



DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

# Fire extent and severity mapping

Annual report for the 2019-20, 2018-19 and 2017-18 fire years



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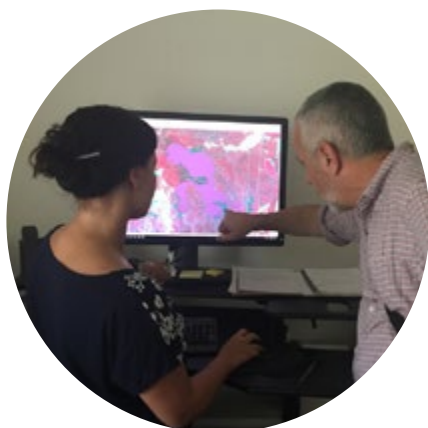
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# Introduction

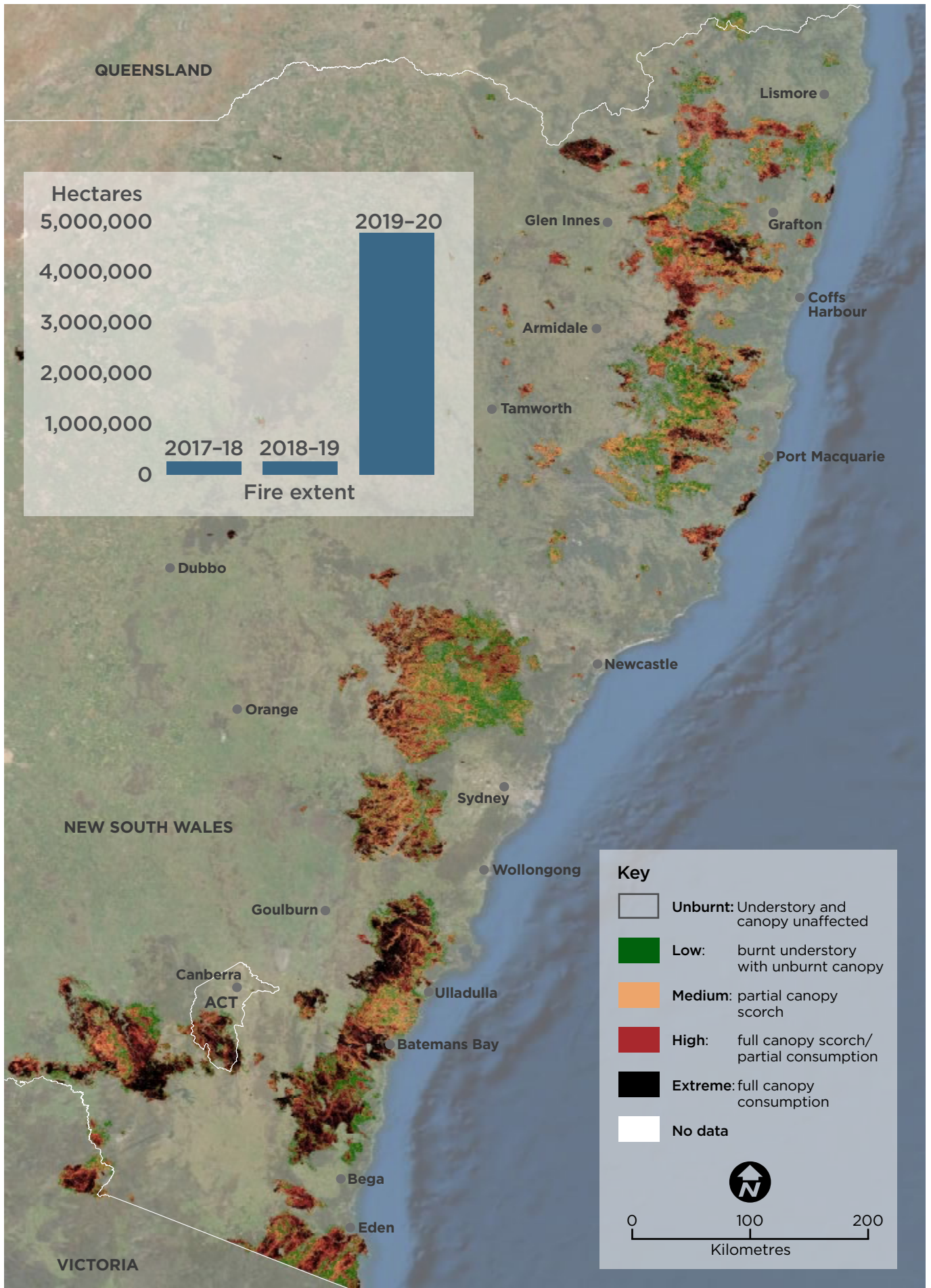
Information about the severity of a fire on a landscape is critical to understanding the relationship between fuels, fire behaviour and landscapes. Remote sensing experts from the Department of Planning, Industry and Environment's (the Department's) Science, Economics and Insights Division, in collaboration with the NSW Rural Fire Service (RFS), have developed a semi-automated approach to fire extent and severity mapping (FESM) in New South Wales.

Although bushfires are part of a natural cycle in our environment, they are increasing in frequency, severity and extent. This makes fire an increasing threat for environmental management in New South Wales. We produce maps year on year through the FESM system (Figure 1). These maps enable us to understand vegetation changes because of fire events, as well as vegetation trends that impact fire behaviour over time. This enables our scientists to better understand how future fire events may unfold and the potential impacts of these events on the environment. It also provides vital information supporting conservation efforts during fire events, as well as for ongoing fire research and post-fire recovery efforts.

This report is the first FESM annual report produced for New South Wales. It outlines analyses for the 2019–20 fire season and retrospectively compares the 2017–18 and 2018–19 fire seasons. Future annual reports covering the September to March fire season will be issued in May each year.

This annual report is accompanied by a data spreadsheet. The report and data can assist governments, fire managers, and conservation and landscape ecology researchers to understand and respond to environmental effects of fire on the landscape. FESM spatial data are available on the Sharing and Enabling Environmental Data (SEED) portal.

More information about the FESM system can be found on our [Fire Extent and Severity Mapping webpage](#). Our website also includes information about [understanding the effects of the 2019–20 fires what influences fire regimes and climate change](#), and links to current research being undertaken through the [Bushfire Risk Management Research Hub](#).



**Figure 1** Map of the eastern part of New South Wales showing the extent and severity of the 2019-20 fire season. The bar chart shows a comparison of fire extent between the 2019-20, 2018-19 and 2017-18 fire years.

# Key findings from 2019-20



**7%** of NSW was affected by fire in the 2019-20 fire season, almost **20 times** more than in 2018-19



## Northern NSW

had mostly low and moderate fires

## Australian Alps and south coast bioregions

had mostly high and extreme fires



**2,593,940 hectares**

or **35%** of NPWS Estate burnt

**42%** of burnt estate had

**80-100%** total area burnt



Over **30%** of the Australian Alps bioregion burnt

**39%** of NSW State forest burnt



Over **30%** of rainforest and alpine complex vegetation types burnt

Over **30%** of the Sydney Basin bioregion burnt



**20%** of highly organic peat soils burnt





# How fire extent and severity mapping works

FESM is a remote sensing assessment of fire severity that measures the loss or change in vegetation caused by fire. FESM uses machine learning trained on fire severity class samples from over half a million training data points, interpreted from high-resolution post-fire aerial photography. The FESM fire severity classes are described in Table 1.

**Table 1** Fire severity classification ruleset

| Severity class  | Description                                       | Percentage foliage fire-affected                     |
|-----------------|---|--|
| <b>Unburnt</b>  | Unburnt surface with green canopy                 | 0% canopy and understory burnt                       |
| <b>Low</b>      | Burnt understory with unburnt canopy              | >10% burnt understory<br>>90% green canopy           |
| <b>Moderate</b> | Partial canopy scorch                             | 20–90% canopy scorch                                 |
| <b>High</b>     | Complete canopy scorch/partial canopy consumption | >90% canopy scorched<br><50% canopy biomass consumed |
| <b>Extreme</b>  | Complete canopy consumption                       | >50% canopy biomass consumed                         |

FESM is based on the best available information. It is anticipated that future versions of the algorithm will incorporate refined methods and enhanced training data. The latest version of the FESM algorithm, version 3 (FESMv3, December 2020) includes enhanced training data captured from fires in the 2019–20 season.

Independent aerial photo and field validation data used to assess the accuracy of the FESM algorithm show that accuracy is:

- between 85% and 95% for unburnt and extreme severity classes
- between 60% and 85% accuracy for low, moderate and high severity classes.

In July 2020, the operational automated system developed by the Department in collaboration with the NSW RFS was launched, delivering fire extent and severity maps in near-real time.

Further information on the FESM method is available on our [Fire Extent and Severity Mapping webpage](#).





## Accuracy and future improvements

The FESM approach has been peer reviewed and rigorously validated and continues to be updated and refined. The accuracy statistics for FESMv3 are independently assessed on high-resolution post-fire aerial photography as well as post-fire field surveys.

FESM has reduced accuracy with topographic roughness, high canopy density and in wetter areas that change significantly in optical reflectance signals over short time-periods, especially through summer. Detailed assessments of the performance of the modelling across vegetation type, terrain and climatic regions using high-resolution aerial photography interpretation and post-fire field assessments are ongoing, to help inform the improvement of future FESM models.

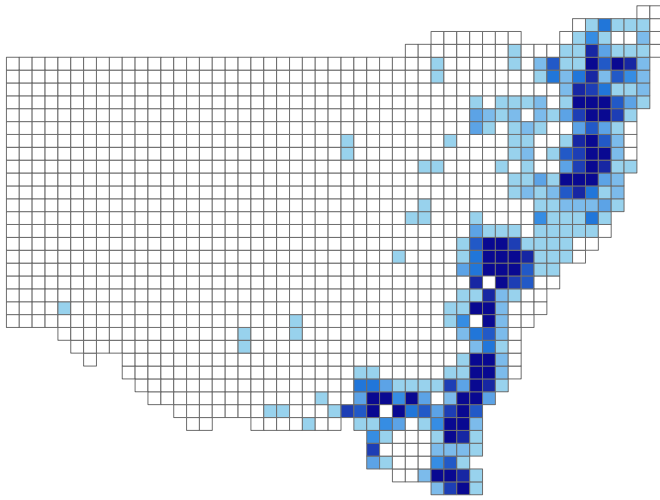




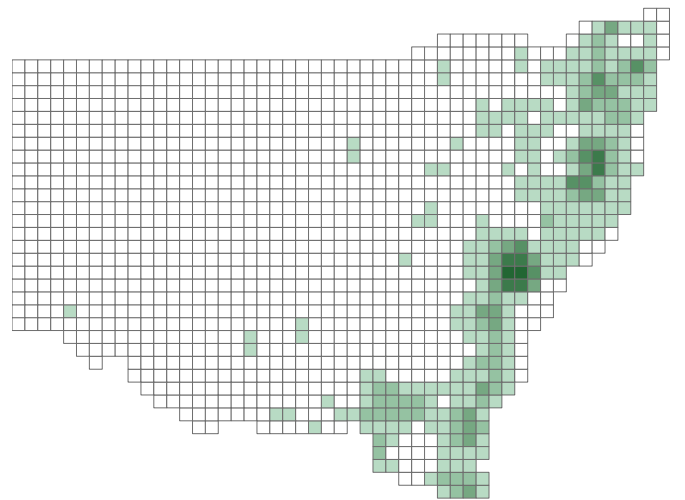
## **NSW state-wide assessment of fire extent and severity for 2019–20**

The black summer of 2019–20 is widely recognised as unprecedented in the extent of wildfires that occurred along the eastern part of New South Wales. The fire ground in New South Wales estimated by FESM (FESMv3, December 2020) covered 4.8 million hectares (7% of the State), including over 2.6 million hectares in the NSW National Parks and Wildlife Service (NPWS) estate or 35% of the NSW national park system.

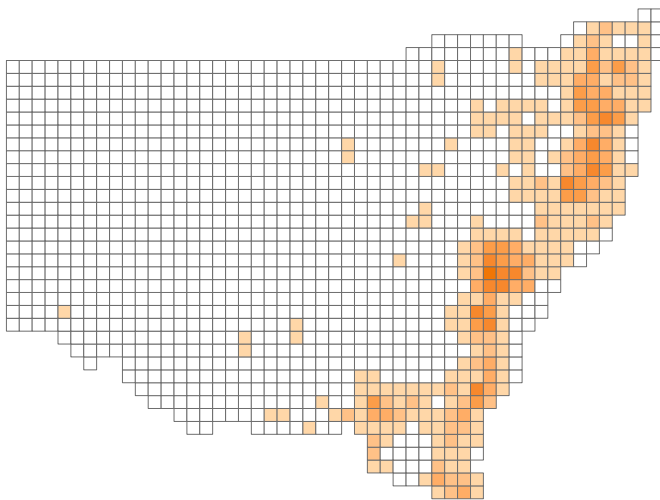
The geographic distribution of severity varied greatly between the northern and southern areas of eastern New South Wales. Figure 2 shows there was a larger area of high and extreme fire severity in the south of the State, and a larger area of low and moderate fire severity in the north of the State.



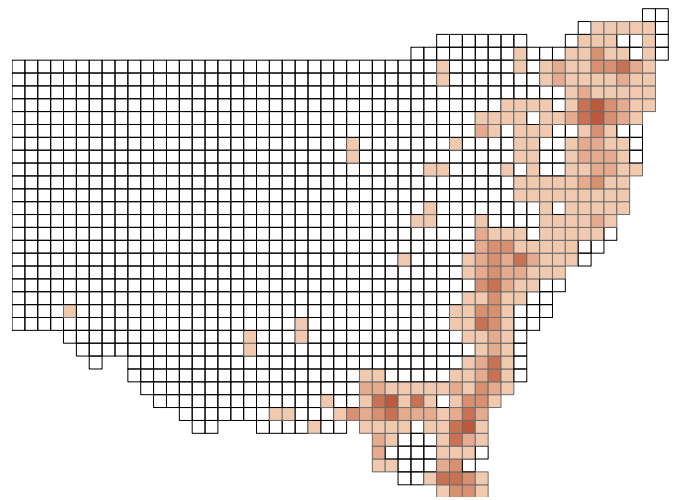
**a. Fire extent 2019-20**



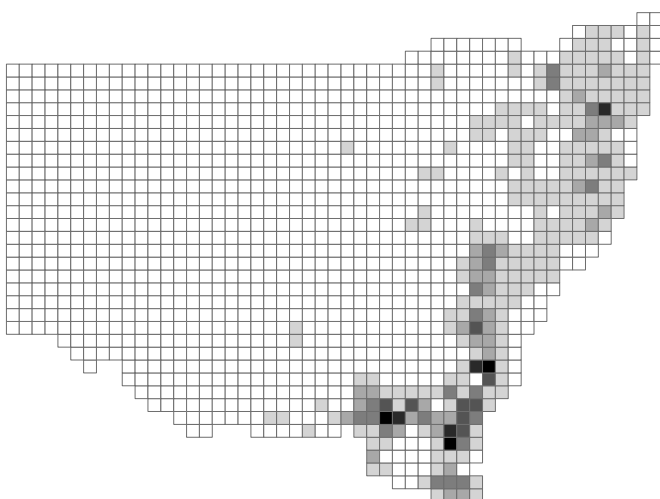
**b. Low fire severity 2019-20**



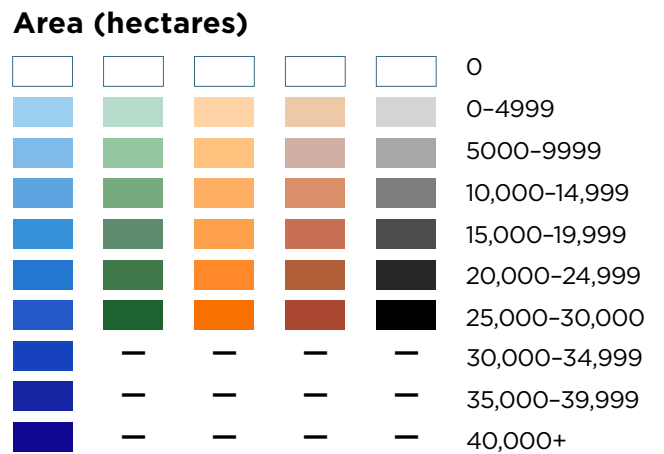
**c. Moderate fire severity 2019-20**



**d. High fire severity 2019-20**



**e. Extreme fire severity 2019-20**



**Figure 2** Geographic distribution of fire extent and fire severity across New South Wales for the 2019-20 fire year; (a) fire extent, (b) low severity, (c) moderate severity, (d) high severity and (e) extreme severity

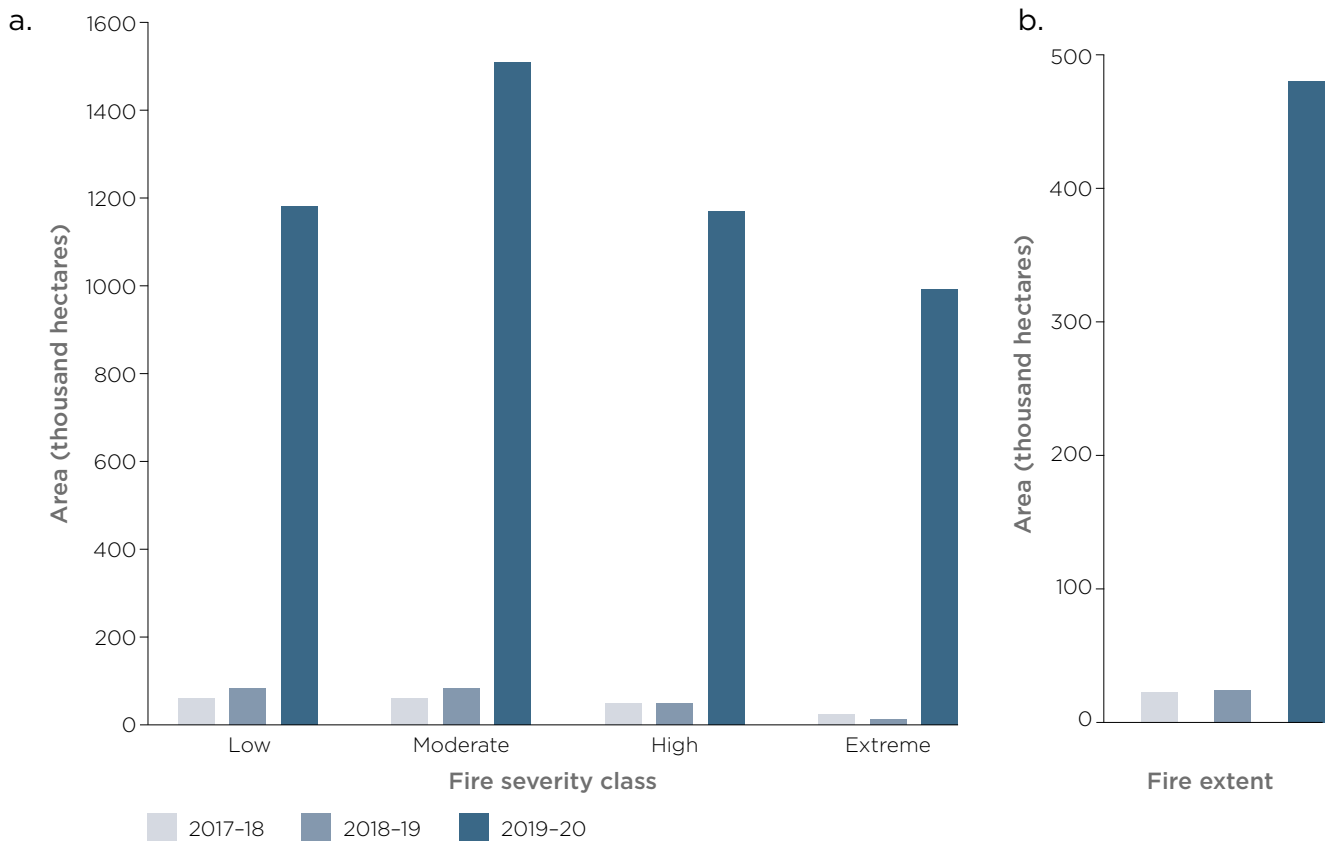


## Comparison with previous years

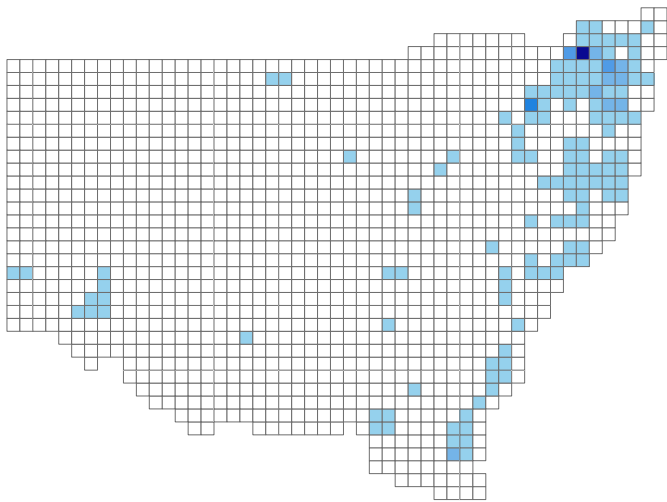
This section compares the 2019–20 fire year with the previous two fire years.

The 2019–20 fire extent was an order of magnitude larger than the preceding two years (Figure 3). There were also differences in the geographic distribution of fire extent and severity across the State between the fire years (Figures 2, 4 and 5). In 2018–19, most of the burnt area occurred in the north of the State and there was relatively more fire in the west of the State compared to 2019–20 (Figure 4). In the 2017–18 fire year the burnt area spread across the north-east of the State, with a notable area of high and extreme severity in the Pilliga region in the central-north of the State.

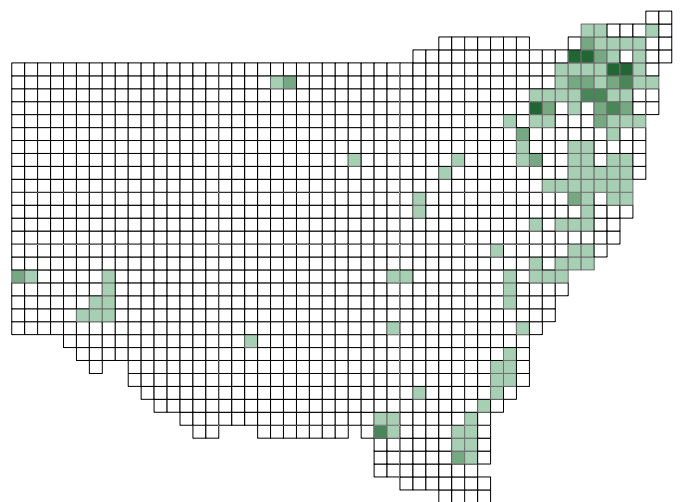
The proportion of severity classes within the burnt extent also differed between the fire years (Figure 6). The largest proportion of extreme severity and the smallest proportion of low severity occurred in 2019–20 compared to the other fire years. The proportion of the extreme severity class in 2019–20 was more than double that of 2018–19 (8% and 21%, respectively). The proportion of low severity was more than 10% lower in 2019–20 compared to 2018–19 (24% and 36%, respectively).



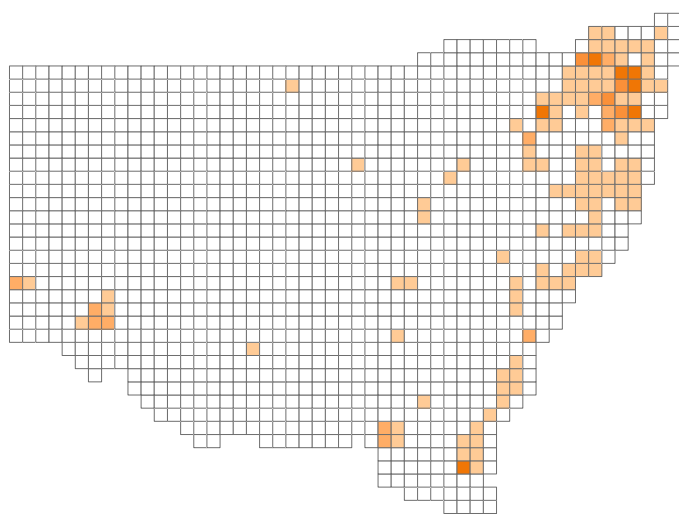
**Figure 3** Comparison of (a) NSW fire severity, and (b) fire extent between 2019–20, 2018–19 and 2017–18 fire years



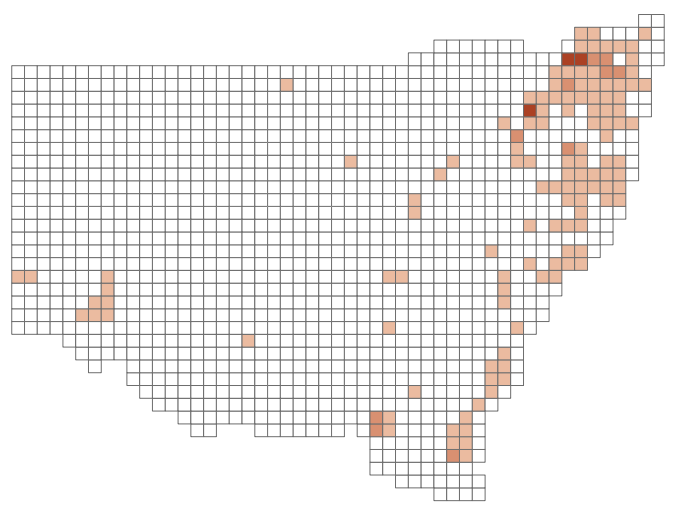
**a. Fire extent 2018-19**



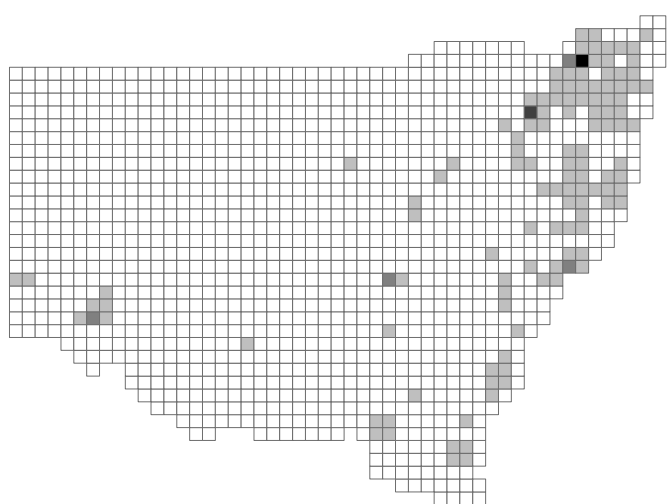
**b. Low fire severity 2018-19**



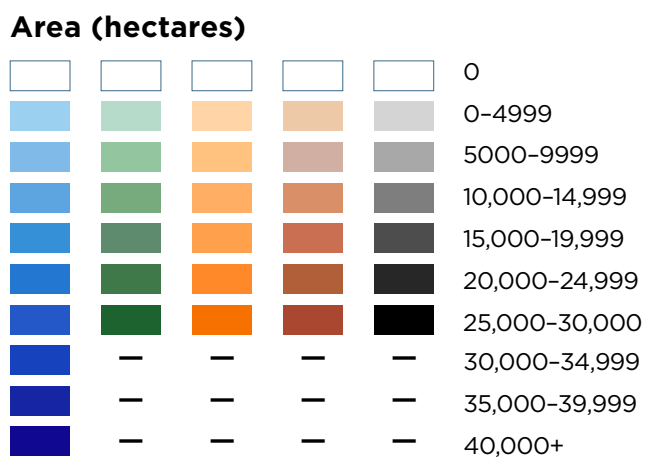
**c. Moderate fire severity 2018-19**



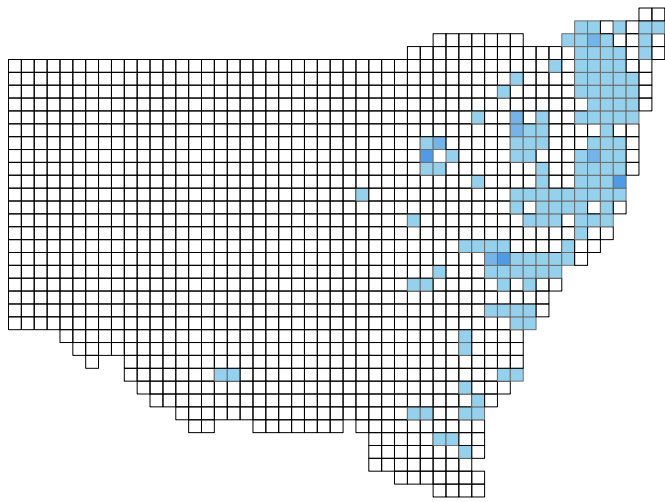
**d. High fire severity 2018-19**



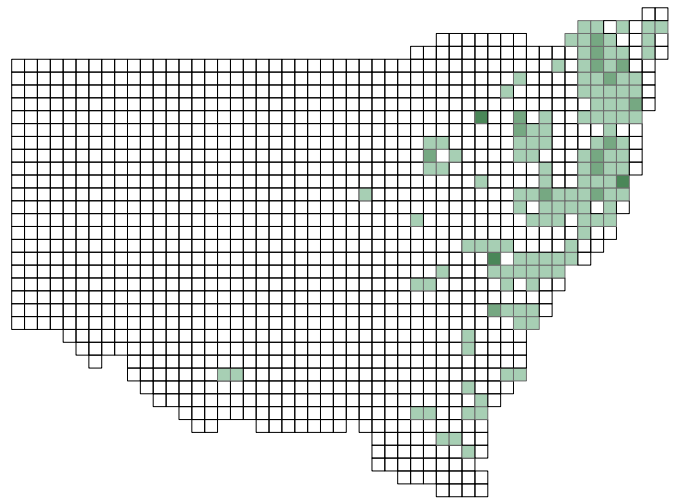
**e. Extreme fire severity 2018-19**



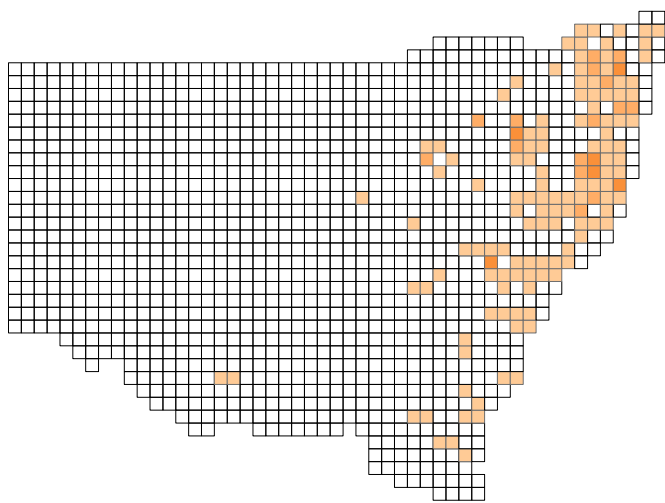
**Figure 4** Geographic distribution of fire extent and fire severity across New South Wales for the 2018-19 fire year; (a) fire extent, (b) low severity, (c) moderate severity, (d) high severity and (e) extreme severity



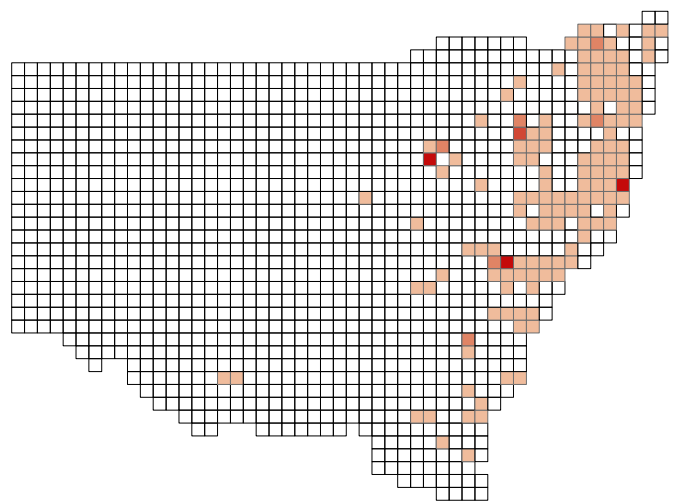
**a. Fire extent 2017-18**



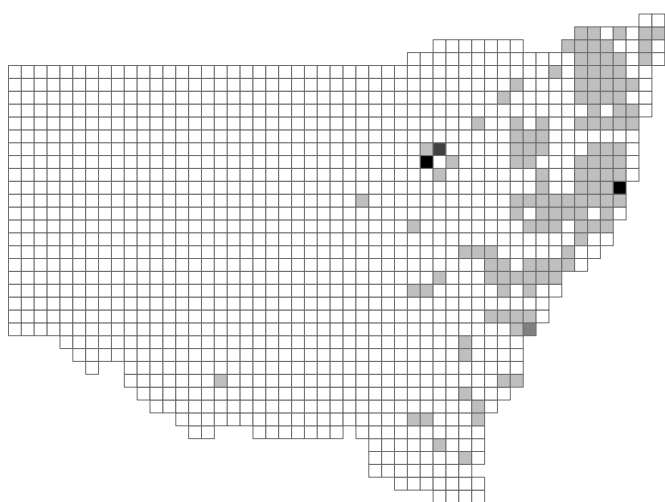
**b. Low fire severity 2017-18**



**c. Moderate fire severity 2017-18**



**d. High fire severity 2017-18**

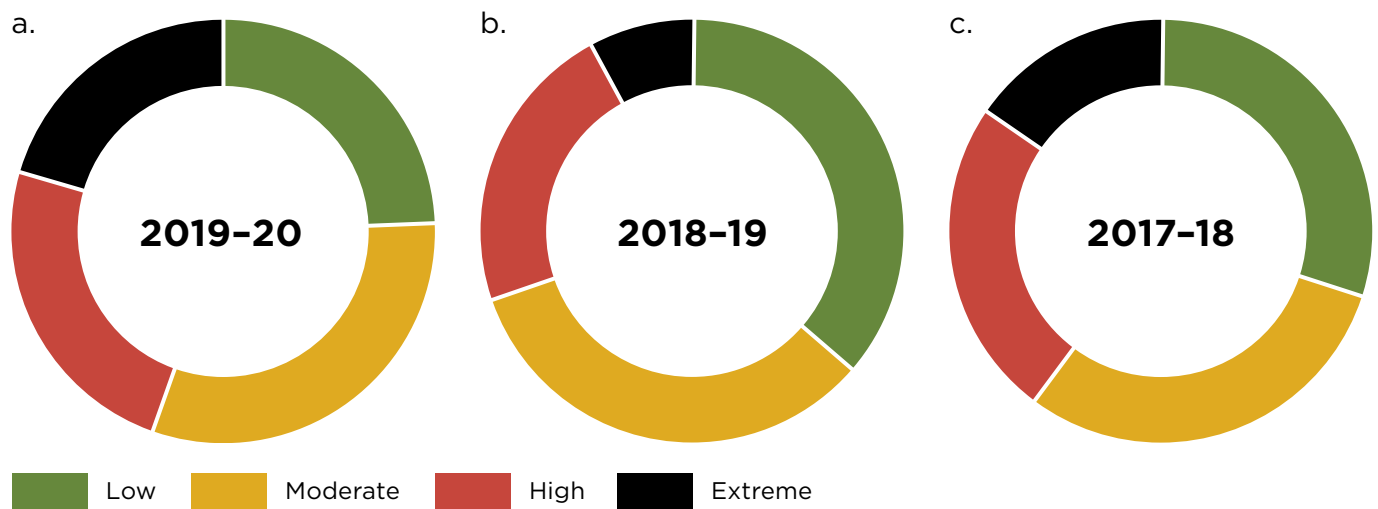


**e. Extreme fire severity 2017-18**

**Area (hectares)**

|  |  |  |  |  |               |
|--|--|--|--|--|---------------|
|  |  |  |  |  | 0             |
|  |  |  |  |  | 0-4999        |
|  |  |  |  |  | 5000-9999     |
|  |  |  |  |  | 10,000-14,999 |
|  |  |  |  |  | 15,000-19,999 |
|  |  |  |  |  | 20,000-24,999 |
|  |  |  |  |  | 25,000-30,000 |
|  |  |  |  |  | 30,000-34,999 |
|  |  |  |  |  | 35,000-39,999 |
|  |  |  |  |  | 40,000+       |

**Figure 5** Geographic distribution of fire extent and fire severity across New South Wales for the 2017-18 fire year; (a) fire extent, (b) low severity, (c) moderate severity, (d) high severity and (e) extreme severity



**Figure 6** Comparison of the proportion of each severity class in New South Wales in (a) 2019-20, (b) 2018-19 and (c) 2017-18 fire years

## Fire extent for the 2019-20 fire season

To help decision-makers and conservation efforts, the severity and impact of fires are reported on in a variety of ways across land management and ecological units.

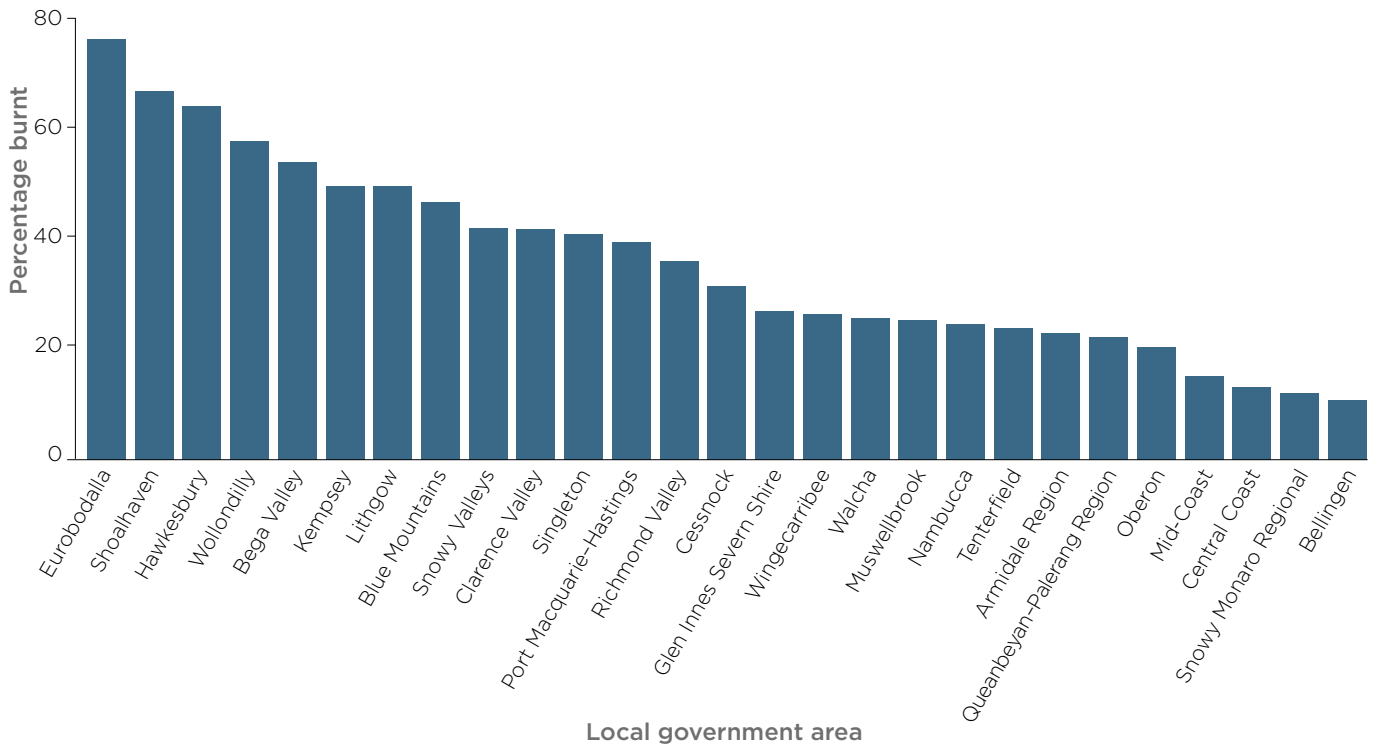
This section summaries fire extent results of the FESM system mapped against:

- local government areas (LGAs)
- Local Land Services (LLS) regions
- land tenure
- Interim Biogeographic Regionalisation for Australia (IBRA) bioregions
- NPWS estate
- vegetation formations (Keith 2004)
- soil types.

FESM spatial data are available on the [SEED](#) portal.

## Fire extent across local government areas

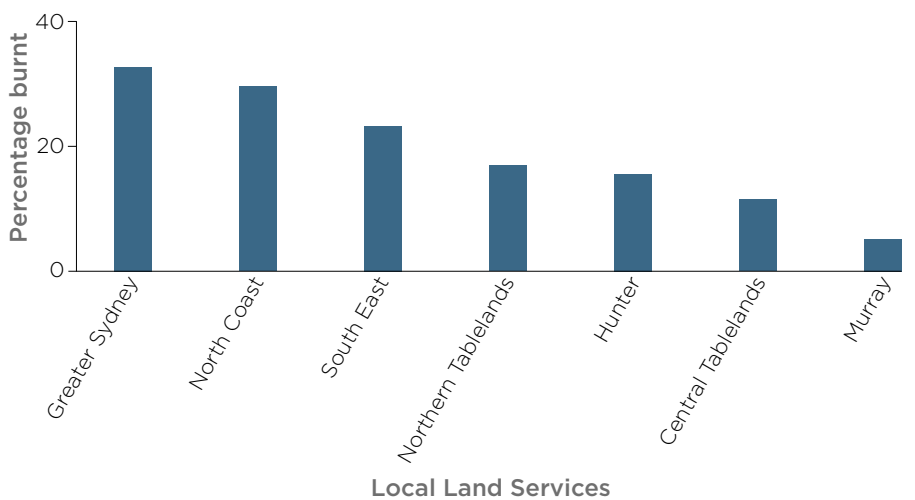
Eurobodalla, Shoalhaven and Hawkesbury LGAs had the highest proportion of area burnt, at more than 60% (Figure 7). LGAs with <10% burnt were excluded from the figure.



**Figure 7** The percentage of area burnt for each local government area (LGA) in the 2019–20 fire year. LGAs that had more than 10% of their area burnt have been included

### Fire extent across Local Land Services regions

The Greater Sydney and North Coast LLS regions had the highest proportion of area burnt, at more than 30% (Figure 8). LLS regions with <5% burnt (Riverina, North West, Central West and Western Regions) have been excluded from the figure.



**Figure 8** The percentage of area burnt for each Local Land Services (LLS) regions in the 2019–20 fire year. LLS regions included had more than 5% of their area burnt



## Fire extent across NSW National Parks and Wildlife Service estate

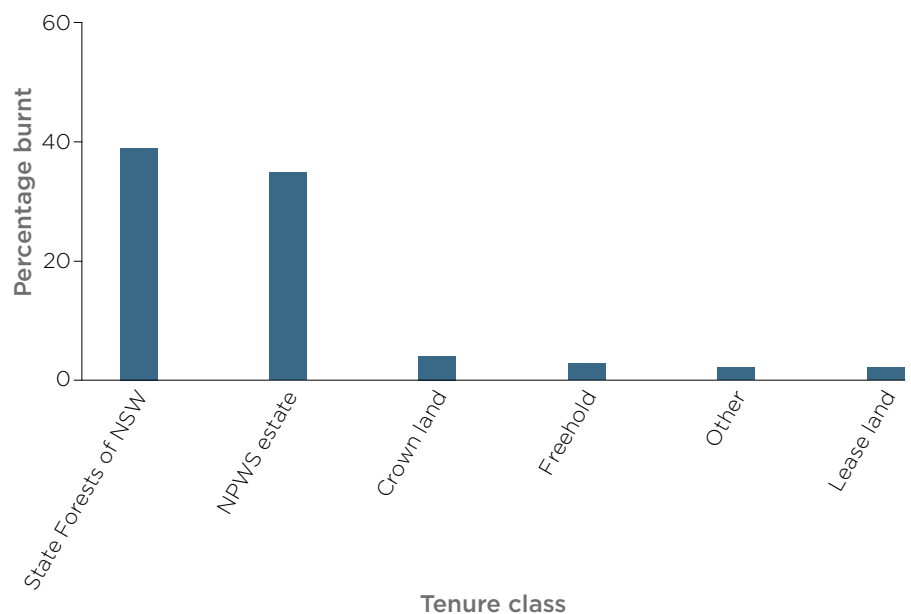
A total of 2,593,940 hectares of NPWS estate burnt in 2019–20. This represents 35% of the total area of the NPWS estate (Figure 9). Of the individual NPWS estate areas that burnt, 42% had 80–100% of their total area burnt (Table 2).

**Table 2** The number of NPWS estate areas that were burnt in the 2019–20 fire year. Classes represent varying levels of total area burnt, with class 1 the highest and class 5 the lowest.

| Fire extent class | Proportion of area burnt | Number of NPWS estate areas | Percentage of total area burnt |
|-------------------|--------------------------|-----------------------------|--------------------------------|
| Class 1           | 80–100%                  | 109                         | 42                             |
| Class 2           | 60–80%                   | 35                          | 13                             |
| Class 3           | 40–60%                   | 28                          | 11                             |
| Class 4           | 20–40%                   | 31                          | 12                             |
| Class 5           | 1–20%                    | 57                          | 22                             |
| Subtotal (burnt)  |                          | 260                         |                                |
| Class 6           | 0%                       | 622                         | 71                             |
| Total             |                          | 882                         |                                |

## Fire extent across NSW land tenure classes

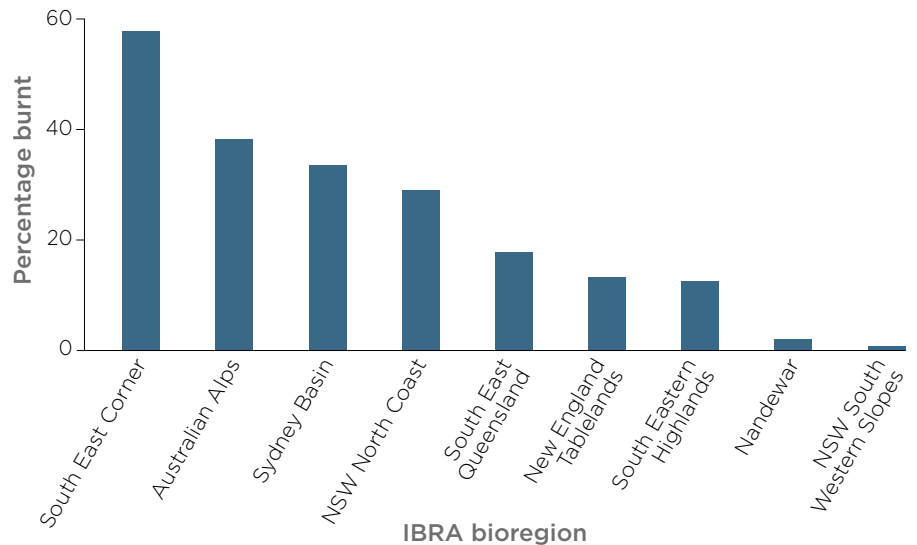
State Forests of NSW and the NPWS estate had a similar proportion of area burnt, at 39% and 35%, respectively (Figure 9). No areas of lease land were burnt.



**Figure 9** The percentage of each tenure class burnt in the 2019–20 fire year as a proportion of the total area of each tenure in New South Wales; NPWS = NSW National Parks and Wildlife Service

## Fire extent across Interim Biogeographic Regionalisation for Australia bioregions

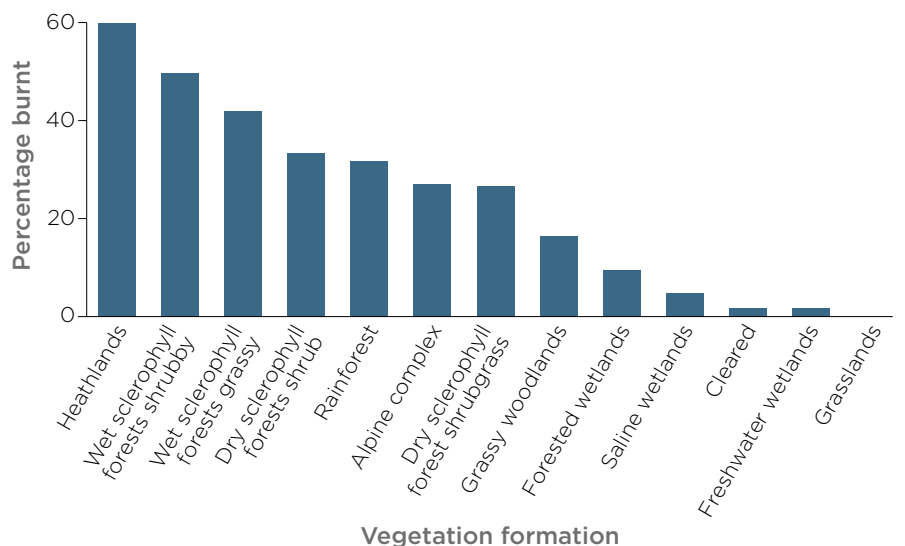
The South East Corner Bioregion had the highest proportion of area burnt, at 58%. The Australian Alps and the Sydney Basin bioregions both had over 30% of total area burnt (Figure 10). Data represent the proportion of the bioregion that is within New South Wales.



**Figure 10** The proportion percentage of area burnt for Interim Biogeographic Regionalisation for Australia (IBRA) bioregions in the 2019-20 fire year

## Fire extent across NSW Keith vegetation formations

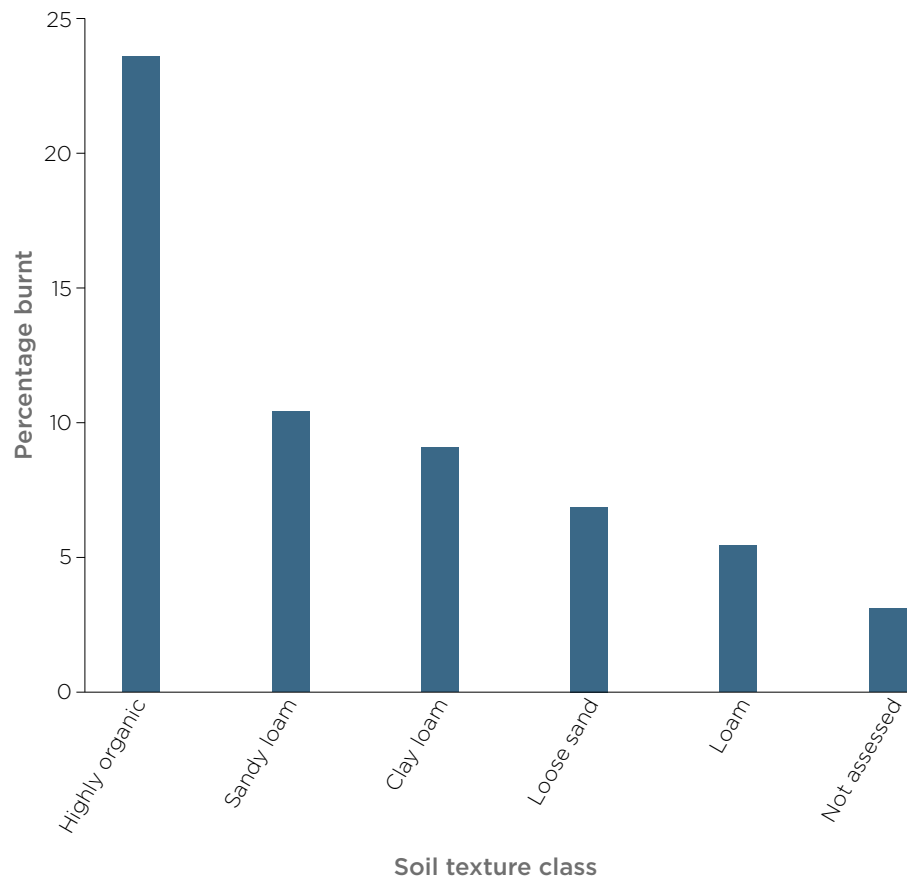
Heathlands and wet sclerophyll forests had the greatest proportion of area burnt, at over 40% (Figure 11). Dry sclerophyll forests, rainforests and alpine complex had around 30% of the area burnt.



**Figure 11** The percentage of each vegetation formation (Keith, 2004) burnt in the 2019-20 fire year as a proportion of the total area of each formation in New South Wales

## Fire extent across NSW soil types

Highly organic/peat soil texture types had the greatest proportion of area burnt, at 20% (Figure 12). Soil texture classes with high organics or low clay percentages (e.g. highly organic, sandy loam and loose sand) are more vulnerable to damage following hot fires.



**Figure 12** The percentage of each soil texture class burnt in the 2019–20 fire year as a proportion of the total area of the soil class in New South Wales





## More information

[Landcover monitoring and reporting webpage](http://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/landcover-monitoring-and-reporting), NSW Department of Planning, Industry and Environment, [www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/landcover-monitoring-and-reporting](http://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/landcover-monitoring-and-reporting)

[Fire extent and severity maps webpage](http://www.environment.nsw.gov.au/research-and-publications/our-science-and-research/our-research/land-and-biodiversity/landcover-science/fire-extent-and-severity-mapping), NSW Department of Planning, Industry and Environment, [www.environment.nsw.gov.au/research-and-publications/our-science-and-research/our-research/land-and-biodiversity/landcover-science/fire-extent-and-severity-mapping](http://www.environment.nsw.gov.au/research-and-publications/our-science-and-research/our-research/land-and-biodiversity/landcover-science/fire-extent-and-severity-mapping)

Fact sheet: Supporting fire management with the Fire Extent and Severity Maps, 2020, NSW Department of Planning, Industry and Environment, [www.environment.nsw.gov.au/research-and-publications/publications-search/supporting-fire-management-with-the-fire-extent-and-severity-maps](http://www.environment.nsw.gov.au/research-and-publications/publications-search/supporting-fire-management-with-the-fire-extent-and-severity-maps)

Fire extent and severity mapping results for the 2017-18 fire year, [www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-vegetation/fire-extent-severity-mapping-results-2017-18.xlsx](http://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-vegetation/fire-extent-severity-mapping-results-2017-18.xlsx)

Fire extent and severity mapping results for the 2018-19 fire year, [www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-vegetation/fire-extent-severity-mapping-results-2018-19.xlsx](http://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-vegetation/fire-extent-severity-mapping-results-2018-19.xlsx)

Fire extent and severity mapping results for the 2019-20 fire year, [www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-vegetation/fire-extent-severity-mapping-results-2019-20.xlsx](http://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Native-vegetation/fire-extent-severity-mapping-results-2019-20.xlsx)

FESM datasets available on the SEED portal, <https://datasets.seed.nsw.gov.au/dataset/fire-extent-and-severity-mapping-fesm>

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