Extreme Dryness Enabled Intense and Massive Bushfires

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Key point: The Soil Dryness Index can be used to objectively identify areas at risk of extreme bushfire behaviour in advance. As such, it allows the deployment of resources in the most appropriate areas to monitor ignition events and inform action for prompt suppression.

Introduction

In spring 2019 and summer 2019/2020 there was very low rainfall in large parts of South Eastern Australia. Consequently, soils and vegetation have also been extremely dry and large areas have experienced some of the worst bushfires in recorded history.

As a vital part of understanding these bushfire events, it is imperative that the extreme dryness is quantified. In this short submission we wish to draw attention to an established and important indicator, that we believe needs to be given a far more prominent role in anticipating severe bushfire behaviour.

Soil Dryness Index (SDI)

The Soil Dryness Index (SDI) was introduced by Mount (1972) to quantify just how dry the soil really is. It does this by providing a numerical measure of the quantity of rain required to saturate the soil in any given location. Specifically the SDI is a number in millimetres (mm); and the higher the number, the more millimetres of rain that are required to saturate the soil. In the many years since the SDI was introduced and in the many independent studies which have evaluated the SDI, e.g. Finkele *et al* (2006) and Styger and Kirkpatrick (2015), extensive datasets have been created. The SDI ranges from 0mm (saturated soil) to 200mm (extremely dry soil) and, in practice, a value of close to 200mm has never yet been recorded.

In the Braidwood region of NSW, one of us (Roger Hosking, a former NSW NPWS staff member) has been recording meteorological observations, which are reported to the Bureau of Meteorology (BoM) for Station Number 069010, for over 35 years and has used established datasets to extend the meteorological information available to determine the Soil Dryness Index (SDI) daily from 1888 to the present day. The references already given detail the technical information necessary to determine SDI in millimetres. Hence, our submission will not repeat these details, but rather it will present the SDI over the crucial eight months leading up to and during the 2019/2020 intense and massive bushfires, drawing attention to its significance and the implications for anticipating severe bushfire behaviour. In particular, for the dataset from the Braidwood site, graphs of the 90^{th} percentile of the SDI reveal that an SDI of greater than 125mm should be regarded as extreme.

The Crucial Time Period

Winter and spring 2019, through to early February 2020 saw the continuation and exacerbation of extreme drought in parts of SE Australia. Ignitions in November 2019

resulted in massive bushfires in many areas, including the greater Braidwood region. In this region the massive bushfires were enabled by extreme dryness of soils and vegetation. The soil dryness is objectively quantified by the SDI, an established, but in our opinion not widely enough used, metric for quantifying soil dryness. Importantly, soil dryness is an indicator of fine fuel dryness. The SDI can be used to identify areas at risk of extreme bushfire behaviour in advance: as such, it allows the deployment of resources in the most appropriate areas to monitor ignition events and inform action for prompt suppression.

The attached figure displays the Soil Dryness Index (SDI) calculated from measurements of rainfall and temperature at a Bureau of Meteorology site at Braidwood, NSW.
The period shown is from July 2019 to February 2020 inclusive. In particular we wish to draw attention to the high values of the SDI in the winter and spring of 2019 which were followed by the extremely high values of the SDI at the beginning of summer. The January value of 175mm is the highest ever determined in the dataset which spans 1888 to 2020 (yes, over 130 years). Moreover, the attached figure shows the SDI to have surpassed the extreme 125mm mark in early November 2019. It is our contention that this could have served as a red flag to emergency services and fire authorities.

The setting of a (local) objective criterion such as a value of SDI beyond which there is a significant risk of extreme bushfires seems to us a sensible and practical risk management tool. Furthermore, there seems no reason why many other regions could not also benefit from a careful examination of their available data in order to set region specific extreme criteria.

Better appreciation of the SDI could lead to better advance planning for extreme bushfire behaviour which can only occur during extreme dry conditions; and these extreme dry conditions are anticipated by the SDI.

Key point: The Soil Dryness Index can be used to objectively identify areas at risk of extreme bushfire behaviour in advance. As such, it allows the deployment of resources in the most appropriate areas to monitor ignition events and inform action for prompt suppression.

In the interests of brevity and conciseness only some of the available 130+ years of available data have been presented and discussed: all of the data and further details and discussion can readily be provided to assist with any further evaluation and implementation.

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