AUSTRALIAN EARTH SCIENCE EDUCATION

# Bushfires of 2019-2020

## Causes and Effects

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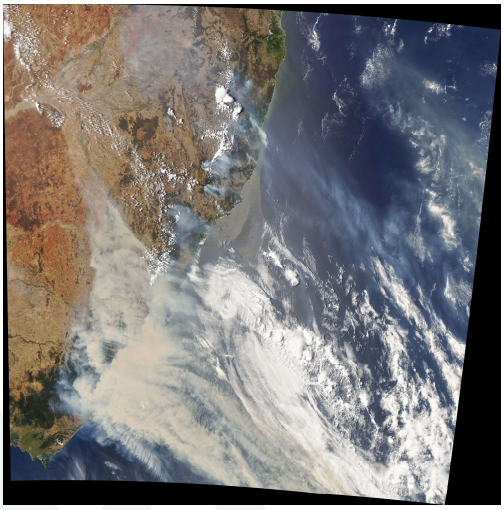
## Overview of fires

- 240 days
- 11 774 fires
- 5.5 million hectares
- 6% of NSW



Landsat 8 image of south-eastern Australia 1 January 2020 (J Stevens, NASA Earth Observatory, public domain)

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Between July 2019 and March 2020, eastern Australia experienced the largest recorded fire season. 11 774 fires burned more than 6% of NSW (5.5 million hectares). Most fires affected parks and reserves.

## What lit the fires?

- **Lightning**
- Debris burning
- Powerlines
- Equipment
- Shredded tire

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(M Kozlenko 2007, Creative Commons)

Of 32 major fires, 26 were caused by lightning, including the most devastating fire at Gospers Mountain that burned over 500 000 hectares. Minor causes were debris burning (3), powerlines (2), equipment and a shredded tire (1 each).

## Causes – Climate change

- Steady increase in temperature
- 2019 – hottest year on record (at that point)
- Overall decrease in rainfall


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Temperature is steadily increasing with each year generally setting records for high temperatures. 2019 was no exception, being the hottest year recorded. In addition, rainfall has been decreasing in south-east Australia.

This background effect played a major role in the catastrophic fire conditions.

## Causes – Drought and climate drivers

- 3rd year of drought
- Positive Indian Ocean Dipole
- Negative Southern Annular Mode
- Neutral ENSO

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(CSIRO Science Image 2000, Creative Commons)

Most of NSW was in its third year of severe drought in 2019. A strong and long-lived positive Indian Ocean Dipole and negative Southern Annular Mode are large-scale climate drivers that led to drought in Eastern Australia. The El Niño Southern Oscillation (ENSO) was close to the El Niño threshold, but had returned to a neutral condition by September 2019.

## Causes – Dry landscape

- Little grass left west of dividing range
- Gullies and swamps dry up

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(CSIRO Science Image 2007, Creative Commons)

The combination of extreme heat and extreme drought left the landscape drier than ever before. The moist gullies and swamps that often break up forest landscapes were dry, increasing the potential for megafires. The prolonged drought led to little grass cover west of the dividing range. This limited the high-risk areas to the forest regions on and east of the range.

## Causes – Fuel load

- Fuel load was average for past 30 years
- More flammable due to extreme dryness
- Hazard reduction burning only effective in moderate weather

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(CSIRO Science Image 2008, Creative Commons)

After the fires, many people criticised the hazard reduction burns that had occurred before the summer. Subsequent analysis has shown that fuel load was high, but this has been the case for the past 30 years. However, the fuel was more flammable due to extreme dryness.

Hazard reduction or previous bushfires reduced the spread of fires during moderate fire weather, but had no effect on fire spread or speed during days of extreme fire weather.

## Causes – Fire Weather

- Hot nights and high westerly winds
  - Catastrophic – 6 days
  - Extreme – 22 days
  - Severe – 72 days
- Highest **MINIMUM** fire weather in December


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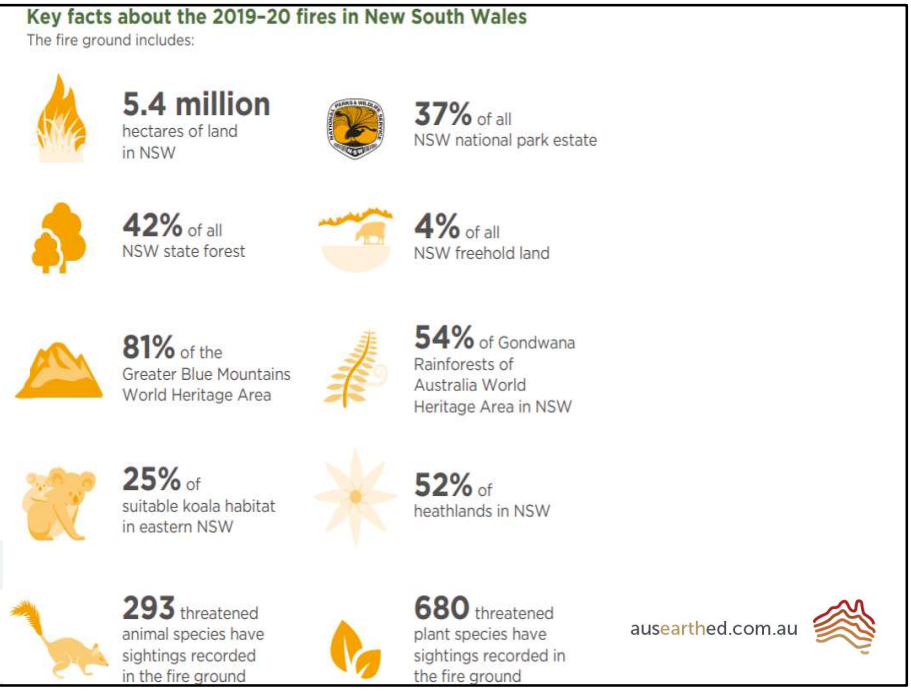
(Mattinbgn 2014, Creative Commons)

The combination of a negative Southern Annular Mode and a sudden stratospheric warming event led to strong westerly winds in combination with extreme heat and drought.

The combination of weather and climate effects is brought together in the Forest fire Danger Index that is posted on signs. 6 days of Catastrophic, 22 days of Extreme and 72 days of Severe fire danger from October to December 2019. Records were set for the number of high-risk days, but also for the highest monthly **minimum** fire weather conditions, particularly in December. The lack of reprieve from dangerous conditions increased the severity and spread of the fires.

# Impact




From: Department of Planning, Industry and Environment (2020) NSW Fire and the Environment 2019-20 Summary, p 5

## Damaged ecosystems

- 81% of Greater Blue Mountains Heritage Area
- 52% of heathland ecosystems
- 39% reduction in ecological carrying capacity

Vegetation recovery 6 months after fire in the Blue Mountains World Heritage Area

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The fire ground in NSW included 37% of national parks, 42% of state forests and huge areas of World Heritage status. The ecological carrying capacity of the fire ground was reduced by 39% compared to 2013 assessments. Heathland ecosystems were most heavily damaged (52%), followed by wet sclerophyll forests (50%) and rainforests (37%).

## Effect on threatened species

- 60 plants live mainly in fire ground
- Threatened animal species include
  - long-nosed potoroo
  - frog *Philora pugh*
  - greater glider
  - Hastings River mouse

Long-nosed potoroo (G Pandey 2018, Creative Commons)

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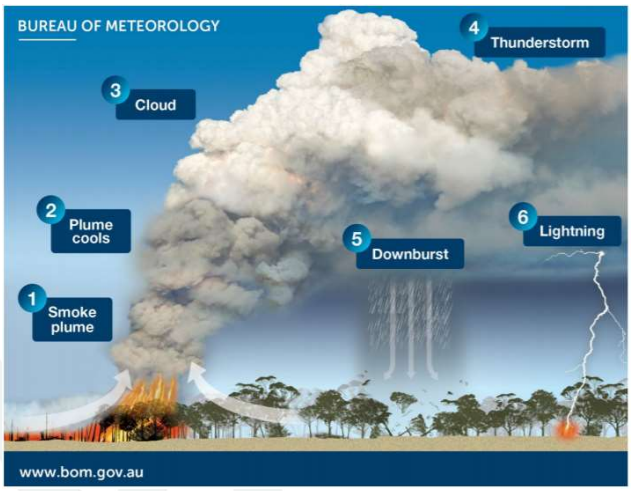
More than 60 threatened plant species live predominantly in the fire ground. Threatened animal species reported mainly (>80% of reports) in the fire ground include the critically endangered long-nosed potoroo, the endangered frog *Philora pughi*, the greater glider endangered population in Eurobodalla and the endangered Hastings River mouse.

# Fire-generated thunderstorms

- 89 fire-generated thunderstorms
- Extreme wind
- Lightning
- Tornadoes
- Black hail
- Spread embers




From: Owens D, O'Kane M (2020). Final Report of the NSW Bushfire Inquiry. P 68.

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50% increase in the number of fire-generated thunderstorms (pyrocumulonimbus). Thunderstorm conditions make it too dangerous to fly firefighting aircraft in the storm. Storms knock down standing trees, destroy vegetation and can spread embers 10s of kilometres from the parent fire.

## Erosion

- 113% increase in national parks
- 143% increase in state forests
- 59% increase on other Crown land

Erosion after fires in Yellowstone National Park, USA
(J Peaco/National Park Service, public domain)

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The reduction in vegetation increased erosion across the fire ground, more than doubling erosion rates in national parks and state forests. Topsoil loss is particularly devastating because of the slow rate of soil formation in Australia and the loss of vital trace elements contained in topsoil.

## Runoff affects water quality

- Heavy rains in February
- Soil, leaves, ash and debris in runoff
- Decomposing organic material uses up oxygen

Ash flowing into a river after a fire in New Mexico, USA
(US Dept of Agriculture 2013,Creative Commons)

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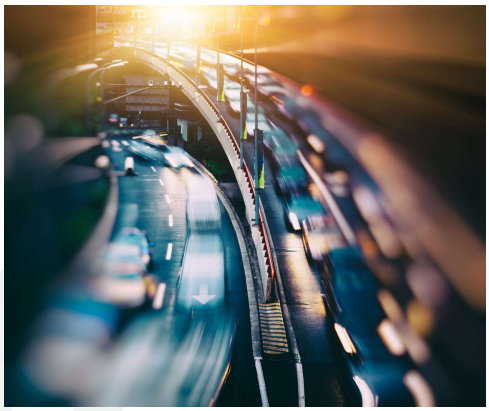
Heavy rains in February 2020 led to increased water runoff and erosion. The runoff contained soil, leaves, ash and burn debris into water, affecting water quality. As the organic material decomposes, it uses up oxygen that would otherwise be used for respiration by fish, oysters and other aquatic species.

## Human contribution:
## Climate change

- Greenhouse gas release leading to climate change
- Consistent warming
- Less rainfall
- Extreme weather



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The enhanced greenhouse effect results from human production of greenhouse gases. Whilst not directly responsible for any single weather event, higher temperatures, lower rainfall and more extreme weather associated with the enhanced greenhouse effect contributed to the devastating fire conditions.

## Human contribution: Hazard reduction burning

- Fuel load was not unusually high
- Reduction burning is helpful if in normal fire weather
- Reduction burning has no effect during severe fire weather

NSW RFS volunteer conducting a hazard reduction burn in 2019 (R Lagois 2020, Creative Commons)

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Many members of the public and politicians argued that hazard reduction burning before the summer was inadequate. Measurements of fuel load indicated that this was high, but at an average level for the past 30 years.

Analysis of areas that had experienced hazard reduction burns or natural fire in the years prior to 2019-20 indicated that this slowed the fire in normal conditions. However, it had no effect on the speed or spread of fire during the severe fire weather that was common that summer.

## Human contribution:
## Traditional Aboriginal land management

- Not necessarily for fuel reduction
- Limited funding
- Difficult to get permission

Cultural burning in the Top End (CSIRO 2000, CSIRO Science Image)

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Cultural burning does not necessarily aim to reduce fuel for bushfires. It is about caring for Country, maintaining healthy, diverse landscapes and practicing cultural traditions. Legislative and funding limitations make it difficult for Aboriginal groups to carry out cultural burning over the long timeframes necessary to achieve vegetation change. The bushfire inquiry recommended that the NSW Government commit to greater application of cultural burning and evaluation of these techniques, which are credited with saving property in several areas during the 2019-20 season.

## Human contribution: Firefighting

- Hard to spot fires
- Fires in difficult areas
- Weather challenges
- High number of fires
- Late extra support

Water bombing helicopter in action (Aussie Oc 2015, Creative Commons)

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Many fires started in rugged terrain and were difficult to spot with current technology. For example, the Gospers Mountain fire was detected when 4 hectares were burning at 1pm on 26 October, but it was too windy and rugged to insert a firefighting team or water bucket with helicopters. Four hours later (5 pm) the fire had grown to about 25 hectares and was too large for a single firefighting crew. The next day firefighters were brought in, helicopters deployed and fixed-wing water bombers on the scene. However, crews had to be withdrawn by mid afternoon due unpredictable fire conditions caused by extreme fire weather.

The high number of fire incidents stretched resources past breaking point. At times, the NSW Rural Fire Service (RFS) was managing more than 150 fires. Extra air support from overseas was brought in relatively late when large fires were well established. Firefighters from the RFS were supported by Fire and Rescue NSW, National Parks and Wildlife Service, the Forestry Corporation of NSW, the State Emergency Service, the NSW Police Force and thousands of interstate and overseas personnel.

## Recommendations from Inquiry

- 76 recommendations
  - Improvements in fire fighting methods and equipment
  - Better telecommunication
  - Government response
  - Education

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The official NSW state government inquiry into the bushfires made 76 recommendations. These ranged from improving the methods and equipment for fighting fires to improving communication among firefighters and to the community, to improving governance of people and land to educating the public about fire risk and response.


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