# Climate Change: Where are we and where are we going?

#### Lesley Hughes







# Climate changing 170 times faster (70s to 2016) than in previous 7000 years





https://data.giss.nasa.gov/gistemp/ Average of monthly temperature anomalies. GISTEMP base period 1951-1980.

#### Observed global temperatures & atmospheric CO<sub>2</sub>



20 of the hottest years on record have occurred in the last 22 years

![](_page_4_Picture_0.jpeg)

## 2018 was fourth hottest year on record

![](_page_5_Figure_1.jpeg)

- 2018 was 42<sup>nd</sup>
   consecutive year of above average temperatures
- No one aged <40 has experienced global average temperatures below the global 20<sup>th</sup> C average

# 93% excess heat being absorbed by the oceans

# Warming detectable to depth of 2 km

# Sea level rise is accelerating

# 3x rate compared to 1990s

# Sea level rise is accelerating

0.5m rise over next 100 years but collapse of Antarctic ice shelves could mean 2-2.5m
1/100 yr flood/storm surge → 1/10 years

# Oceans are acidifying

![](_page_9_Picture_1.jpeg)

## 30% more acid than pre-industrial

# **Cyclone intensity increasing**

# **Need for Category 6?**

# Extreme hot days & heatwaves are increasing

9 of 10 hottest years on record have occurred since 2005

# Rainfall patterns are changing

![](_page_12_Figure_1.jpeg)

Commonwealth of Australia 2018, Australian Bureau of Meteorology

# Water cycle is intensifying

Droughts are becoming longer and more severe

## No. of "natural" catastrophes worldwide since 1980s

![](_page_15_Figure_1.jpeg)

![](_page_16_Picture_0.jpeg)

#### MAIN FACTORS AFFECTING BUSHFIRES

![](_page_17_Picture_1.jpeg)

#### 3 | People

Fires may be deliberately started (arson) or be started by accident (e.g. by powerline fault). Human activities can also reduce fire, either by direct suppression or by reducing fuel load by prescribed burning.

#### 2 | Fuel

1 | Ignition

accidentally.

Fires can be started by

lightning or people,

either deliberately or

Fires need fuel of sufficient quantity and dryness. A wet year creates favourable conditions for vegetation growth. If this is followed by a dry season or year, fires are more likely to spread and become intense.

#### 4 | Weather

Fires are more likely to spread on hot, dry, windy days. Hot weather also dries out fuel, favouring fire spread and intensity.

![](_page_18_Figure_0.jpeg)

Fuel load **Fuel condition** 

### The Flammable Continent

![](_page_19_Picture_1.jpeg)

- 5% burnt every year
- Many species adapted to particular fire regimes

![](_page_19_Figure_4.jpeg)

![](_page_20_Figure_0.jpeg)

http://www.ethos.org.au/online-resources/engage-mail/bushfires-fuels-and-climate-change

![](_page_21_Picture_0.jpeg)

## Australia: fire season is lengthening

- Fire season starting earlier, lasting longer
- Globally, length of fire season increased nearly 19% (1979-2013)

 E.g. 2014: 55 Local Government areas in NSW declared earlier start to bushfire season (August or Sept cf Oct)

![](_page_21_Picture_5.jpeg)

### Change in frequency of long fire weather seasons (%)

![](_page_22_Picture_1.jpeg)

![](_page_22_Figure_2.jpeg)

#### Australia: Fire danger weather is increasing

![](_page_23_Figure_1.jpeg)

### Observed trends in FFDI (1973-2010)

![](_page_24_Figure_1.jpeg)

![](_page_24_Figure_2.jpeg)

Observed trend in cumulative FFDI for Nowra (Lucas et al 2007)

### Observed trends in FFDI (1973-2010)

![](_page_25_Picture_1.jpeg)

![](_page_25_Figure_2.jpeg)

#### Australia: trends in burnt area

![](_page_26_Picture_1.jpeg)

- Australian fire datasets generally too short to detect convincing trends **BUT**:
- Recent analysis of 35 yr dataset (1975-2009) for south east shows:
- Increase in area burned for 7/8 forest Bioregions in coastal areas, correlated with increasing max temps
- Area burned declined or showed no change in drier woodlands consistent with complex interactions between fire, weather and fuel

![](_page_26_Picture_6.jpeg)

#### Bradstock et al 2014

# Fires are penetrating into new ecosystems

Cent

Conserval

![](_page_28_Picture_0.jpeg)

# Fire danger weather will continue to increase as the climate changes

![](_page_29_Figure_1.jpeg)

Estimated changes in days of high to catastrophic fire danger based single model run of annual maximum temperature and total rainfall from a grid square over Melbourne from the CSIRO Mark3.5 A1B model (Jones et al 2013).

![](_page_29_Picture_3.jpeg)

# Fire danger will be exacerbated by changes in population

![](_page_30_Picture_1.jpeg)

• Australian population projected to grow from 22.3 million in 2011 to 31-43 million by 2056 and to 34-62 million by 2101 (ABS 2008)

• Population growth & urban development near bushland will increase vulnerability of communities

![](_page_30_Picture_4.jpeg)

Marysville, VIC

## Bushfire impacts: health

![](_page_31_Picture_1.jpeg)

- >800 deaths since 1850
- Reduced air quality: Oct 2013 air quality levels in Sydney region were 50 x worse than normal; 228 admitted for breathing difficulties; 124% increased asthma

![](_page_31_Picture_4.jpeg)

# Bushfire impacts: economy

![](_page_32_Picture_1.jpeg)

- 1966-2013: \$5.6 billion insured losses due to bushfires (2011/12 values)
- Bushfires cost \$337 million per year on average (but doesn't include indirect costs) (Deloitte Access Economics 2014)
- 23% Australian households do not have a building or contents policy (ICA 2007)
- 13% properties lost in Black Saturday fires were uninsured
- 2018: \$1.2 billion insured losses in Australia (all weather-related events)

# Tingha, NSW 15/2/19

![](_page_34_Picture_1.jpeg)

# Increasing fire risk has significant implications for:

- Hazard reduction opportunities
- Resourcing of emergency services and fire management agencies

![](_page_34_Picture_5.jpeg)

# Fire changes elsewhere will affect Australia

![](_page_35_Picture_1.jpeg)

![](_page_35_Figure_2.jpeg)

U.S. Global Change Research Program, 6/16/09

### California fires 2017

![](_page_36_Picture_1.jpeg)

- Most destructive on record
- >9000 fires
- >6000km<sup>2</sup> burnt
- 47 fatalities
- >US\$18 billion in damages

![](_page_36_Picture_7.jpeg)

![](_page_37_Picture_0.jpeg)

#### Resources

![](_page_38_Picture_2.jpeg)

Climate Council www.climatecouncil.org.au

@climatecouncil

![](_page_39_Picture_0.jpeg)

#### WEATHER GONE WILD: CLIMATE CHANGE-FUELLED EXTREME WEATHER IN 2018

![](_page_39_Picture_2.jpeg)