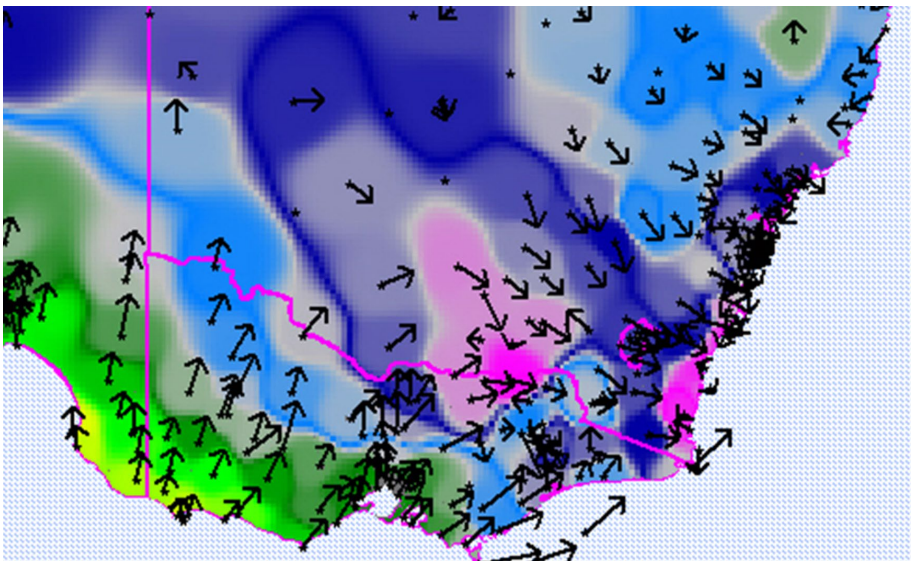
AUSTRALIAN FIRE PATTERN ANALYSES USING MODIS HOTSPOTS



Part 4: RECENT CHANGES IN FIRE ACTIVITY ACROSS AUSTRALIA

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PART 4 - RECENT CHANGES IN FIRE ACTIVITY ACROSS AUSTRALIA

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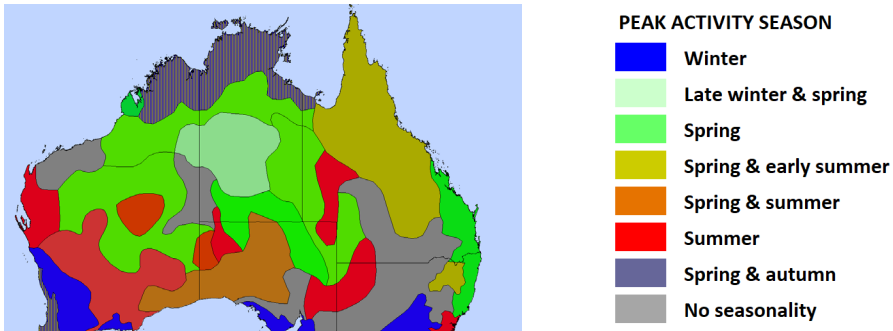
Over the past decade, the bushfire outlook for many parts of Australia has changed drastically. Environmental conditions have transformed and have produced larger and more destructive bushfires. The frequency of bushfires that alter the atmospheric conditions around them has also increased. Nowhere was this more evident than during the Black Summer bushfires of 2019-2020. As we continue to experience the effects of climate change, these environmental changes and destructive fire events will only become more prevalent.

Thanks to satellite imaging data collected over the past 20 years, we can quantify the region-by-region impact that climate change has had on different parts of Australia and how this has affected the prevalence of fire in that environment. With more accurate bushfire modelling we can assist fire services and land managers to determine where they need to refocus their efforts as we adjust to the long-haul of adaptation to climate change.

The beginning of satellite fire monitoring

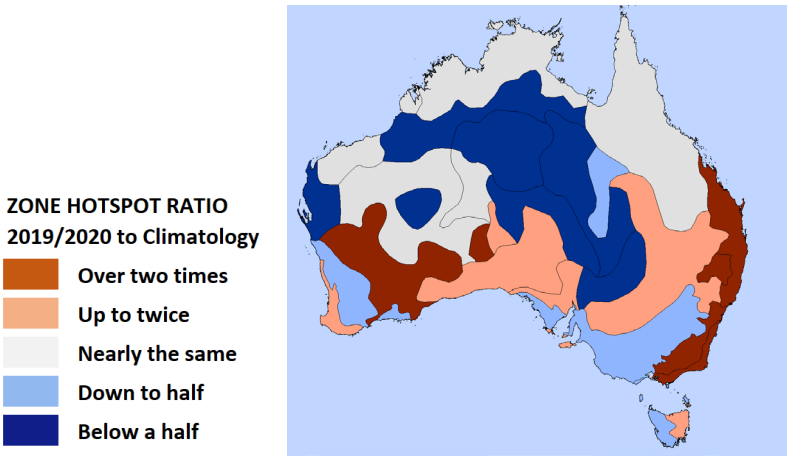
More than 20 years ago NASA launched two satellites (Terra in 1999 and on Aqua in 2002) to monitor the Earth's surface with specialised sensors. One sensor, MODIS (MODerate resolution Imaging Spectroradiometer), was able to see both smoke plumes and the infrared signature of fires. An algorithm was developed to classify image pixels containing fire, producing a set of what was called "hotspots". Both satellites have lasted well beyond their planned mission durations, which is significant for fire managers. We now have two decades of continuous hotspot data.

Mapping Australia's fire hotspots



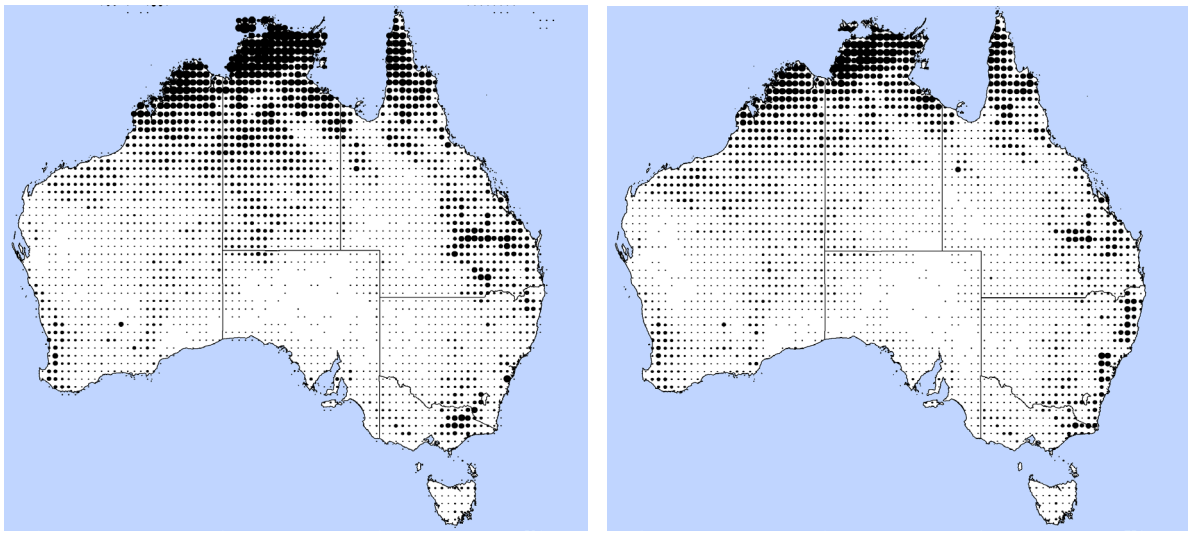
For many years I have been analysing MODIS data from the perspective of seasonality – looking at when fires occurred and did that reflect expectations. This was to support the validation of seasonal bushfire outlooks. The past 20 years of annual seasonality reviews are now available online. Each year the previous 12 months' data were compared against those from a set time range or control period. This was a decadal-length interval that covered a mix of El Niño and La Niña years, indicating 'average'

conditions. Recently, we passed the end of the second decade of MODIS data, and this opened the prospect of comparing two decades and looking for differences.



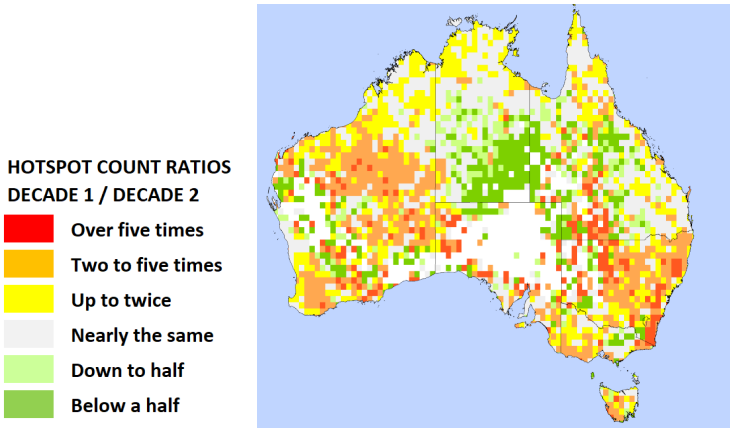
In a year with a lot of fire, Australia creates more than 400,000 hotspots. This makes the 20 years of MODIS data an irreplaceable tool for seamless, quantitative assessments of fire dynamics across Australia. The datasets are freely available online, and have been used to create useful products designed to assist fire managers. There are several caveats for hotspot datasets – low intensity fires (especially well-planned hazard reduction burns), fires under heavy cloud cover, and fire runs that burn out quickly may not produce a hotspot. The latter was the case for many of the worst fire events during the Black Summer fires. There is also no way to separate wildfire from planned fire.

To determine how fire activity had changed between the first and second decades of data, hotspots were aggregated into grid-cells that spanned half a degree of both latitude and longitude.



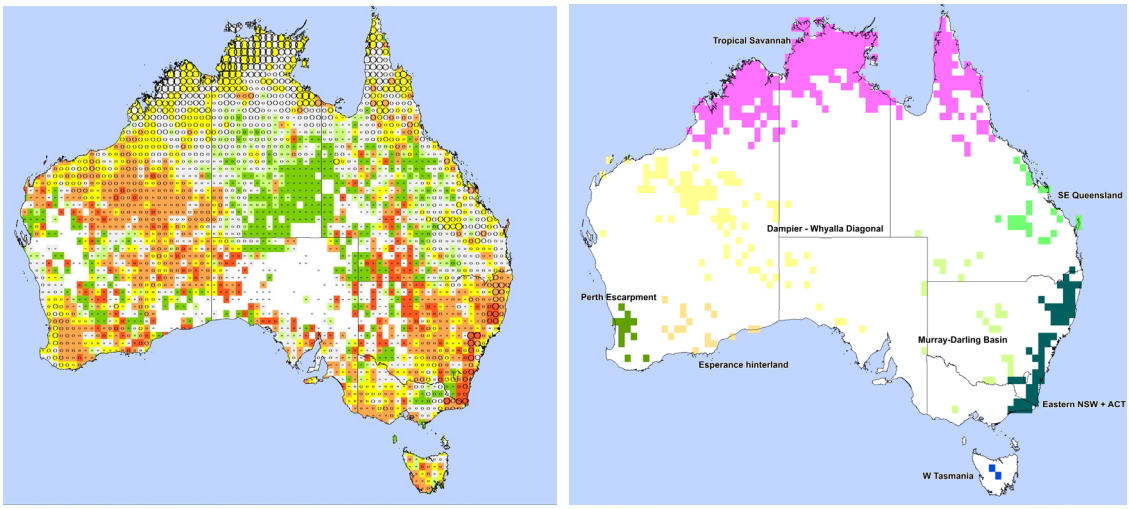
Hotspot count maps for decade one (left) and decade two (right). Larger symbols indicate higher counts.

By comparing the number and ratio of hotspots in the grid-cell count from decade one to that from decade two, we could determine where fire frequency was changing the most.



Some areas, like eastern NSW, have a very high ratio of change between the first and second decade, reflecting Black Summer. Some areas, like Arnhem Land, have a very high hotspot count and a slight increase, which may produce a significant challenge in the future. To encompass the effects of both high counts and high ratios, a threshold was set and any region which exceeded this was an area that needed the most attention.

This produced a set of geographic regions with consistent patterns.



(Left) Combinations of decade two count and inter-decadal ratios used to create regions of change (right).

The impacts detailed in the above graphic must be considered as longer-term management issues. Year-to-year fire patterns have been showing extreme swings in recent years, which may swamp the longer-term trends. However, these trends have picked up many of the key operational challenges (including fire thunderstorms) of recent years: evident in forests in the south-east and south-west, south-east Queensland, central Tasmania and the tropics.

Hotspot mapping in the future

Challenges as we move forward include developing ways to merge the MODIS data with that from the next generation of satellites, and the ability to separate data for wildfire and prescribed burning.

This and other work will allow us to better anticipate what the next decade will bring.