitoring and forecasting

Factors that cause or contribute to droughts

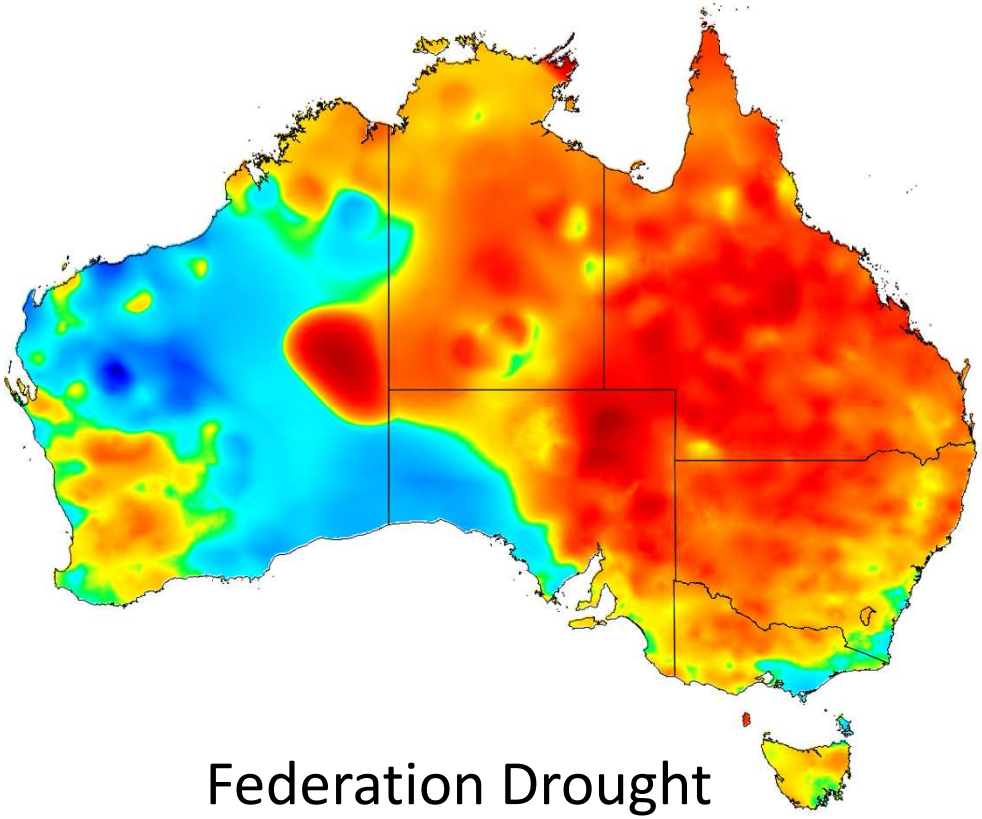
- It is difficult to compare one drought to another since each drought differs in the seasonality, location, spatial extent, magnitude and duration of its impacts
- Also, droughts are caused by a variety of both ocean-atmospheric and hydrological factors and it is rare, especially during the period covered by Australia's relatively short instrumental hydroclimate records that these factors are in similar states across multiple drought periods (van Dijk et al. 2013).
- What we do know is that drought in Australia is caused (or contributed to) by at least the following factors:

Australia's drought history

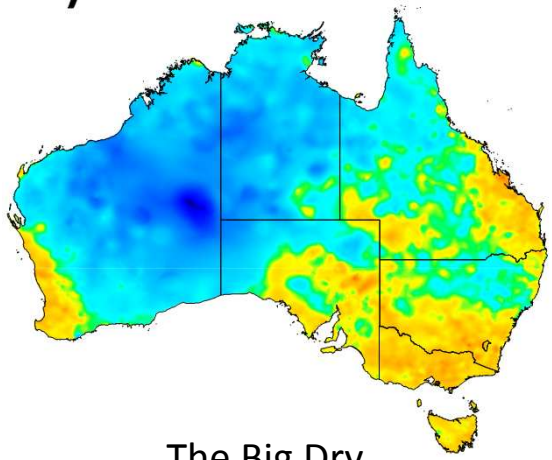
- Instrumental period (~1900-present)



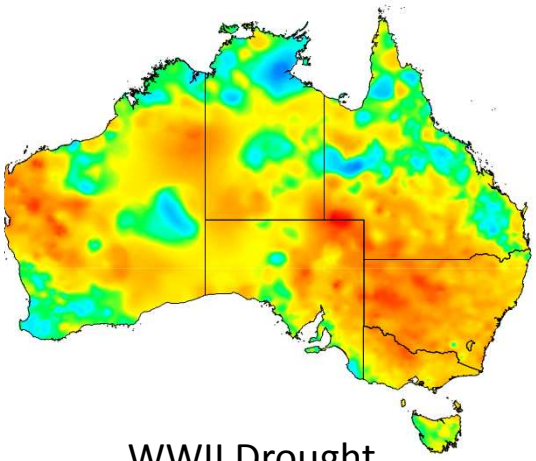
% departure from average



Federation Drought
1895-1902

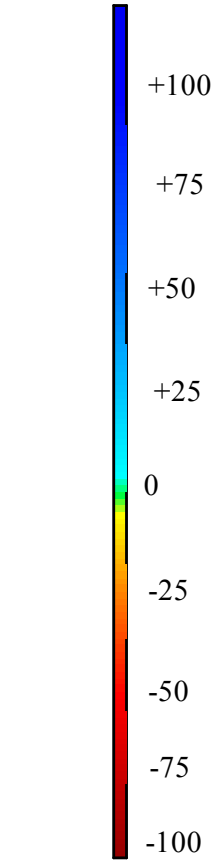


The Big Dry
1997-2010



WWII Drought
1937-1945

Australia's drought history – instrumental (~1900-present)



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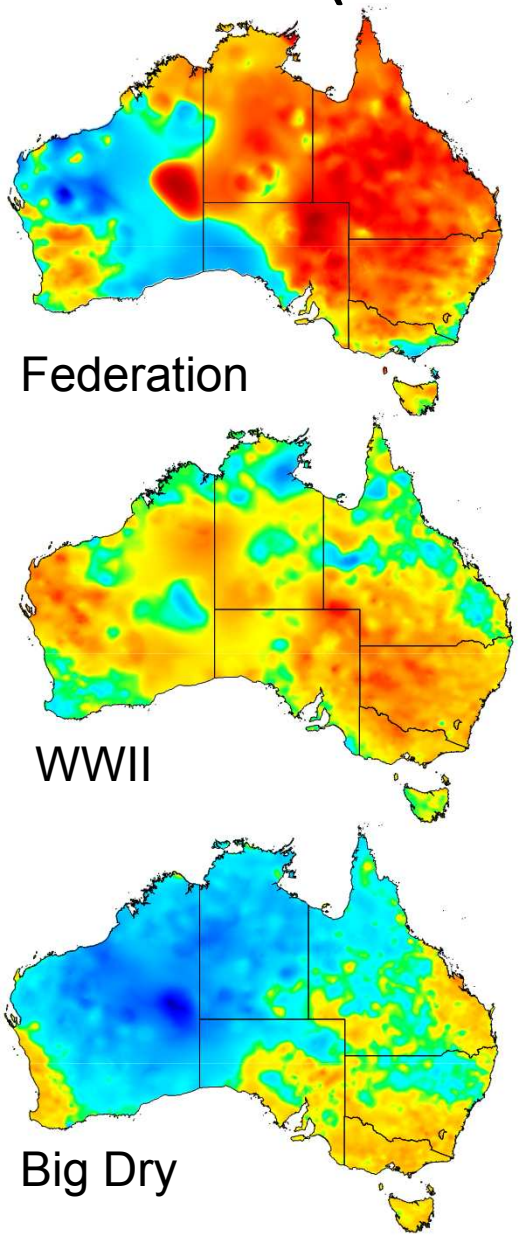

- Northeast Australia
- Spring/summer decline
- Strongly linked to ENSO

- Widespread - northwest-southeast gradient
- Decline across all seasons
- Strong links to Indian Ocean SSTs but ENSO + SAM also play a role

- Southeast & southwest Australia
- Autumn decline
- SAM + ENSO