Threshold conditions for extreme fire behaviour

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The caveat

DRAFT

Project under development

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Project collaborators

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- Dr Kevin Tolhurst (UOM)
- Derek Chong (UOM)
- Dr Jason Sharples (UNSW)
- Dr Rodman Linn (Los Alamos National Laboratory)
- Dr Domingos Viegas (University of Coimbra)

Project background

- Most models assume that while the weather, fuel, terrain remains constant, fire behaviour will reach a quasi-steady state rate of spread

  e.g.

  – VESTA dry eucalypt forest fire behaviour model
  – McArthur Mk5 forest fire behaviour
  – CSIRO Grassland fire behaviour
  – CSIRO Mallee-Heath fire model

- Fire behaviour models are based on observations of small to moderate fires

Dynamic Fire Behaviour

- Biggest impacts on human assets come from large or “extreme” fires
- Project focuses on “Blowup Fires” / “Extreme Fire Behaviour”
  - **Blowup Fires** – *a dramatic change in behaviour of the whole fire, the point of rapid transition to a severe fire* (Pyne et al. 1996, p.48)
  - **Extreme Fire Behaviour** - *the set of forest fire spread characteristics and properties that preclude the possibility of controlling it safely using available present day technology and knowledge* (Viegas 2014)
- Dynamic feedbacks escalate growth and intensity
- Multiple pathways possible

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Project objectives

- Investigate the conditions and processes under which bushfire behaviour undergoes major transitions

- Identify if threshold conditions occur that could allow for the prediction of extreme fire behaviour from environmental conditions

- Derive empirical relationships that **could** be implemented in a fire behaviour model

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Methodology

- Collate data from large and extreme fires
  - Fire progression information
  - Topographic data
  - Climatic data, including atmospheric data
  - BOM radar data
  - Impact on assets
  - Other satellite data
- Identify cases where “extreme” fire behaviour occurred using the classification of Viegas (2014)
- Extreme event statistics to analyse data
- Develop hypotheses to be tested using coupled fire-atmosphere modelling

Viegas 2014

- Describes seven extreme fire behaviours
- Not independent
- Developing framework

1. **Eruptive fires**
   - Continual acceleration
   - Terrain interactions affect spread
   - Fire build up important
   - Convection influenced by terrain

CSIRO PUBLISHING

www.publish.csiro.au/journals/ijwf *International Journal of Wildland Fire*, 2004, **13**, 253–274

Fire spread in canyons

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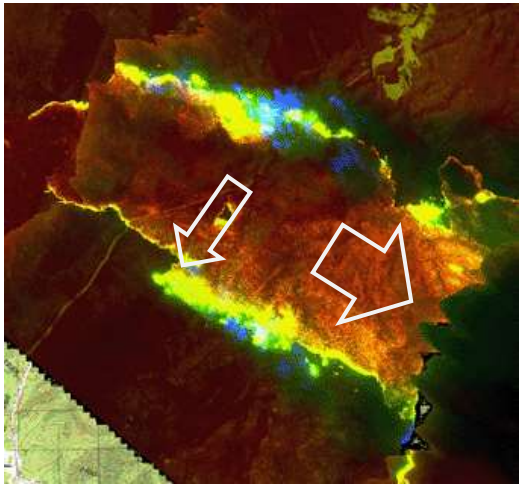
2. **Fire Whirls**
   - Combination heat and winds
   - e.g. Canberra 2003 fire tornado

www.australiantimes.co.uk

3. Horizontal Vortices

- Spread of the fire perpendicular to the wind
- Research:
  - Simpson *et al.* 2013; Sharples et al. 2011; Sharples et al. 2012
- Australian examples:
  - McIntyre's Hut 2003, Aberfeldy 2013, Wambelong 2013



4. **Spot Fires (Fire Storm)**
   - 100-1km medium distance
   - 1 -10 km long distance
   - 10km + very long distance

   - Examples include
     - Strathewan, Narbethong, Marysville 2009

CSIRO PUBLISHING

International Journal of Wildland Fire **2012**, *21*, 609–627
http://dx.doi.org/10.1071/WF11020

A mathematical model for predicting the maximum potential spotting distance from a crown fire

Frank A. Albini[A,F], *Martin E. Alexander*[B,C,E] *and Miguel G. Cruz*[D]

5. **Crown fires**
   - Easily measurable through remote sensing such as severity mapping, LIDAR etc
   - Combination of fuel structure and weather
   - Examples

CSIRO PUBLISHING

International Journal of Wildland Fire 2014, *23*, 9–20
http://dx.doi.org/10.1071/WF12184

Can precipitation influence landscape controls on wildfire severity? A case study within temperate eucalypt forests of south-eastern Australia

L. Collins[A,B], *R. A. Bradstock*[A] *and T. D. Penman*[A]

6. Conflagrations

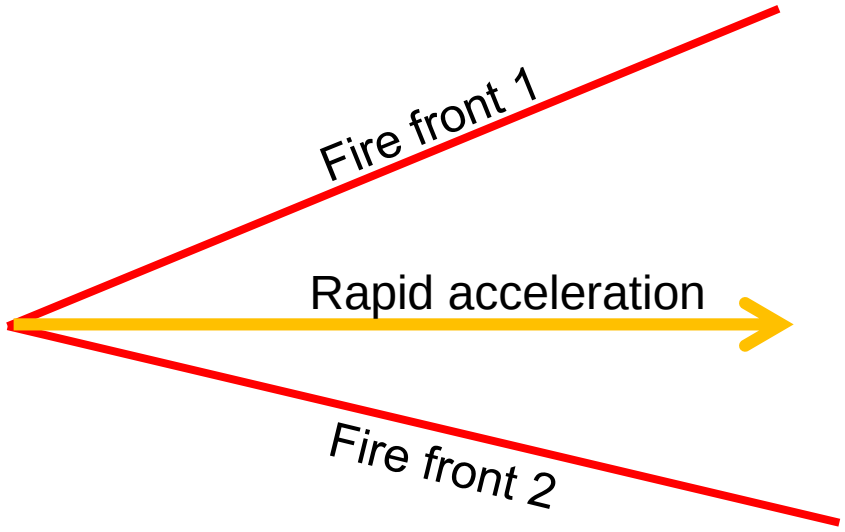
– Upper end of the statistical distribution

– Weather driven

A number of examples in the last ten years

- Portugal 2003
- Wambelong 2013
- State Mine Lithgow 2013
- Black Saturday Complex 2009
- Tasmania 2013

7. **Jump Fires (Sharples project)**
   - Two fires meet, acceleration in junction zones,
   - e.g. Canberra 2003, ThirtyMile fire USA 2001



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Outputs

- A database with case study of extreme fire behaviour coupled with climatic and environmental data
- Documented occurrence of extreme fire behaviours in Australian system
- Analysis and publication of environmental factors contributing to extreme fire behaviour
- Relationships for implementation in a fire behaviour model

Key early milestones

- Finalise contracts (early 2015)
- Post-doc recruitment early 2015
- Seek PhD student (2015 to start 2016)
- Collation of datasets 2015/2016
- Empirical analysis and publication 2016
- Exploration of fire behaviour models – e.g., WRF-Fire 2017