NOT IF, BUT HOW

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Black Summer Bushfires 2019/20 in Australia

Bushfire hazard results from the complex interaction of a wide range of human and natural factors. It is the only natural hazard in which humans have a direct influence on the hazard situation. The majority of fires near populated areas are ignited by either deliberate or accidental human activity, and a smaller portion start naturally by lightning.

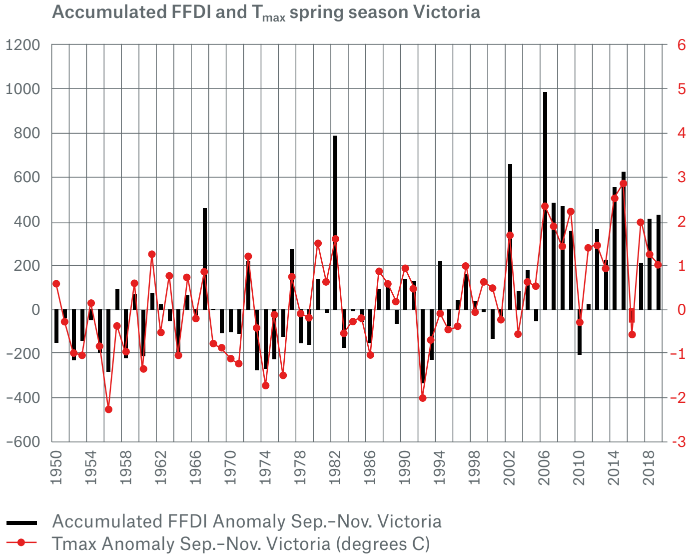
Besides ignition, other components contributing to bushfire hazard are fuel abundance, topography, vegetation management and – most important for the capacity of fires to spread quickly – the weather and fuel conditions, such as maximum temperature, humidity of the air, wind speed, soil moisture and dryness of the vegetation.

During a period with increased fire danger, i.e. hot and dry weather conditions combined with high wind speeds, bushfires can cause major property losses in the bush-urban interface. The average bushfire hazard level and accordingly risk level in southeastern Australia is especially high, as high hazard meets high exposure.

Higher temperatures are driving increasing fire hazard

The 2019/20 bushfire season was particularly severe, with an unusually early start in September in New South Wales and Queensland. An important precondition was the long-term change over decades, where parts of southeastern Australia have experienced increasing maximum temperatures and soil dryness. The latter is only partly due to decreasing rainfall, and is substantially due to the increasing drying of soils and vegetation driven by a higher frequency of days with very high maximum temperatures. The following diagram demonstrates this substantial increase in fire-prone weather conditions over the decades (black bars: McArthur's Forest Fire Danger Index) and concomitant springtime maximum temperatures for Victoria (red curve). These increasing values are statistically well correlated (R = 0.82).

Deviations of accumulated Sep–Nov McArthur's Forest Fire Danger Index (black bars) and maximum temperature (red curve) for Victoria relative to the average over the period 1961–1990



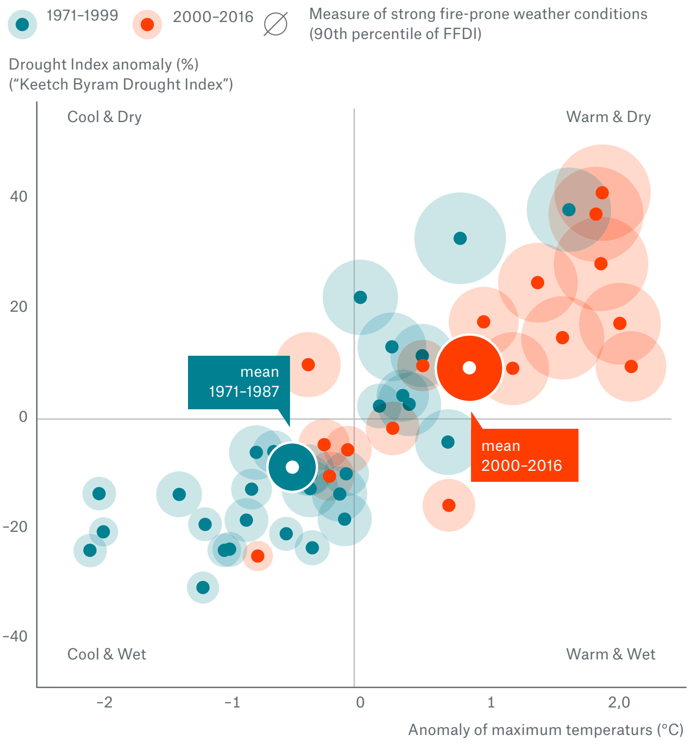
Source: Munich Re 2020, based on data of the Bureau of Meteorology, Australia

Similar results can also be found for the entire region of southeastern Australia (Victoria, New South Wales, Australian Capital Territory). This means, increasing maximum temperatures with some support from decreasing rainfall have driven up evaporation/transpiration from soils and vegetation and thereby increased conditions prone to bushfire.

The fire season is becoming longer

An index measuring fire-prone weather conditions representing the most extreme 10% of fire weather days is FFDI90. The following diagram displays the seasonal measure of FFDI90 for spring seasons in the period 1971–2016, indicated by the diameter of the circles. The four quarters of the diagram represent combinations of deviations of maximum temperature (X axis) and dryness of soils (Y axis: Keetch Byram Drought Index) from the long-term mean. So the lower-left quadrant indicates anomalously cool and wet conditions, while the upper-right indicates anomalously warm and dry conditions. The orange circles represent the most recent 17 years 2000–2016, whereas the blue circles represent the earlier years 1971–1999.

Fire-prone weather conditions in Australia
Season September–November, 1971–2016



Source: Munich Re 2020, based on data from Harris and Lucas, 2019, PLoS ONE

The diameter of the circles indicate the Sep–Oct average of the seasonal aggregate of the 90th percentile of McArthur's Forest Fire Danger Index at 12 selected stations distributed across Victoria and New South Wales (including Canberra). These values are depicted as dependent on the deviation of maximum temperatures (X axis) and a soil drought index (Y axis) from the long-term mean, averaged over the same selected stations. Orange-coloured circles indicate seasons of the recent period 2000–2016, light blue circles indicate the earlier period 1971–1999. The dark-blue circle with white edging indicates the 1971–1987 average, the dark-orange-coloured one with white edging the 2000–2016 average.

The diameter of the circles, i.e. the measure of strong fire-prone weather conditions, is increasing from the lower-left quadrant (anomalously cool & wet) to the upper-right (anomalously warm & dry). Additionally, the majority of the most recent period seasons are situated in the warm & dry upper-right quadrant, while most of the early-period seasons are situated in the cool & wet quadrant. This shift over time indicates that the spring season has become a part of the fire season, leading to an overall increase in the length of the fire season.

Climate change is driving fire weather

As this shift over time is driven to a large extent by the increase in maximum temperatures, several studies have demonstrated that this change is mostly driven by long-term anthropogenic climate change, which has increased (maximum) temperatures over decades (Harris and Lucas, 2019, PLoS ONE 14(9); Dowdy, 2018, Journal of Applied Meteorology and Climatology, 57, 221–234). December 2019 was the warmest December averaged over Australian territory since measurements began. December 2019 had 11 days when area-averaged maximum temperatures exceeded 40°C, seven of them in a row from 23 to 29 December. Prior to December 2019, there had been only 11 such days in December in Australia since 1910. Seven of these prior days occurred in the summer 2018–2019, just one year before. On 18 December, Australia had its hottest day on record with area-averaged maximum temperature at 41.88°C. Besides the heat in December, the most extreme heat in eastern New South Wales occurred in early January – a number of stations in metropolitan Sydney recorded temperatures in excess of 47°C, Penrith registered 48.9°C. A final period of extreme heat affected southeastern Australia end of January/beginning of February 2020, when the maximum temperature in Canberra was 42.7°C (Bureau of Meteorology, Special Climate Statement 73, 2020).

A study by international climate scientists from March 2020 addressed the question of whether or not an event as destructive as the bushfire season Sep 2019–Jan 2020 has become more likely due to climate change. As the climate models could not reproduce the heat and fire weather characteristics in an adequate way, it was not possible to reliably quantify the extent to which climate change contributed. To give a lower limit, this study found that hazardous fire weather conditions have been intensified by climate change by at least 30% since 1900. However, according to the authors, the true value could be much higher. Using reanalysis data, the highest aggregated 7-day fire weather index (FWI) in the season 2019/2020 in southeastern Australia was estimated to have a return period of around 30 years (best estimate) in the present climate, but was much rarer in 1900 (> 800 years). Although uncertainties are high due to poor climate model performance, the analysis was able to clearly establish that climate change was a contributing driver for such an event to have become more likely over the decades (Van Oldenborgh, G.J., et al., 2020).

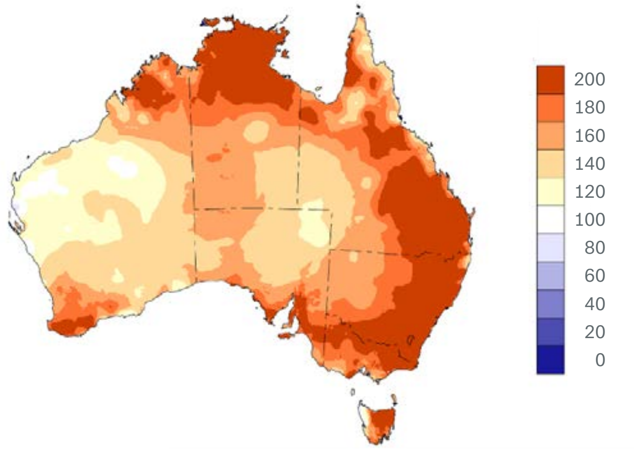
The contribution of natural climate variability

On top of the effect from long-term climate change, the 2019/20 bushfire season was imprinted by two elements of **natural climate variability**, which furthermore exacerbated the fire-prone conditions and fostered the very early and extreme bushfire outbreaks:

- The **Indian Ocean Dipole (IOD)**, which is an element of natural climate variability in the Indian Ocean, has a strong influence on cool-season rainfall and the potential development of particularly dry conditions in parts of western, southern and eastern Australia. During a positive phase of the IOD, the large-scale atmospheric transport brings drier than normal air masses into western, southern and eastern Australia. Over the last months of the cool season, there was a strongly positive phase of the IOD which reached extremely high index levels in late September and October, contributing to the strong deficit in rainfall over the winter and spring of 2019 and to the flammability of vegetation.

- In addition, between September and December, the prevailing negative phase of the **Southern Annular Mode (SAM)** had the effect of shifting westerly winds from the Southern Ocean further north, thereby also increasing spring temperatures and decreasing rainfall in New South Wales, parts of Victoria, and southern Queensland.

Forest Fire Danger Index in Australia for December 2019 relative to 1950–2018



Source: Australian Government/Bureau of Meteorology, 17 March 2020: Special Climate Statement 73 – extreme heat and fire weather in December 2019 and January 2020.

A recent attribution study found that more than half of the July–December 2019 dryness in the southeast of Australia was driven by the positive phase of the IOD and the negative phase of the SAM (Van Oldenborgh, G.J., et al., 2020). As a consequence of the influences from anthropogenic climate change and superimposed reinforcing phases of the IOD and SAM, the percentage deviations of the accumulated FFDI for spring 2019 and for summer (December) relative to the long-term mean 1950–2018 were particularly high, i.e. +200% and more, in those areas of southern Queensland, New South Wales and northern Victoria where most of the bushfires raged.

Widespread property losses and underinsurance trends

The weather conditions helped the bushfires continuing to burn for a long period of time. Up until mid-February 2020, almost 10 million square kilometres of bushland and forests had been burnt in Queensland, New South Wales, Australian Capital Territory, Victoria, and South Australia. During periods with catastrophic fire conditions including higher wind speeds and ember transport over substantial distances, fires got out of control and spread into populated areas, where some 3,000 homes and many other buildings were destroyed. The majority of losses were caused in rural areas and smaller settlements in New South Wales. Major cities were spared, but the smoke from the fires worsened the air quality dramatically in Sydney and Canberra, promoting many respiratory diseases which also caused many fatalities. Other historic Australian bushfires that caused major losses occurred in 1983 and 2009 in Victoria. During Ash Wednesday (1983) some 2,400 homes and during Black Saturday (2009) more than 2,000 homes were consumed by flames.

It is estimated that 95% of buildings located in the 2019/20 bushfire-affected regions had insurance cover. Contents were insured to a lesser degree. In 2009 the uninsured rate was higher, as 87% of the destroyed residential properties were insured. The aggregated insured property loss for the fire season 2019/20 set a record for this peril in Australia. In the period from November 2019 to January 2020 some AU$ 2.2bn (US$ 1.5bn) of insured losses have been claimed (ICA Data-Globe). Some 80% of the claims were made in New South Wales. Besides the insured losses in personal lines, significant losses were caused in farm and forestry insurance.

Compared with other natural hazards, the share of total losses (destroyed houses) is higher on average for bushfires; therefore underinsurance effects can be greater. Most houses are either destroyed completely or left virtually undamaged – there are only few structures with partial damage.

Bushfire mitigation

While the Australian system represents a globally high standard of bushfire mitigation, there are still some hurdles until we reach an improved bushfire mitigation for both lives and property. Often, people in bushfire areas are not sufficiently aware of their risk, not sufficiently prepared to manage their risk, wait until the last chance to leave the location, or even come back to defend property. This is particularly true for suburban areas that are not as often threatened by bushfires. It is crucial for property preparedness, in particular for buildings in the highest bushfire danger zone, to have window and door systems that can withstand up to 30 minutes of fire exposure, and non-combustible construction materials for decking, walls and roofs. This can prevent damage in substantial fires (Van Oldenborgh, G.J., et al., 2020). For extreme and catastrophic fire conditions, such measures cannot however avoid destruction of the property.

Conclusion

Over the decades, particularly in southeastern Australia, long-term anthropogenic climate change has exacerbated the meteorological conditions supporting the spread and intensification of bushfires once they have ignited, given an abundance of fuel. This means that it has become ever more important to have high prevention standards for residential homes and other structures, such as consideration of distance to vegetation for land-use planning in the bush-urban interface, the use of non-combustible materials for the outer shell of buildings, and the clearing of vegetation debris from roofs and in gutters. Risk assessment cannot be based on conditions including data from decades ago. Rather, the trend in the hazard, as well as trends in vulnerability due to ever increasing exposure in the bush-urban interface, have to be accounted for in today's risk assessment.

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