Fires are now wicked problems

Key Topics:

- fire [2]
- fire impacts [3]
- fire severity [4]

Threshold conditions for extreme fire behaviour [5]

This study is identifying the thresholds beyond which dynamic fire behaviour becomes a dominant factor, the effects that these dynamic effects have on the overall power output of a fire, and the impacts that such dynamic effects have on fire severity. This will necessarily include consideration of other factors such as how fine fuel moisture varies across a landscape. The research team is investigating the conditions and processes under which bushfire behaviour undergoes major transitions, including fire convection and plume dynamics, evaluating the consequences of eruptive fire behaviour (spotting, convection driven wind damage, rapid fire spread) and determining the combination of conditions for such behaviours to occur (unstable atmosphere, fuel properties and weather conditions).

Project: detail Notabs

Research team

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Description

While a number of advances have been made in understanding bushfire development under extreme conditions, these have not been quantified in a manner that is suitable for inclusion in fire behaviour modelling framework. This project aims is to develop statistical models that allow for the inclusion of dynamic effects when they are important – that is, when fires grow sufficiently large and complex.

The study is identifying the thresholds beyond which dynamic fire behaviour becomes a dominant factor, the effects that these dynamic effects have on the overall power output of a fire, and the impacts that such dynamic effects have on fire severity. This will necessarily include consideration of other factors such as how fine fuel moisture varies across a landscape.

The research team is investigating the conditions and processes under which bushfire behaviour undergoes major transitions, including fire convection and plume dynamics, evaluating the consequences of eruptive fire behaviour (spotting, convection driven wind damage, rapid fire spread) and determining the combination of conditions for such behaviours to occur (unstable atmosphere, fuel properties and weather conditions).

There are three overlapping research activities:

1. Collating fire behaviour observations - creating a database of observations of extreme fire behaviour to use in model development and verification, working with government agencies to develop reconstructions of past fires.
2. Understanding extreme fire weather and fire behaviour - determining the thresholds in fire and environmental conditions (weather, fuel, topography) that lead to extreme fire phenomena, such as fire tornados and ember storms.
3. Factors linked to extreme fire behaviour - developing simple statistical equations to represent dynamic fire phenomena that can be integrated into existing fire-behaviour models.

It is expected that both the research and operational management communities will benefit by greatly improving knowledge of extreme bushfires. Currently, there is limited information with which to develop new models or test theories about extreme fire behaviour.

This project will create new observational datasets of such fires and use them to describe empirical relationships between fire phenomena and the key environmental conditions that drive them. These relationships could be incorporated into existing fire simulation systems and generate further research, including the verification of physics-based models and the development of new theories of fire propagation.

The research will be utilised through the development of guidelines for identifying environmental conditions causing the extreme fire behaviour phenomena during operational fire behaviour analysis and improved fire behaviour simulators through the inclusion of extreme fire behaviours.

These outputs will result in improved prediction of fire behaviour at the point where damage to property and loss of life is more likely. Improved predictions will improve the knowledge base of fire managers and their ability to make informed decisions during fires and about landscape vulnerability. This will include improving the efficiency and safety of fire suppression activities, better targeting of public information and warnings, and an improved understanding of the potential effectiveness strategies for managing landscape fire risk.

Related News

29 JAN 2021

How heatwaves and drought combine to produce the perfect firestorm

FIRE, FIRE SEVERITY

[37]

28 JAN 2021

Australia Day Honours for CRC experts

FIRE, FIRE IMPACTS

[38]

28 JAN 2021

New online - January 2021

COMMUNICATION, EMERGENCY MANAGEMENT

[39]

15 DEC 2020

New online - December 2020

COMMUNICATION, EMERGENCY MANAGEMENT

[40]

09 DEC 2020

International awards for CRC experts

FIRE IMPACTS, FIRE WEATHER

[41]

16 NOV 2020

New online - November 2020

COMMUNICATION, EMERGENCY MANAGEMENT

[42]

08 OCT 2020

CRC researchers recognised as science leaders

EMERGENCY MANAGEMENT, HYDROLOGY

[43]

22 JUL 2020

New online - July 2020

COMMUNICATION, EMERGENCY MANAGEMENT

[44]

21 MAY 2020

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COMMUNICATION, EMERGENCY MANAGEMENT

[45]

19 NOV 2019

CRC science making national impact

FIRE, FIRE SEVERITY

[46]

23 OCT 2019

Predictive services research spotlighted

EMERGENCY MANAGEMENT, FORECASTING

[47]

09 OCT 2019

New online - October 2019

EMERGENCY MANAGEMENT, ENGINEERING

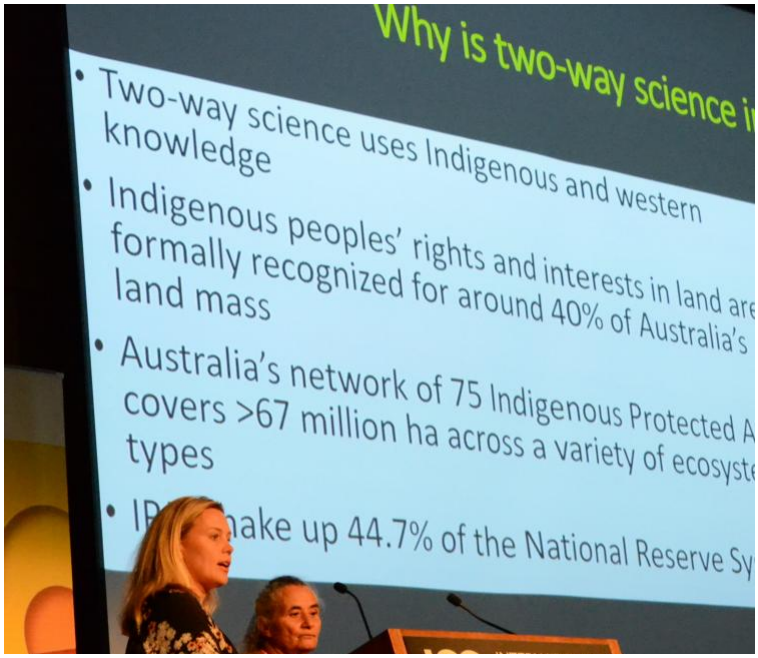
[48]

11 SEP 2019

New online - September 2019

EMERGENCY MANAGEMENT, MULTI-HAZARD

[49]



15 MAY 2019

Global fire focus on diversity, cultural burning and communities

COMMUNITIES, DIVERSITY AND INCLUSION

[50]

15 MAY 2019

Prescribed burning research warm up to conference

FORECASTING, MITIGATION

[51]

15 NOV 2018

New online – November 2018

EARTHQUAKE, MODELLING

[52]

19 SEP 2018

New online - September 2018

EMERGENCY MANAGEMENT, INDIGENOUS COMMUNITIES

[53]

18 SEP 2018

Conference papers available online

EMERGENCY MANAGEMENT, MULTI-HAZARD

[54]

14 MAR 2018

New online - March 2018

EMERGENCY MANAGEMENT, MULTI-HAZARD

[55]

17 NOV 2017

New online - November 2017

[56]

16 AUG 2016

New online - August 2016

[57]

19 APR 2016

Fire expertise honoured

FIRE, MODELLING

[58]

10 JUN 2015

Researcher awarded Queen's Birthday Honour

[59]

07 OCT 2014

Mercury rising replay available

COMMUNITIES, FIRE SEVERITY

[60]

Publications

Year	Type	Citation
2022	Book Chapter	Filkov, A. [9], Cawson, J. [61], Swan, M. [62] & Penman, T. [8] *Handbook of Fire and the Environment* **The Society of Fire Protection Engineers Series,** (Springer, 2022). DOI [63] Google Scholar [64]
2022	Report	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Determining threshold conditions for extreme fire behaviour - final project report** [67]. (Bushfire and Natural Hazards CRC, 2022). Google Scholar [68] E
2021	Conference Paper	Filkov, A. [9] **Predicting merging fire behaviour in Planned Burning** [71]. *AFAC21* (AFAC, 2021). at <https://www.afac.com.au/events/proceedings/05-10-21/article/predicting-merging-fire-behaviour-i
2020	Journal Article	Burton, J. [76], Cawson, J. [61], Filkov, A. [9] & Penman, T. [8] **Leaf traits predict global patterns in the structure and flammability of forest litter beds** [77]. *Journal of Ecology* (2020). doi:https://do
2020	Journal Article	Prohanov, S. [82], Filkov, A. [9], Kasymov, D. P. [83], Agafontsev, M. [84] & Reyno, V. [85] **Determination of Firebrand Characteristics Using Thermal Videos** [86]. *Fire* **3,** (2020). DOI [87] Google Sc
2020	Journal Article	Cawson, J. [61] *et al.* **Exploring the key drivers of forest flammability in wet eucalypt forests using expert-derived conceptual models** [91]. *Landscape Ecology* **35,** 1775–1798 (2020). DOI [92] G
2020	Journal Article	Filkov, A. [9], Ngo, T. [96], Matthews, S. [35], Telfer, S. [97] & Penman, T. [8] **Impact of Australia's catastrophic 2019/20 bushfire season on communities and environment. Retrospective analysi**
2020	Report	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Determining threshold conditions for extreme fire behaviour - annual report 2019-2020** [103]. (Bushfire and Natural Hazards CRC, 2020). Google Schola
2019	Conference Paper	Filkov, A. [9], Cirulis, B. [107] & Penman, T. [8] **Quantifying dynamic fire behaviour phenomena using Unmanned Aerial Vehicle technology** [108]. *23rd International Congress on Modelling and Si*
2019	Journal Article	Penman, T. [8] & Cirulis, B. [107] **Cost effectiveness of fire management strategies in southern Australia** [113]. *International Journal of Wildland Fire* **29,** 427-439 (2019). DOI [114] Google Scholar
2019	Journal Article	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Frequency of Dynamic Fire Behaviours in Australian Forest Environments** [118]. *Fire* **3,** (2019). DOI [119] Google Scholar [120] BibTeX [121] EndNote X
2019	Report	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Determining threshold conditions for extreme bushfire behaviour annual report 2018-2019** [123]. (Bushfire and Natural Hazards CRC, 2019). Google Scl
2019	Report	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Determining Threshold Conditions for Extreme Fire Behaviour Annual Report 2017-2018** [127]. (Bushfire and Natural Hazards CRC, 2019). Google Scho
2018	Conference Paper	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Extreme fire behaviours: Surveying fire management staff to determine behaviour frequencies and importance** [131]. *AFAC18* (Bushfire and Natural H
2018	Conference Paper	Bates, J. [135] **Research proceedings from the 2018 Bushfire and Natural Hazards CRC and AFAC Conference** [136]. *Bushfire and Natural Hazards CRC & AFAC annual conference 2017* (Bushfir
2018	Journal Article	Read, N. [140], Duff, T. [6] & Taylor, P. [141] **A lightning-caused wildfire ignition forecasting model for operational use** [142]. *Agricultural and Forest Meteorology* **253-254,** 16 (2018). DOI [143] Go
2018	Journal Article	Matvienko, O. V. [147], Kasymov, D. P. [83], Filkov, A. [9], Daneyko, O. I. [148] & Gorbatov, D. A. [149] **Simulation of fuel bed ignition by wildland firebrands** [150]. *International Journal of Wildland F*
2018	Journal Article	Filkov, A. [9] & Prohanov, S. [82] **Particle tracking and detection software for firebrands characterization in wildland fires** [154]. *Fire Technology* **55,** 817-836 (2018). DOI [155] Google Scholar [15
2018	Journal Article	Filkov, A. [9], Duff, T. [6] & Penman, T. [8] **Improving Fire Behaviour Data Obtained from Wildfires** [159]. *Forests* **9,** (2018). DOI [160] Google Scholar [161] BibTeX [162] EndNote XML [163]
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2017	Journal Article	Thomas, J. [168] *et al.* **Investigation of firebrand generation from an experimental fire: development of a reliable data collection methodology** [169]. *Fire Safety Journal* **91,** 864-871 (2017). DOI
2017	Journal Article	Mueller, E. [174] *et al.* **Utilization of remote sensing techniques for the quantification of fire behavior in two pine stands** [175]. *Fire Safety Journal* **91,** 845-854 (2017). DOI [176] Google Scholar [
2017	Journal Article	Fateev, V. [180], Agafontsev, M. [84], Volkov, S. [181] & Filkov, A. [9] **Determination of smoldering time and thermal characteristics of firebrands under laboratory conditions** [182]. *Fire Safety J*
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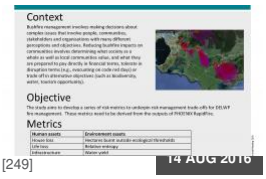
2016	Conference Paper	Tolhurst, K. G. [196] & McCarthy, G. J. [197] **Effect of prescribed burning on wildfire severity - a landscape case study from the 2003 fires in Victoria** [198]. *AFAC16* (Bushfire and Natural Hazarc
2016	Report	Duff, T. [6], Penman, T. [8] & Filkov, A. [9] **Determining threshold conditions for extreme fire behaviour: Annual project report 2015-2016** [202]. (Bushfire and Natural Hazards CRC, 2016). Google
2015	Presentation	Duff, T. [6] & Penman, T. [8] **Determining threshold conditions for extreme fire behaviour** [206]. (2015). Google Scholar [207] BibTeX [208] EndNote XML [209]
2015	Report	Duff, T. [6] & Penman, T. [8] **Determining threshold conditions for extreme fire behaviour: Annual project report 2014-2015** [210]. (Bushfire and Natural Hazards CRC, 2015). Google Scholar [211

Presentations & Resources

DATE [214]	TITLE [215]	DOWNLOAD	KEY TOPICS
27 Oct 2014	Environmental thresholds for dynamic fire propagation [216]		fire [2], propagation [217]
04 Dec 2014	Threshold conditions for extreme fire behaviour [218]	610.43 KB	[219] (610.43 KB) [4], modelling [220]
22 Mar 2016	Severe and High Impact Weather - cluster overview [221]	0 bytes	[222] (0 bytes) [220], scenario analysis [223]
24 Oct 2016	Determining threshold conditions for extreme fire behaviour [224]	1.88 MB	[225] (1.88 MB) [4], mitigation [226], severe weather [
25 Oct 2016	Next generation fire modelling [228]	1.35 MB	[229] (1.35 MB) [3], fire severity [4], fire weather [230]
07 Jul 2017	Building bushfire predictive services capability [231]	9.97 MB	[232] (9.97 MB) [230], modelling [220]
07 Jul 2017	Building bushfire predictive services capability - Simon Heemstra [233]	0 bytes	[234] (0 bytes) [3], modelling [220]
31 Oct 2017	Determining threshold conditions for extreme fire behaviour: standardising data obtained from wildfires [235]	567.23 KB	[236] (567.23 KB) [3], fire severity [4]
19 Sep 2018	The development of a pyrocumulonimbus prediction tool [237]	2.01 MB	[238] (2.01 MB) [3], fire severity [4]
23 Nov 2018	Determining threshold conditions for extreme fire behaviour [239]	868.87 KB	[240] (868.87 KB) [3]
18 Jun 2019	Interactions between climate, vegetation and fuel [241]	3.16 MB	[242] (3.16 MB) [243], fire weather [230], severe wea
17 Oct 2019	Thresholds for dynamic fire behaviours [244]	5.88 MB	[245] (5.88 MB) [3], fire severity [4]
01 Dec 2020	PHOENIX RapidFire [246]		fire [2], fire impacts [3], fire severity [4]
18 Feb 2022	Understanding what happens when bushfires merge [247]	1.28 MB	[248] (1.28 MB) [3], fire severity [4]

Posters



[249]

Determining threshold conditions for extreme fire behaviour

[249]

FIRE
IMPACTS [3]

The bushfire behaviour and management group of the University of Melbourne is conducting a project to...

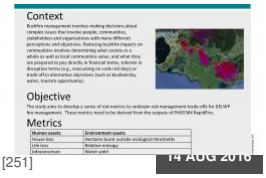
[250]

14 AUG 2016

Severe fire behaviour – improved planning responses

[250]

This project aims to better describe the nature of bushfires, especially very severe ones, and the effect of...



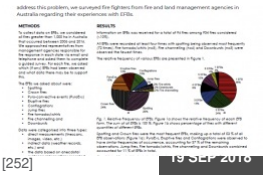
[251]

14 AUG 2016

Developing wildfire risk metrics in Phoenix RapidFire

[251]

Bushfire management involves making decisions about complex issues that involve people, communities,...



[252]

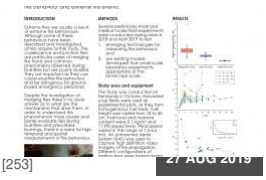
19 SEP 2016

Extreme fire behaviours: Surveying fire management staff to determine behaviour frequencies and importance

[252]

FIRE
FIRE [2], IMPACTS [3]

Extreme fire behaviours (EFBs) are phenomena that occur within intense fires that have been shown to...



[253]

27 AUG 2019

Using advancements in technology for better understanding of fire behaviour and decision making

[253]

DECISION MAKING [254]

[255]

31 AUG 2020

Flammability of live plants, do we need a new testing approach?

[255]

FIRE [2], FIRE WEATHER [230]

Key findings: The validity of using dynamic heating regimes and VHFlux apparatus as a standardised method has...

Linked Projects

Fire spread prediction across fuel types
[256]

BUSHFIRE PREDICTIVE SERVICES [257]

A/Prof Khalid Moinuddin
Victoria University [258]

[258]

Through the flames - quantitative analysis of strategic and tactical wildfire suppression
[259]

BUSHFIRE PREDICTIVE SERVICES [257]

Dr Greg Penney
Edith Cowan University [260]

[260]

Threshold conditions for extreme fire behaviour [5]

BUSHFIRE PREDICTIVE SERVICES [257]

A/Prof Trent Penman
University of Melbourne [7]

[7]

Fire coalescence and mass spotfire dynamics [261]

BUSHFIRE PREDICTIVE SERVICES [257]

Prof Jason Sharples
University of New South Wales [11]

[11]

Coupled fire-atmosphere modelling [262]

SEVERE AND HIGH IMPACT WEATHER [263]

Dr Mika Peace
Bureau of Meteorology [19]

[19]

Links

[1] https://www.bnhcrc.com.au/files/dscf9267jpg [2] https://www.bnhcrc.com.au/research/topics/fire [3] https://www.bnhcrc.com.au/research/topics/fire-impacts [4] https://www.bnhcrc.com.au/research/topics/fire-severity [5] https://www.bnhcrc.com.au/research/extremefirebehaviour [6] https://www.bnhcrc.com.au/people/tduff [7] https://www.bnhcrc.com.au/organisations/umelb [8] https://www.bnhcrc.com.au/people/tpenman [9] https://www.bnhcrc.com.au/people/afilkov [10] https://www.bnhcrc.com.au/people/jsharples [11] https://www.bnhcrc.com.au/organisations/unsw [12] https://www.bnhcrc.com.au/people/aleavesley [13] https://www.bnhcrc.com.au/organisations/act-parks-and-conservation [14] https://www.bnhcrc.com.au/people/astark [15] https://www.bnhcrc.com.au/organisations/cfs [16] https://www.bnhcrc.com.au/people/brdavies [17] https://www.bnhcrc.com.au/organisations/nswrfs [18] https://www.bnhcrc.com.au/people/jkepert [19] https://www.bnhcrc.com.au/organisations/bom [20] 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