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The Effective Drought Index applied as a real-time, daily index for quantifying properties of drought and monitoring of ongoing drought in Australia

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Abstract
Australia is a relatively dry continent with frequent, intermittent and long-lasting drought events. As droughts are challenging to comprehend, scientific investments to tackle their episodic development require robust tools that can detect onset and termination dates, and quantify duration severity and intensity. Conventional methods for drought studies utilize monthly or annual indices. These indices cannot quantify short-term events (e.g. weekly) and continuing drought arising from changes in weekly, multi-monthly or semi-yearly rainfall.

In this article we introduce a scientific tool new to Australia, the Effective Drought Index, *EDI* [1]. *EDI* can measure duration and severity of drought. It recognises that deficits of water resources can return to normal with a single day's rainfall, or event worsen with several days of acute shortage of rain. *EDI* diagnoses short-term (days) and long-term drought (months) using the concept of 'precipitation needed to return to normal' conditions on a daily basis. The *EDI* was computed using Australian Bureau of Meteorology's high quality rainfall [2] by a simple model,

$$EP = \sum_{n=1}^{i}\left[\left(\sum_{m=1}^{n} P_m\right)/n\right] \quad (1)$$

$$DEP = EP - MEP_{1971-2000\ normal\ period} \quad (2)$$

$$EDI = DEP / ST(DEP)_{1971-2000\ normal\ period} \quad (3)$$

$$PRN = DEP / \left(\sum_{N=1}^{365}(1/N)\right) \quad (4)$$

Very briefly to say, as stipulated in Eq. (1), the *i* (duration of summation) equals 365, the most commonly used rainfall cycle worldwide. *MEP* and *ST*(*DEP*) represent climatological mean and standard deviation of *DEP* for calendar day for normal period. Eq. (4) gives the

daily rainfall needed to return to normal (*PRN*) with extreme drought for $EDI \leq -2.0$, severe for $-2.0 < EDI \leq 1.5$ and moderate for $1.5 < EDI \leq 1.0$.

Figure 1(a) plots the distribution of the daily minimum *EDI* for the period 1900–2010. Strongly negative *EDI* are displayed in coastal Queensland, New South Wales, Victoria, South Australia and southwest Western Australia. However, droughts manifest spatio-temporal patterns and year-to-year variations. For example, eastern Australia has become progressively drier since second half of 20th century [3].

Table 1 ranks major droughts events. Evidently, 1944 suffered one of the worst droughts (Rank 1; $EDI \approx -0.82$) while 1940 was second most severe (Rank 2) with $EDI \approx -0.76$. The high ranks agree with World War II drought that persisted largely over NSW/VIC and South Australia from 1936–1947.

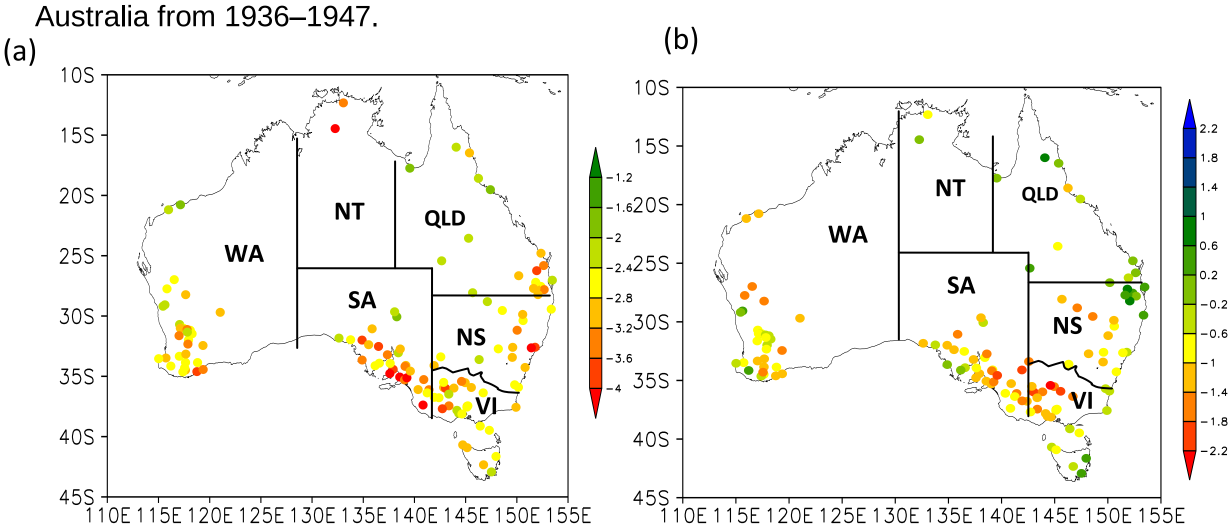

Fig. 1 Distribution of (a) minimum *EDI*; (b) yearly average *EDI* for 1944. New South Wales (NSW), Queensland (QLD), Victoria (VIC), South Australia (SA), Western Australia (WA), Northern Territory (NT).

Table 1 The rank of minimum of year average.

Rank	Year	*EDI*
1	1944	-0.82
2	1940	-0.76
3	2002	-0.7
4	1919	-0.62
5	2007	-0.57

Figure 1(b) plots yearly average *EDI* for 1944. Strongly negative values are clustered around New South Wales, Victoria and South Australia with $EDI < 2.0$, suggesting an extreme drought event. The reasonable representation of drought around 1944 agrees with reports showing loss of nearly 30 million sheep in eastern Australia (1942–1945), with 1940s being a very dry year [4]. By contrast, our analysis reveals lesser impact in Queensland/Northern Territory. Finally the proposed method appear to be feasible for drought studies with further investigations currently underway, which will be reported in the full paper.

References

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