Earth Systems and Climate Change Hub

National Environmental Science Programme

climate change **science brief**

# Flash drought in Australia

Drought in Australia causes significant hardships for primary producers, their families, their communities and, ultimately, the Australian economy.

Some droughts can seemingly come out of nowhere. Vegetation dries rapidly and crops and pastures wither with little warning. These events are called 'flash droughts' and their onset – within just a handful of weeks – can leave farming communities and natural resource managers underprepared.

The Earth Systems and Climate Change Hub has been working on identifying the risk of flash drought in Australia. Research has focused on understanding when, where and why flash drought occurs, and what tools might be most useful for identifying and monitoring them.

## What is flash drought?

From near-normal conditions to extreme drought in just a few weeks, flash drought develops quickly. But while they may develop quickly, flash droughts can last from as little as a month to more sustained periods over six months. The subsequent drought can cause declines in crop yields. These impacts result not only because the drought intensifies rapidly, but because there is little time for warning or preparation. Crops and pasturelands from North America to China have been devastated by flash droughts, and Australia is not immune.

## How do flash droughts work?

Flash droughts usually begin when soil moisture is near-normal and persistent meteorological conditions set in that encourage higher than normal evapotranspiration from vegetation and evaporation from the soil. This is known as high evaporative demand. Periods of high evaporative demand describe a 'thirsty' atmosphere, which occurs when there are clear skies, warm temperatures and a dry atmosphere.

As weather conditions that bring little to no rain and have high evaporative demand persist for weeks, water stress increases. Plants hold onto what little moisture they have left, and the dry land surface now turns any energy it gets from the atmosphere and the extra sunshine (due to clear skies) into heat energy, further warming the atmosphere from below. This is a positive feedback, with heating and drying of the surface occurring from both the atmospheric conditions and the lack of sub-surface soil moisture. The rapid decline in sub-surface soil moisture to a critical point causes major vegetation stress and heralds the start of a flash drought. In some cases, extreme heat associated with the dry surface provides a 'double whammy', severely compounding the impacts of the drought.

TOP: iStock.com/ VMJones

RIGHT: A rapid decline in soil moisture causes major vegetation stress and heralds the start of a flash drought.

## What does flash drought look like in Australia?

Flash droughts can occur year-round, registering in at least part of the country during every season. In Australia, flash droughts are most prevalent during the summer months and into autumn. However, research from the Earth System and Climate Change (ESCC) Hub has shown that flash droughts can also occur during winter in southeast and southwest Australia. This suggests that a sudden shut-off in rainfall, coupled with unusual evaporative demand for the time of year, can also result in a flash drought.

Flash droughts typically last around a month. But research under the ESCC Hub shows that in summer and autumn some flash droughts have been the catalyst for longer droughts, up to 6 or 7 months in duration. This means that a flash drought that has commenced in summer or autumn might plunge a region into drought through to the following winter or spring.

## Predicting flash drought

Given the rapid onset and often devastating nature of flash drought, particularly for agriculture, predicting future events could assist communities and sectors in preparing for their impacts. As flash droughts appear to be closely related to particular meteorological conditions, there is scope for predicting these events if the conditions can be forecast.

ESCC Hub researchers have also identified connections between El Niño–Southern Oscillation, the state of which is predictable several months in advance, and the size of the area affected by flash droughts in a given year. During the winter and spring, larger areas are affected by flash drought during El Niño-like conditions.

In summer, a link between a rapid move to regimes of high evaporative demand and La Niña-like conditions were identified in parts of southeast Australia, which could elevate flash drought risk. This is likely to be caused by the connection between heatwaves and La Niña conditions in these areas.

> *"Given the rapid onset and often devastating nature of flash drought, particularly for agriculture, predicting future events could assist communities and sectors in preparing for their impacts*

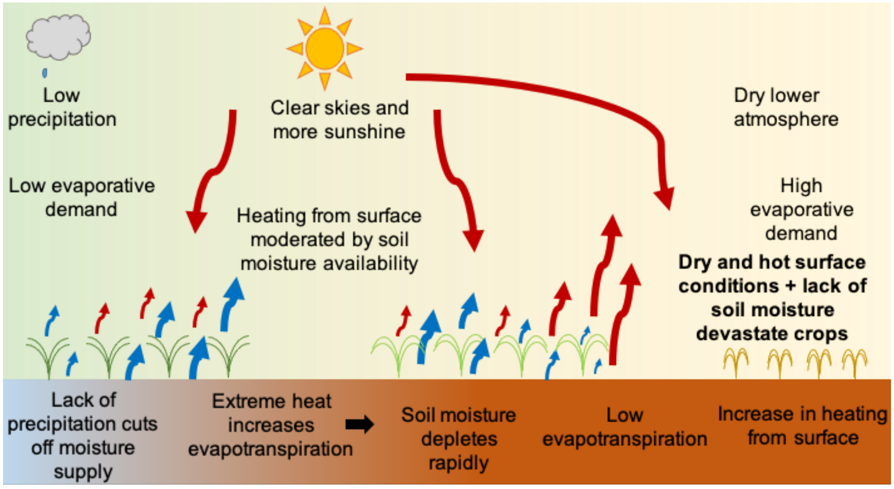


FIGURE 1 **A schematic of the onset of a flash drought.** Blue arrows from the surface indicate evapotranspiration and the red arrows indicate heat. The larger the arrow the bigger the flux from the surface to the lower atmosphere.

A 'thirsty' atmosphere occurs when there are clear skies, warm temperatures and a dry atmosphere.

# A flash drought in the Wimmera region of southeast Australia, spring 2015

The impacts of flash drought can be illustrated through a flash drought that occurred suddenly in the Wimmera cropping region of southeast Australia in spring 2015. A persistent warm spell set in at the end of September, including a heatwave during the first week of October.

With very high evaporative demand from the atmosphere, soil moisture was rapidly depleted. Within 3–4 weeks, the area descended into severe drought (defined as soil moisture in the lowest 10% of the record). Accompanied by temperatures in the mid-high 30s, the hot and dry conditions decimated the region's pulse crops, particularly chickpeas, and caused significant losses to wheat crops in the region.

The conditions following the onset of the flash drought in the Wimmera, as represented by several drought indices, show high evaporative demand, low precipitation and a water-stressed environment.

Just prior to the start of the flash drought in the Wimmera, large changes in the Evaporative Demand Drought Index (EDDI) and the Evaporative Stress Index (ESI) occurred, highlighting the role that evaporative demand can play in flash drought. The ability of the EDDI and the ESI to capture the flash drought as it develops highlights their utility as tools for flash drought monitoring.

RIGHT: **Flash droughts in southeast Australia can have significant impacts on key pulse crops, such as chickpeas.**

Image: iStock.com/Grigorenko

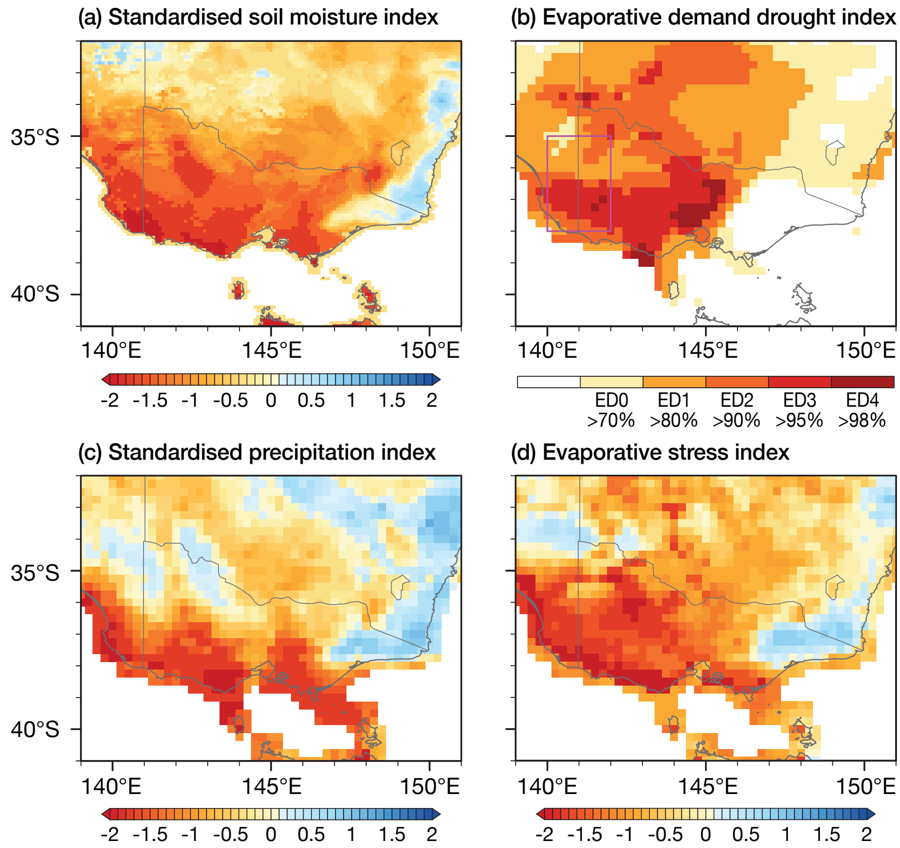


FIGURE 2 **A flash drought in the Wimmera region in spring 2015.** Represented using a) abnormal soil moisture (Standardised Soil Moisture Index, SSI), b) evaporative demand (Evaporative Demand Drought Index, EDDI), c) precipitation anomalies (Standardised Precipitation Index, SPI), and d) water stress (Evaporative Stress Index, ESI).

## Informing agriculture and natural resource managers

Flash drought is a relatively new concept in Australia. ESCC Hub researchers have significantly progressed scientific understanding of the nature of flash droughts in Australia. Future research will examine the meteorological processes leading to flash drought to aid in identifying scope for early warning; and to examine flash droughts in a warming climate. This information is designed to help agriculture and natural resource managers better prepare for flash droughts into the future.


This research was led by ESCC Hub **Project 5.2: Understanding climate variability and change – past, present and future**



For more information: **Christine Chung**
**Christine.Chung@bom.gov.au**





The Earth Systems and Climate Change Hub is funded by the Australian Government's National Environmental Science Program