SOCIETY OF ACTUARIES

Actuarial Weather Extremes December 2019

Actuarial Weather Extremes: December 2019

Widespread Wildfires in Australia, Fueled by Heat, Drought and Wind

Overview

This report is the ninth in a monthly series that was launched in April 2019. Each report covers extreme weather events that occurred in the month prior to the report's issuance. While the focus is upon weather events in North America, we periodically cover extreme weather events in other regions.

This report focuses on wildfires that swept across large areas of Australia during November and December of 2019, many of which continue to burn in January 2020. While wildfires themselves are not a weather phenomenon, they are a consequence of weather conditions.

Over recent months, much of Australia has experienced both unusually high temperatures and unusually low levels of precipitation, setting the stage for dangerous fires that, as of January 2, 2020, have claimed 24 lives and have burned over 12 million acres[1] (about 19,000 square miles), an area equal to the combined size of Vermont and New Hampshire. In a departure from recent geographic patterns, most of the fire activity has occurred in New South Wales and Victoria, the two most densely populated Australian states. The proximity of the fires to major cities such as Sydney and Melbourne has amplified the associated risk to human life and property.

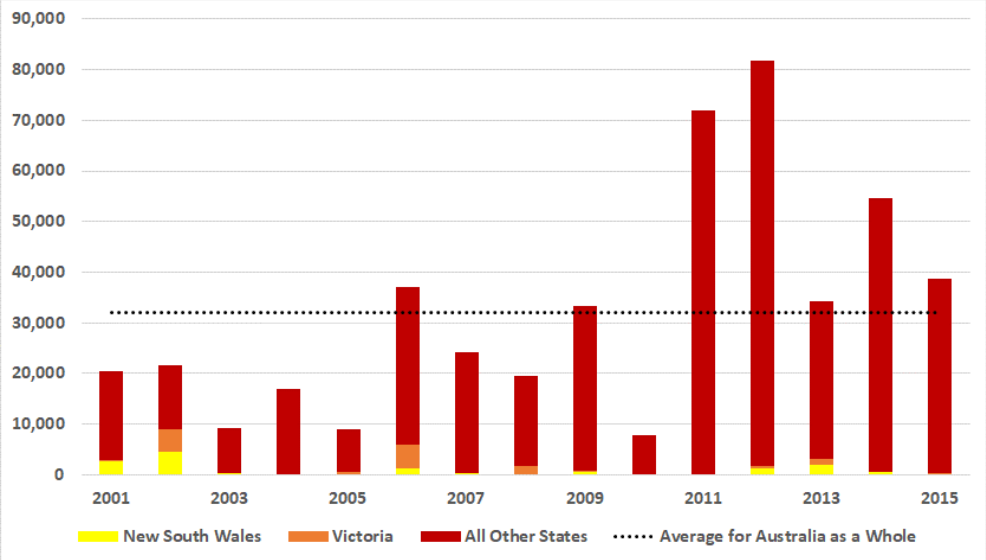
Historical Data on Australian Bushfires

Referred to as "bushfires" by many Australians, wildfires are a common occurrence in Australia. Generally, bushfires affect rural or remote regions, seldom threatening suburban or urban areas.

Between 2001 and 2015[2], an average of 32,000 square miles of forest burned each year as a result of unplanned fires[3]. However, only 6% of the burned area was in New South Wales and Victoria – Australia's two most densely populated states – which together are home to about 60% of Australia's total population.

Figure 1

Total Square Miles of Forest Burned in Australia by Unplanned Bushfires



This data was obtained from the 2008, 2013 and 2018 issues of Australia's quinquennial "State of the Forest Report".

Estimation of the total area burned by bushfires is challenging, involving a combination of data gathered by satellites and data gathered on-the-ground. Although accuracy has improved over time, estimates of burn areas remain subject to significant uncertainty.

[1] https://apnews.com/0cdb881db8142cb75e3765bd780667ba and https://time.com/5758186/australia-bushfire-size/

[2] Bushfire statistics in Australia's State of the Forest Report are tabulated by financial year rather than calendar year. In Figure 1, year "x" refers to the financial year that stretches from July of calendar year "x" to June of calendar year "x + 1".

[3] The average annual burn area of 32,000 square miles is equal to about 6% of Australia's total forest area (which is roughly 520,000 square miles).

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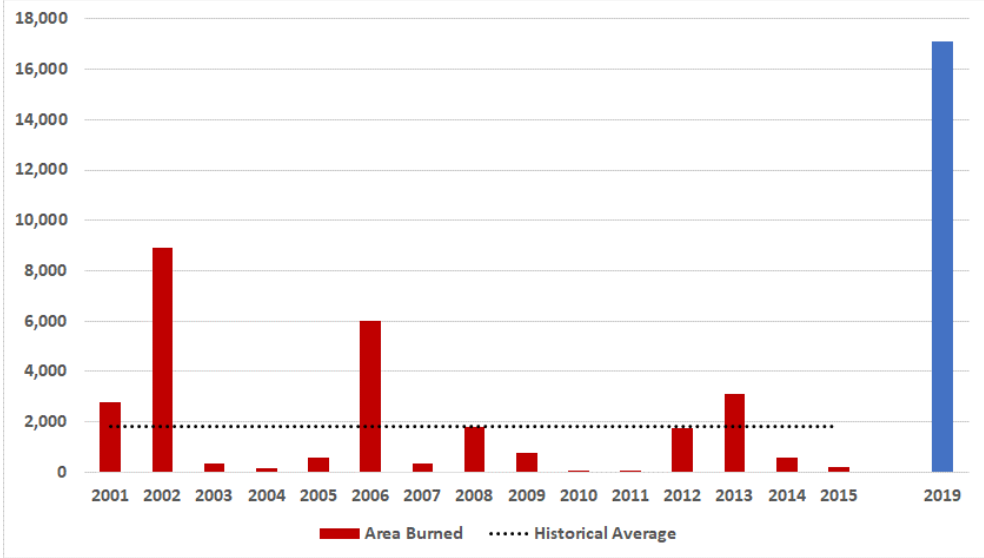
Bushfires in November and December of 2019

While New South Wales and Victoria have historically accounted for a relatively small share of the total area burned by bushfires, it is these two states that have been the hardest hit by the fires that have occurred in November and December of 2019. The proximity of the fires to densely populated areas -- such as the suburbs of both Sydney and Melbourne, Australia's two largest cities – is one factor that distinguishes this extreme event from a typical Australian fire season. The fires have burned roughly 17,000 square miles of land in New South Wales and Victoria, which is about 9 times the historical annual average for the period from 2001 to 2015.

Figure 2

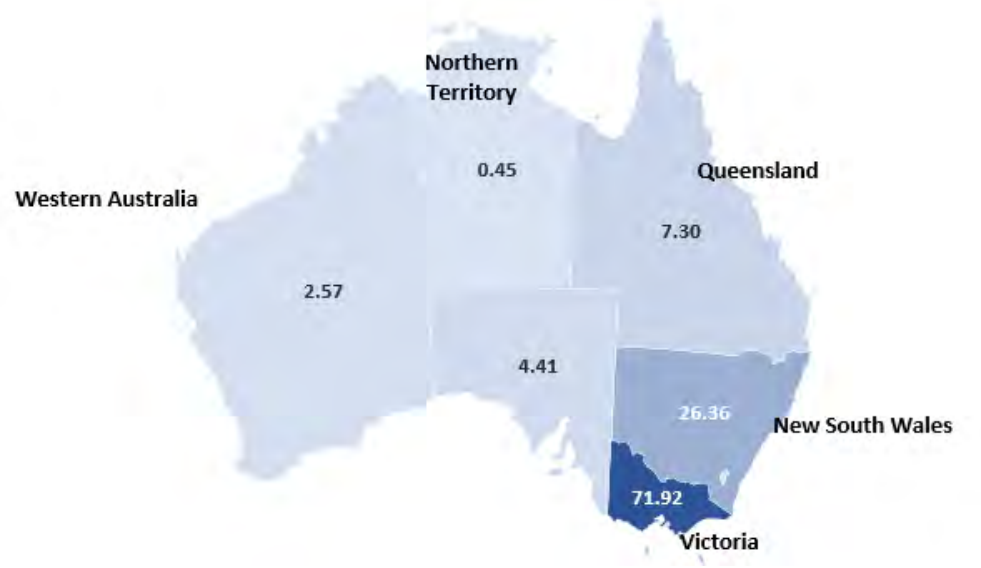
Total Square Miles of Forest Burned in New South Wales and Victoria by Unplanned Bushfires



The data for 2001 through 2015 was obtained from the 2008, 2013 and 2018 issues of Australia's quinquennial "State of the Forest Report". Because the State of the Forest Report is issued only every fifth year, data for 2016 through 2018 is not yet available. The 2019 data is a rough estimate as of early January, obtained from the BBC[4]. Perhaps because the crisis is still unfolding, we were unable to locate an official estimate produced by the government.

Figure 3

Population Per Square Mile in 2019, Separately for Each Australian State (source: Australia Bureau of Statistics)



[4] https://www.bbc.com/news/world-australia-50951043

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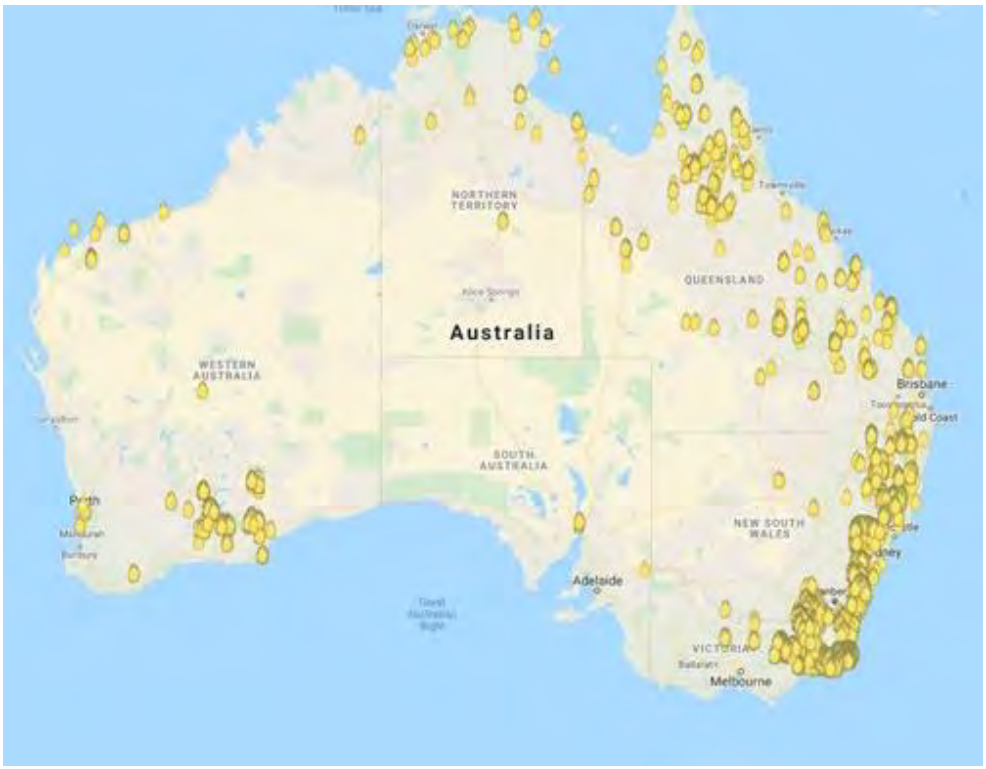
Figure 4

Location of Ongoing Bushfires as of January 2, 2020 (source: https://myfirewatch.landgate.wa.gov.au/)



This map was obtained from "MyFireWatch", which provides bushfire location information for general public use. MyFireWatch is the result of collaboration between Landgate and Edith Cowan University. Landgate is the statutory authority responsible for property and land information in Western Australia.

Weather Factors Associated with the 2019 Bushfires

A prolonged period of unusually low precipitation combined with unusually high temperatures are the key weather factors that have contributed to the 2019 bushfires[5]. The exhibits below highlight these weather conditions using data from the Global Historical Climate Network (GHCN).

Table 1

Tabulation of GHCN Temperature and Precipitation Data for the Period from September 1 to December 15

	Daily High Temperature (Degrees Fahrenheit)		Total Precipitation (Inches)	
	Australia as a Whole	New South Wales and Victoria	Australia as a Whole	New South Wales and Victoria
Average, 1960 to 2018	77.4	70.7	7.0	8.0
Average in 2019	80.4	72.9	3.1	3.8
2019: Ranked Against Each Year from 1960 to 2018	2	8	60	59
2019: Standard Deviations above 1960-2018 Mean	2.3	1.3	-2.3	-1.9

These results were tabulated using data from those GHCN weather stations that have complete or nearly complete data histories from 1960 to the present. These stations are not distributed uniformly across Australia; rather, they are concentrated in populated areas. Most stations are located within a couple hundred miles of the coast, and only a small number of stations are located in Australia's vast interior. The averages presented in this table make no adjustment for the skewed spatial distribution of the stations. Consequently, the averages primarily reflect the weather of Australia's coastal regions. Note that for temperature, a ranking of "1" means that 2019 was the hottest year since 1960. For precipitation, a ranking of "60" means that it was the driest of the 60 years between 1960 and 2019. The tabulations focus solely on the period from September 1 through December 15, so January through August are excluded, as is the period from December 16 to 31. The latter half of December was excluded because 2019 data for this period is not yet available.

[5] In addition to high temperatures and lack of precipitation, brisk winds also played a role, contributing to the spread of fires.

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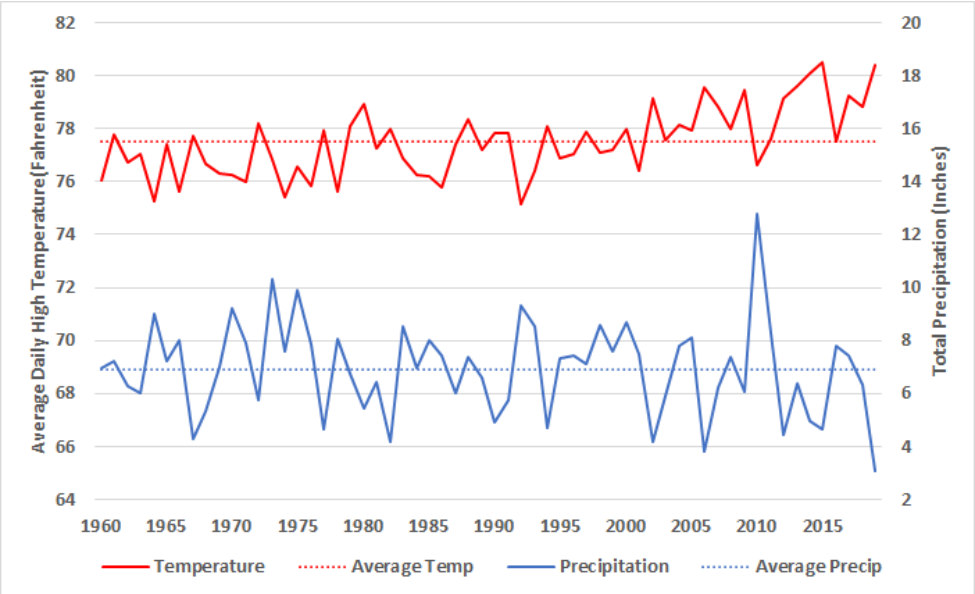
Figure 5

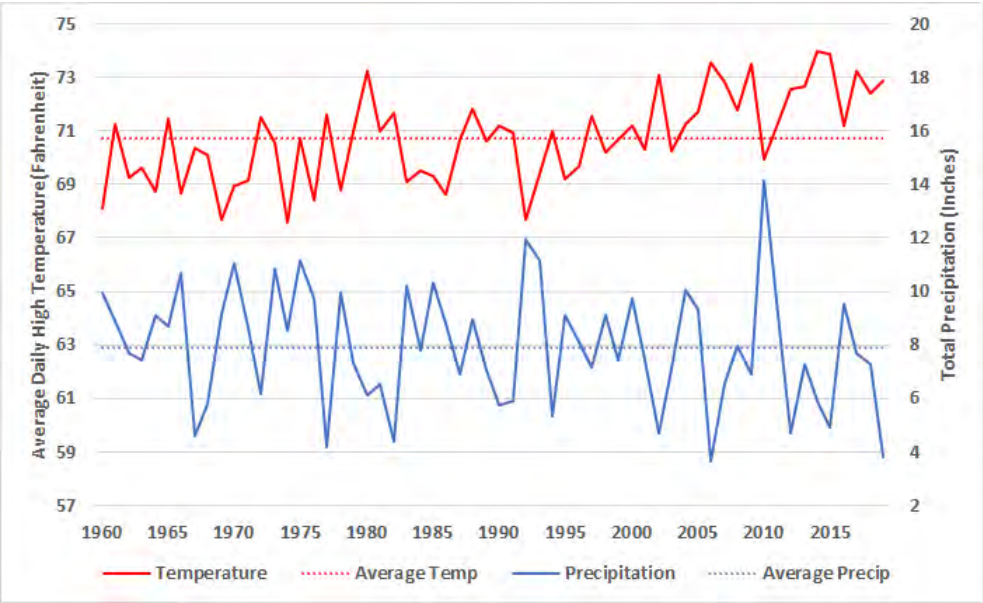
Australia as a Whole: Daily High Temperature and Total Precipitation for September 1 through December 15



These results are averages computed across all GHCN weather stations in Australia that have complete or nearly complete data histories from 1960 to the present. These stations are not distributed uniformly across Australia; rather, they are concentrated in populated areas, which tend to hug the coastline. The tabulations focus solely on the period from September 1 through December 15. The period from December 16 to 31 was excluded because the 2019 data for this period is not yet complete.

Figure 6

New South Wales and Victoria: Daily High Temperature and Total Precipitation for Sept 1 through Dec 15



These results are equivalent to those computed in Figure 5, except they reflect only those stations that are located in either New South Wales or Victoria.

Note that the final set of data points on the righthand side of Figures 5 and 6 correspond to 2019.

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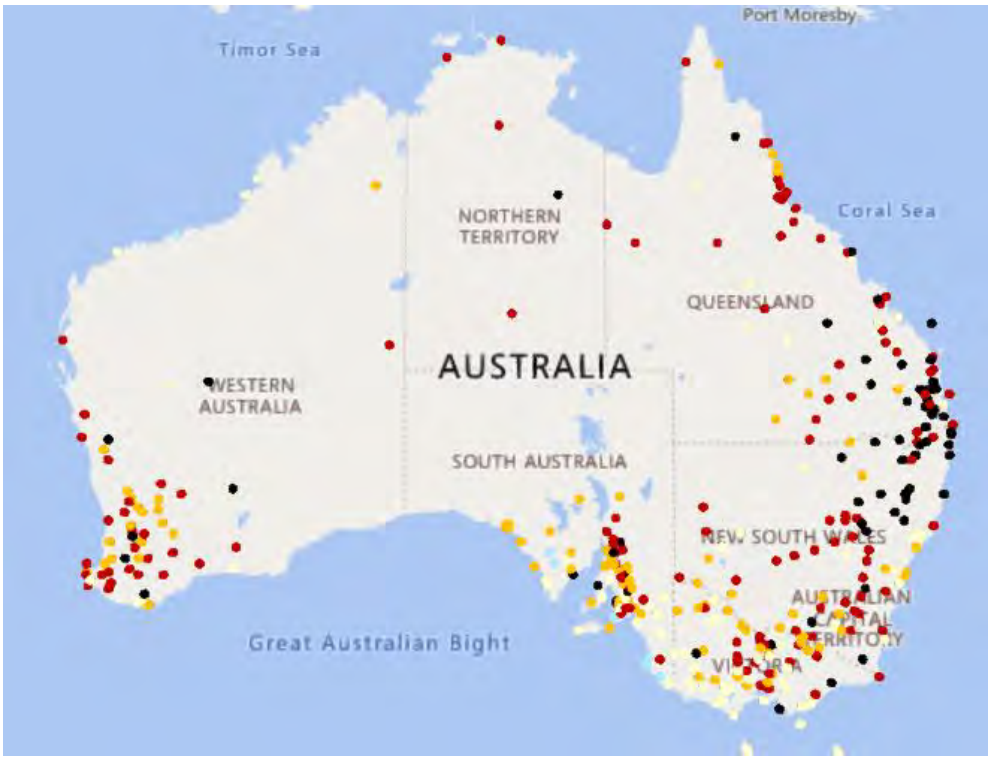
Figure 7

Total Precipitation from September 1 to December 15, 2019, Ranked Against Historical Data



Using GHCN data for weather stations with complete or nearly complete precipitation data from 1960 to the present, total precipitation from September 1 through December 15, 2019 was ranked against historical data from 1960 through 2018 for the same Sept 1 – Dec 15 period. A ranking of "1" means that 2019 was the *driest* on record. A ranking of "2" means that there was only a single year from 1960 to 2018 with less precipitation than 2019. Color codes:

Black = rank of 1
Red = rank from 2 to 5
Orange = rank from 6 to 10
Light Yellow = rank 11 to 30
Light blue = rank 31 to 60

Figure 8

Average Daily High Temperature from September1 to December 15, 2019, Ranked Against Historical Data

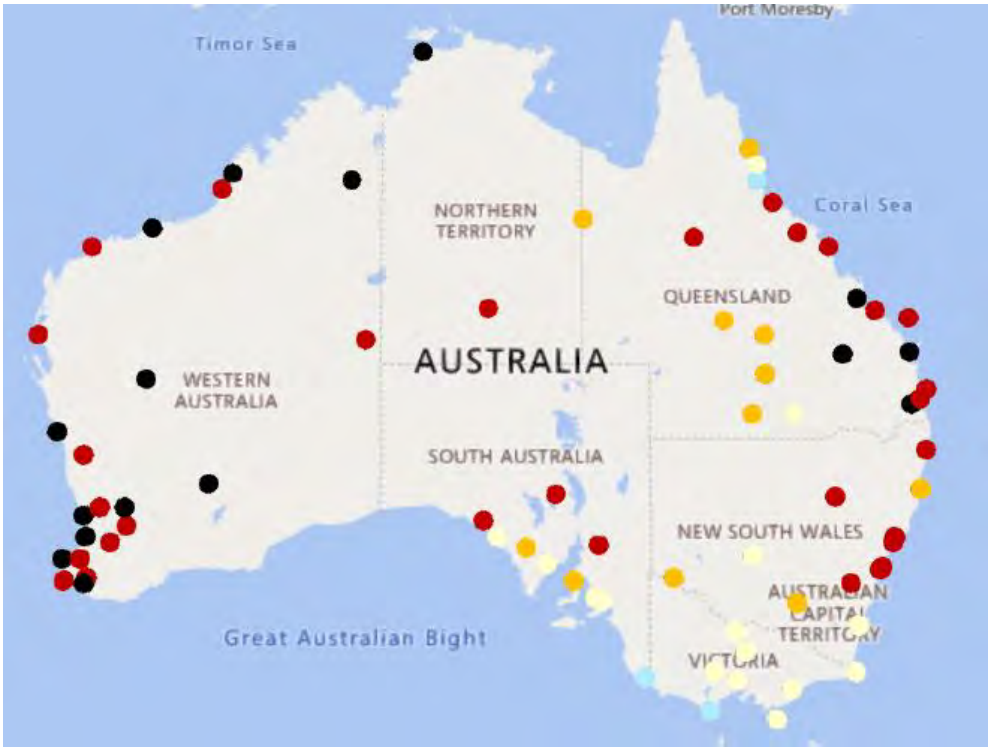


Figure 8 is analogous to Figure 7, except it focuses on average daily high temperatures as opposed to total precipitation. Because there are fewer stations in Australia with temperature data (going back to 1960) than with precipitation data, there are fewer dots on Figure 8 than on Figure 7. In Figure 8, a rank of "1" means the September 1 to December 15 period in 2019 was hotter than any corresponding period between 1960 and 2018.

Color codes:

Black = rank of 1
Red = rank from 2 to 5
Orange = rank from 6 to 10
Light Yellow = rank 11 to 30
Light blue = rank 31 to 60

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Rough Assessment of the Losses Caused by Recent Extreme Weather

Economic and insured losses are often difficult to estimate in the immediate aftermath of an extreme weather event. With the passage of time, the extent of the losses gradually becomes clearer. Below, we offer a rough assessment of the cost of some of the weather events covered in our reports over the last few months:

September – December 2019: Wildfires in Australia

On January 6, "Business Insider" reported[6] the following damage estimates related to recent and ongoing bushfires: 1600 destroyed homes, 5000 insurance claims totally $375 million, and 1% of GDP growth is estimated to be wiped-out. The article suggests that, after the damages are fully tallied, the cost will run into the billions of dollars. On January 7, "Time" reported that the fires have claimed the lives of at least 24 people[7]. On January 7, the Wall Street Journal reported[8] that, in New South Wales, over 600 head of livestock were killed. Researchers at the University of Sydney estimate that nearly half a billion mammals, birds and reptiles have been killed[9].

November: Flooding in Venice, Italy

According to a Wall Street Journal[10] published on November 25, the mayor of Venice has estimated the damage from the floods to be about $1.1 billion. However, the estimated "cost could rise, as further damage emerge".

November: A Series of Winter Storms Across the Northern U.S.

The most widely reported impacts of the winter storms were school closings, road closings, power outages and flight cancellations. Property damage appears to have been minimal, although it is too soon to offer a reliable cost estimate.

October: Typhoon Hagibis

According to AIR Worldwide, Typhoon Hagibis may generate between $8 billion and $16 billion in insured losses[11], with more with than half of the losses due to inland flooding. According to "The Mainichi", a Japanese newspaper, at least 83 people died[12] as a result of Typhoon Hagibis.

October: Cold Spell Across the U.S. and Canadian Great Plains

Some farms have reported agriculture losses due to the unexpected cold. For example, "Freight Waves" reports $45 million of estimated damage[13] to the potato crop in North Dakota and Minnesota.

September: Hurricane Dorian

While Dorian had an impact in the U.S. and Canada, losses are heavily concentrated in the Bahamas where the storm was at its greatest strength. According to the Wall Street Journal, as of September 22 the death count stood at 53, with over 1300 people still missing. Total property losses in the Bahamas are estimated at $7 billion[14].

September: Tropical Storm Imelda

According to the USA Today, the storm has been linked to five deaths[15], and, in its "Global Catastrophe Recap" report for September 2019, AON estimates that economic losses will run over $2 billion.

September: Heat/Dry Spell in the U.S. Southeast

According to the Wall Street Journal[16], the unusual heat and dryness in the U.S. Southeast is having negative effects on agriculture. Potential effects include damage to grass used to feed livestock and damage to the cotton crop. In

[6] https://www.businessinsider.com.au/australian-bushfires-cost-economy-surplus-government-spending-2020-1
[7] https://time.com/5758186/australia-bushfire-size/
[8] https://www.wsj.com/articles/australia-fires-put-farmers-in-double-jeopardy-11578388736?mod=hp_lista_pos1
[9] https://sydney.edu.au/news-opinion/news/2020/01/03/a-statement-about-the-480-million-animals-killed-in-nsw-bushfire.html
[10] https://www.wsj.com/articles/in-venice-a-struggle-to-rescue-damaged-art-and-architecture-11574703868
[11] https://www.air-worldwide.com/Press-Releases/AIR-Worldwide-Estimates-Insured-Losses-for-Typhoon-Hagibis-Will-be-Between-USD-8-Billion-and-USD-16-Billion/
[12] https://mainichi.jp/english/articles/20191022/p2g/00m/0dm/005000c
[13] https://www.freightwaves.com/news/mother-nature-turns-midwestern-spuds-to-duds
[14] https://www.wsj.com/articles/opening-the-door-to-hell-itself-bahamas-confronts-life-after-hurricane-dorian-11569176306
[15] https://www.usatoday.com/story/news/nation/2019/09/21/texas-flooding-tropical-storm-imelda-death-toll-increases-5/2402290001/
[16] https://www.wsj.com/articles/flash-drought-hits-south-as-record-heat-continues-into-fall-11570058348

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addition, the dry soil makes it more challenging to harvest peanuts. The Baltimore Sun (a newspaper) indicates that the drought is affecting soybean crops and could even affect next year's wheat crop which must be planted this fall[17].

August: Heavy Monsoon Rains in India

According to a Reuters' article published on August 14, heavy rains in the first half of August caused floods and landslides that displaced over one million persons in India and led to 270 deaths[18]. An article in Business Today[19] on August 16 indicates that coffee yields in the states of Karnataka, Kerala and Tamil Nadu are expected to decline by 30% to 40% due to August's rains and floods. Sugarcane, cotton and apple yields are also likely to be reduced[20].

Because India's monsoon season is volatile weather phenomenon with significant rainfall variation from year to year, month to month, and region to region, flood-induced fatalities and economic losses are not unusual in India. According to data from India's Central Water Commission, across the period from 1953 to 2017 an average of 1600 persons died each year due to heavy rains and floods, and across the 5-year period from 2013 to 2017, the average was 1953[21].

August: Heat Wave in Alaska

During August, large numbers of dead salmon were found in several Alaskan rivers[22]. According to observers, the fish died prior to spawning, whereas salmon typically die only after spawning. Some researchers are attributing these premature deaths to unusually high river temperatures caused by a combination of high air temperatures and lack of rain[23].

July: Heat Waves in the U.S. and Europe

Fortunately, few human lives were lost in these heat waves. In regard to economic costs, an assessment is difficult. Some examples of the impact of the heat waves are as follows: (1) in both Germany and France, a number of nuclear power plants had to be taken offline, thus temporarily reducing total power generation[24]; (2) in the United Kingdom, railway service was disrupted because the unusually high temperatures caused train tracks to expand or kink[25]; (3) in the United Kingdom, thousands of chickens died in a farmhouse that lacked a cooling system[26]; and (4) on a farm in the Netherlands, over 2000 pigs suffocated[27] after a ventilation system failed during the heat wave.

July 13-16: Hurricane and Tropical Storm "Barry"

Over $600 million in economic losses and nearly $300 million in insured losses, according to industry experts.

June 21-22: Derecho in Central and Eastern U.S.

An extreme wind event known as a "derecho" caused damage across a 1000-mile path from Nebraska to South Carolina. Thousands of structures affected, with economic losses estimated to be over $100 million by industry experts.

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[17] https://www.baltimoresun.com/weather/bs-md-drought-report-20190926-yooqxwbbuvcldise7a4oisugtm-story.html

[18] https://www.reuters.com/article/us-southasia-floods/india-floods-kill-more-than-270-displace-one-million-idUSKCN1V413K

[19] https://www.businesstoday.in/current/economy-politics/karnataka-floods-landslides-brew-fresh-troubles-coffee-second-year-straight/story/372972.html

[20] https://economictimes.indiatimes.com/news/economy/agriculture/sugarcane-cotton-apple-crops-hit-by-late-rainfall-pan-india/articleshow/70744401.cms

[21] https://www.business-standard.com/article/current-affairs/at-107-487-india-accounts-for-1-5th-of-global-deaths-from-floods-in-64-yrs-118071900052_1.html

[22] https://time.com/5661024/alaska-high-temperatures-salmon-deaths/

[23] https://observers.france24.com/en/20190821-salmon-die-alaska

[24] https://www.reuters.com/article/us-france-electricity-heatwave/hot-weather-cuts-french-german-nuclear-power-output-idUSKCN1UK0HR

[25] https://www.telegraph.co.uk/news/2019/07/25/uk-heatwave-britain-bracing-hottest-day-record-temperature-could/

[26] https://www.independent.co.uk/news/uk/home-news/chicken-uk-heatwave-farm-deaths-lincolnshire-tesco-sainsbury-a9025516.html

[27] https://veganuary.com/blog/over-2000-pigs-suffocate-on-factory-farm-as-ventilation-system-fails/

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May: Severe Weather in U.S. Plains, Midwest and Southeast
Tornadoes, straight-line winds, hail, flooding: close to $3 billion of economic losses and $2 billion of insured losses, according to industry experts.

May to June: Flooding in U.S. Breadbasket
Flooding has had a significant impact on farmers' ability to plant crops this year. Economic and insured losses are estimated to be in excess of $4 billion by industry experts.

Data

The temperature and precipitation data presented in this report was obtained from the Global Historical Climatology Network ("GHCN") weather database, which provides daily weather observations from over 100,000 weather stations worldwide, covering over 180 countries. The database is publicly available through the National Oceanic and Atmospheric Administration (NOAA) via the following FTP site:

ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/

Filename = ghcnd_all.tar.gz

SOA Research Team for This Report

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