Climate Change and Extreme Bushfires

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Display at Mt Stromlo, Canberra, 2013

- The overall bushfire story is about assets – the things we value.
- If anyone proposes a solution to the "bushfire problem" without noting assets, it requires scrutiny.
- Our story today is only a part of the main story, the assumption being that extreme fires will do little good, if any, to any of our assets
- Let's start a fire and grow it to an extreme level then see what climate change could do.
- Then, what can we do about changing circumstances?

Introduction



http://www.contraststu dio.co.za/blog/2011/11/ 10/creating-fire-inphotoshop/match-onfire-2/

Some Important Fire Variables

- Rate of spread, ROS, <u>with the wind</u> is the most common variable measured
- "Intensity" is related to the fuel-load multiplied by the ROS: it is a measure of the amount of heat released by part of the perimeter
- "Flame length" can be related to intensity
- Area and perimeter



http://www.blacksaturdaybushfires.com.au/pho tos/black-saturday-bushfires-fire-truck/

Spreading Fire – some background

- 1. Grassfire fronts can spread faster than forest fire fronts.
- 2. Maximum ROS: grassfires, about 22km/hr; forest fires, about 12 km/hr
- 3. Fires can spread in all directions
- ROS upslope doubles for every10 degrees up to 20 degrees at least
- 5. Forest fire max. ROS doubles with every 30 km/hr wind
- Spotting by firebrands ahead of the main fire can increase ROS

7. Spotting is exacerbated when whole forests are alight, when winds are strong and there is plenty of material for firebrands - like loose bark



Sutton Rd 1985 [Jeff Cutting, copyright]

Fires may start from a match but reach huge proportions

- Fires accelerate quickly under extreme weather conditions, extreme upward slopes and continuous fuel
- Not all edges are necessarily high intensity



Stockyard Creek prescribed fire (B. Levine photo)

Getting Bigger and Fiercer



- Day turns to night, roaring, searing heat, isolating, frightening
- With a large area burning intensely in large quantities of fuel and steep terrain, a huge amount of heat is released.
- As fuel burns it releases water vapour as well as heat. Heat rises and water vapour might condense at a great height in an extreme fire – 14km in Canberra – to form pyrocumulus cloud

- Lightning and thunder may form within the cloud – "pyrocumulonimbus"
- Black hail may fall as in Bungendore 2003
- Tornadoes may form as in southwestern Canberra in 2003

[see Fromm et al. 2006]

 It can happen again!

Even fiercer ...



Photograph of pyrocumulus cloud above the Oregon Gulch fire, a part of the Beaver Complex fire taken by James Haseltine on July 31, 2014, at 8:20 PM Pacific Daylight Time. [http://earthobservatory.nasa.gov/IOTD/view.

php?id=84129]

Consequences of Extremes

- Total control is impossible: in fact, in forest fires, only about the lowest 4% of possible intensities fall within the controllable range
- There have been reports of helicopters struggling to avoid being sucked into the updraft
- However, fires spread day and night, with and against the wind

 Social environmental and economic assets are bound to be affected!



Canberra 2003 [A.M. Gill]

Will there be more Fire Extremes in our area due to Climate Change?

- Rising CO₂ and other greenhouse gas – concentrations warm the planet (Arrhenius 1896)
- Rising CO2 enhances plant [fuel] growth



CO₂ enrichment experiment Duke University (www)



Data from CSIRO and BoM

- Fire weather: measured by the Grassland Fire Danger Index, GFDI, and the Forest Fire Danger Index, FFDI (McArthur 1960s)
- Both are related to the ROS on level ground: why not use ROS?
- GFDI needs a measure of the dryness, or "curing", of grass.
- FFDI needs a Drought Factor
- In the Canberra fires the FFDI reached what was then regarded as "worst possible", 100.
- Values of FDIs are grouped as "Fire Danger Ratings" [as in the picture]
- Has FFDI changed over time?

What about Fire Weather?



Trends in Forest-fire Weather Indices

[data courtesy of Dr C. Lucas, Bureau of Meteorology]



Time (years)

Some sites, like this one, show a statistically significant positive trend with time.

Trends in FFDI, the Forest-fire Weather Index [data courtesy of Dr C. Lucas, Bureau of Meteorology]



There is no statistically significant change in 43 years of data here: not long enough? Other measures of change?

Other Time Trends for Canberra

- No increase in maximum FFDI per year (Clarke et al. 2012) and,
- No increase in length of FFDI fire season (Lucas et al. 2007), but,
- Autumn increase in FFDI (Clarke et al. 2012)
- What about predictions for the longer term?



Mt Majura Pines 1985 (FFDI=70)

Longer-term Models give another Perspective

- 2030, 2070 weather models, fire models and grass-growth models can be used to make predictions.
- In Canberra fire-spread and grass-growth models [King et al., 2012], showed higher potential spread rates due to CC were offset by less grass due to drier conditions.

?????????



http://www.theautomaticearth.com/2014/05 /physical-limits-to-food-security-water-andclimate/

Modelled Fire History: Average inter-fire interval, lightning ignition

Current climate





Climate change (2070)



Cary, G.J. (2002) Importance of a changing climate for fire regimes in Australia. In *Flammable Australia: The Fire Regimes and Biodiversity of a Continent*. (Eds R.A. Bradstock, J.E. Williams, A.M. Gill). Cambridge University Press.

People Problems?



Canberra Population 1911-2013



ACT fire causes from 2004 [N. Lhuede, ACT RFS]



The large extreme fires of 2003 were caused by lightning

http://www.gizm odo.com.au/2014 /10/photosmelbourne-hadan-insanelightning-stormlast-night/

Recent Bushfire Numbers in the ACT

• Year Number

| • 2004-05 | 216 |
|-----------|-----|
| • 2005-06 | 265 |
| • 2006-07 | 491 |
| • 2007-08 | 237 |
| • 2008-09 | 336 |
| 2000 10 | 207 |

- 2009-10 267
- 2010-11 124
- 2011-12 216
- 2012-13 290
- 2013-14 187

Ninety seven percent of these fires were under 1 ha in area ..

[Data from N. Lhuede, ACT Rural Fire Service]

...but big ones can still occur!

We are heading for higher fire danger conditions in the medium term, at least, but what can we do about it? Fuels, suppression, building regulations?



Conclusions

- Different places respond differently to climate change
- Strictly speaking, for Canberra, there was no historical trend to higher FFDI but longerterm models suggest increased FFDI
- And, more population, more fires?

- Extreme fires are rare but highly damaging to S.E.E. assets
- Realise that some fires are needed for managing some assets
- Integrated management, a challenge - increased asset resistance; better planning of land use; watch fuels; meet surges in demand for suppression ...

.... and manage the planet better!



NASA image