Thresholds for dynamic fire behaviours

Alex Filkov, Thomas Duff, Trent Penman

PREVIOUS RESULTS

IMPROVING DATA OBTAINED FROM WILDFIRES

Systematic data collection

Introduction of novel methods

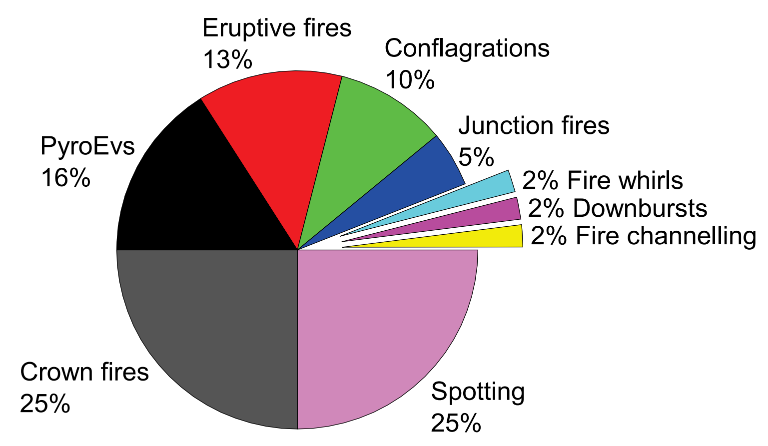
Improved fire science

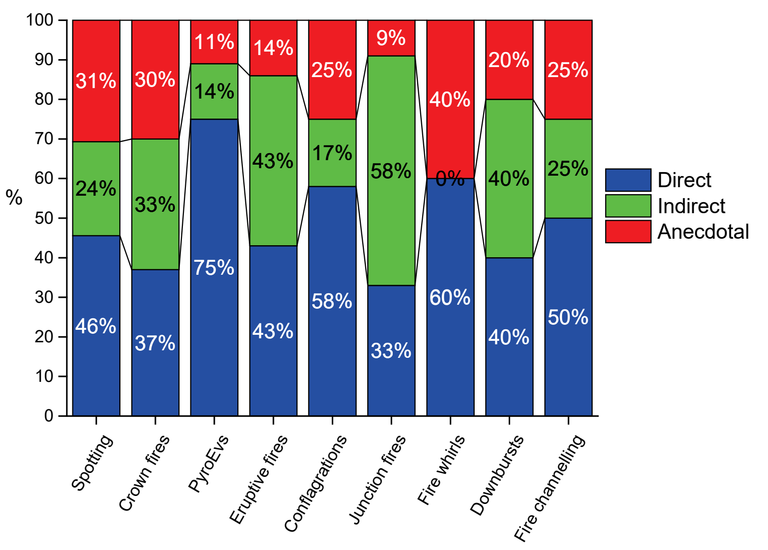
- Ground observations and operational information;
- Linescans;
- Forward Looking IR;
- Aerial observers;
- Satellites;
- Remote weather observations
- UAV observations;
- Vehicle/aircraft GPS tracks; and
- Suppression strategies.

Filkov AI, Duff TJ, Penman TD (2018) Improving fire behaviour data obtained from wildfires. *Forests* **9**. doi:10.3390/f9020081

FREQUENCY OF DYNAMIC FIRE BEHAVIOURS IN FOREST ENVIRONMENTS

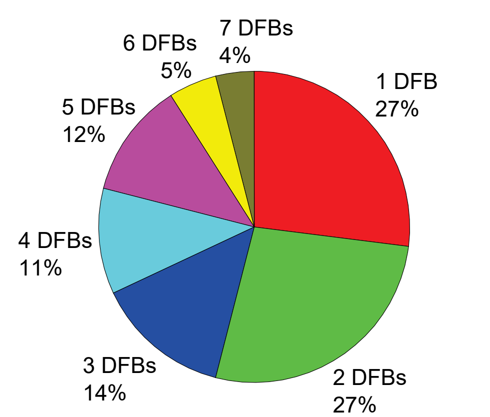
Relative frequency of each DFB form

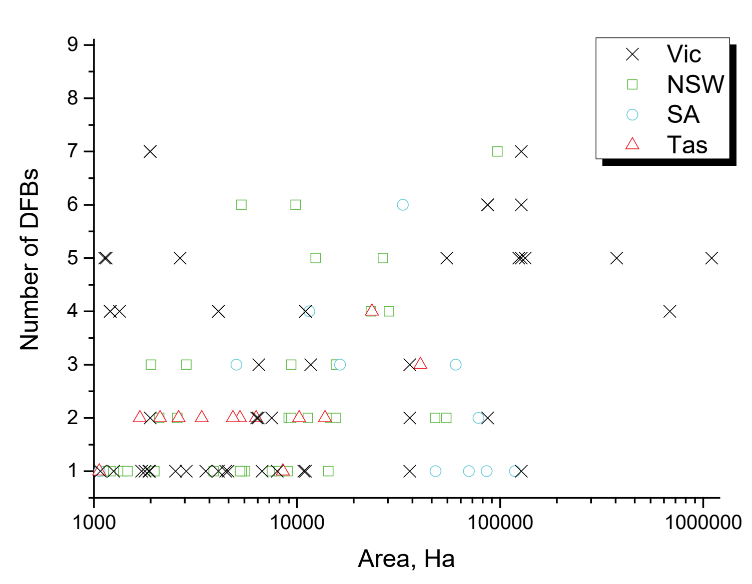




Comparison of DFBs distributions for different data type

Percentage of fires with different quantities of different DFBs

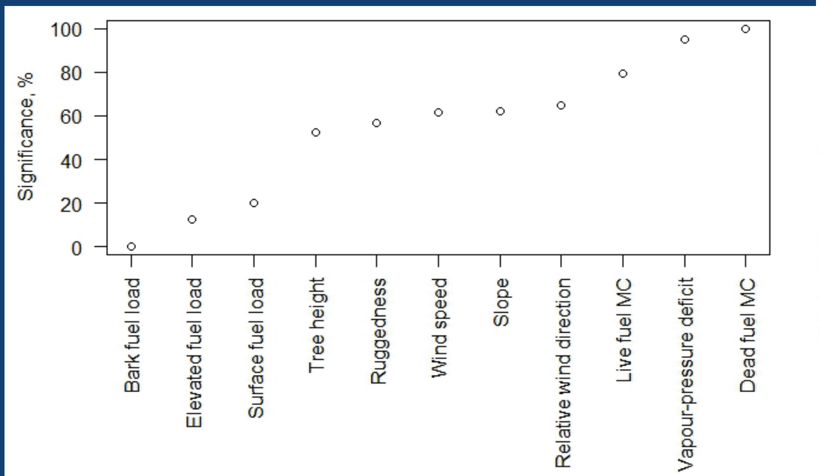




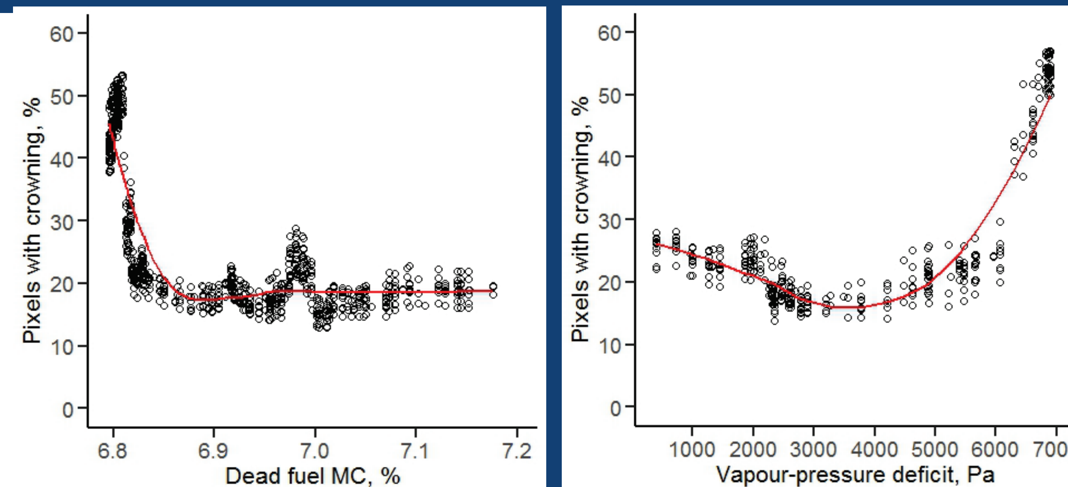
Number of DFBs versus fire area for four states

Filkov AI, Duff TJ, Penman TD Frequency of dynamic fire behaviours in Australian forest environments. Fire. (submitted)

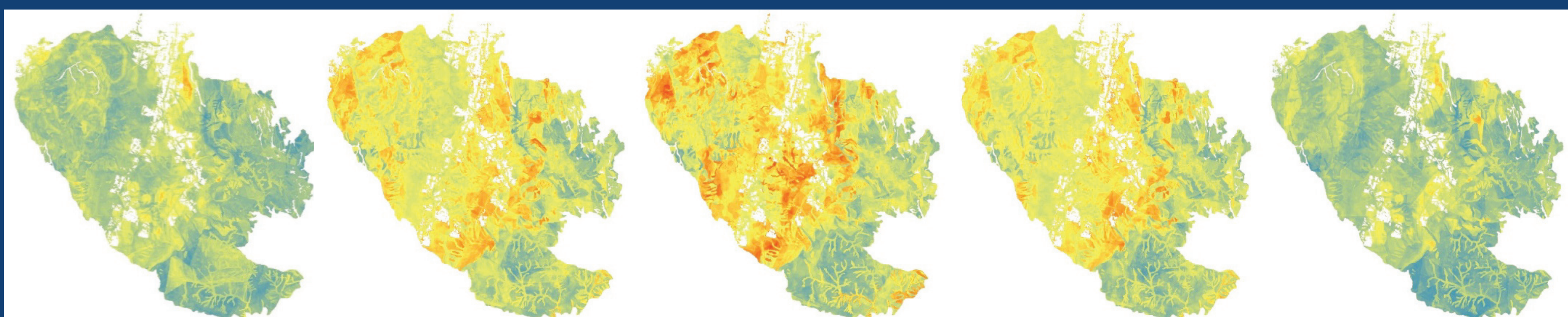
THE DETERMINANTS OF CROWN FIRE RUNS DURING EXTREME WILDFIRES IN BROADLEAF FORESTS IN AUSTRALIA



Importance of predictor variables for the prediction of crown fire extent



Influence of predictor variables on crown fire extent



8.00 12.00 16.00 20.00 22.00

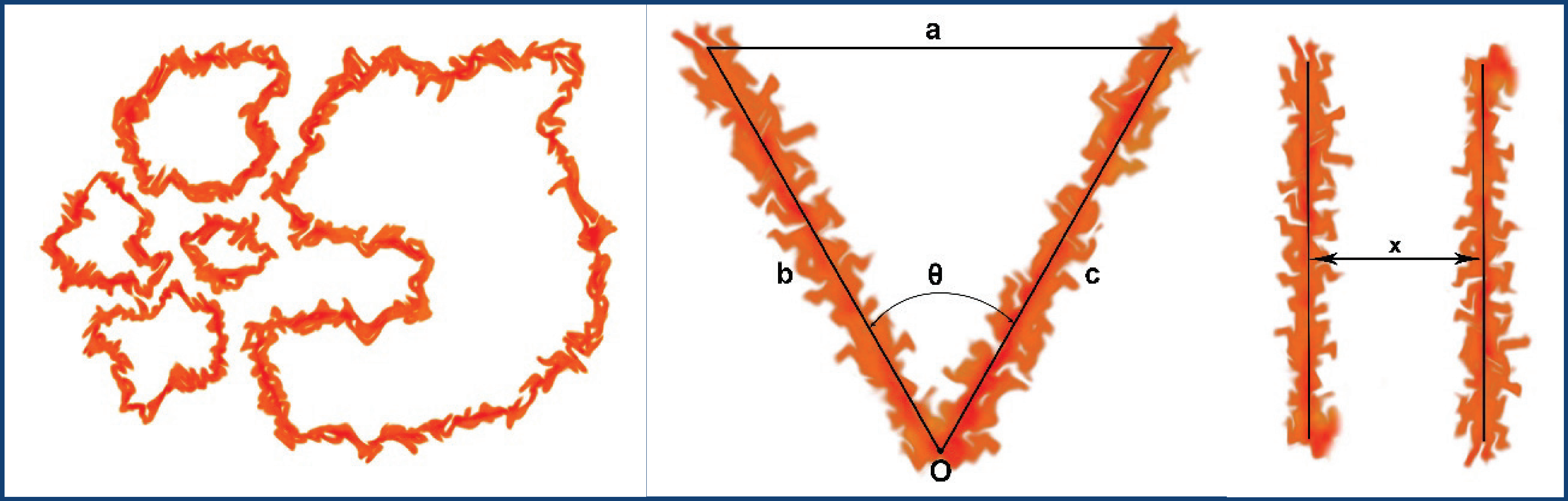
Four hour forecast for Murrindindi fire on February 7th

Filkov A., Collins L., Rawlins A., Duff T., Cirulis B., Penman T. (2018) The determinants of crown fire runs during extreme wildfires in broadleaf forests in Australia // Advances in Forest Fire Research. Coimbra: Imprensa da Universidade de Coimbra, Pp. 1401-1405.

RECENT RESULTS

Using Technological Advancements to Uncover Fire Behaviour Phenomena and for Operational Support

Merging fires

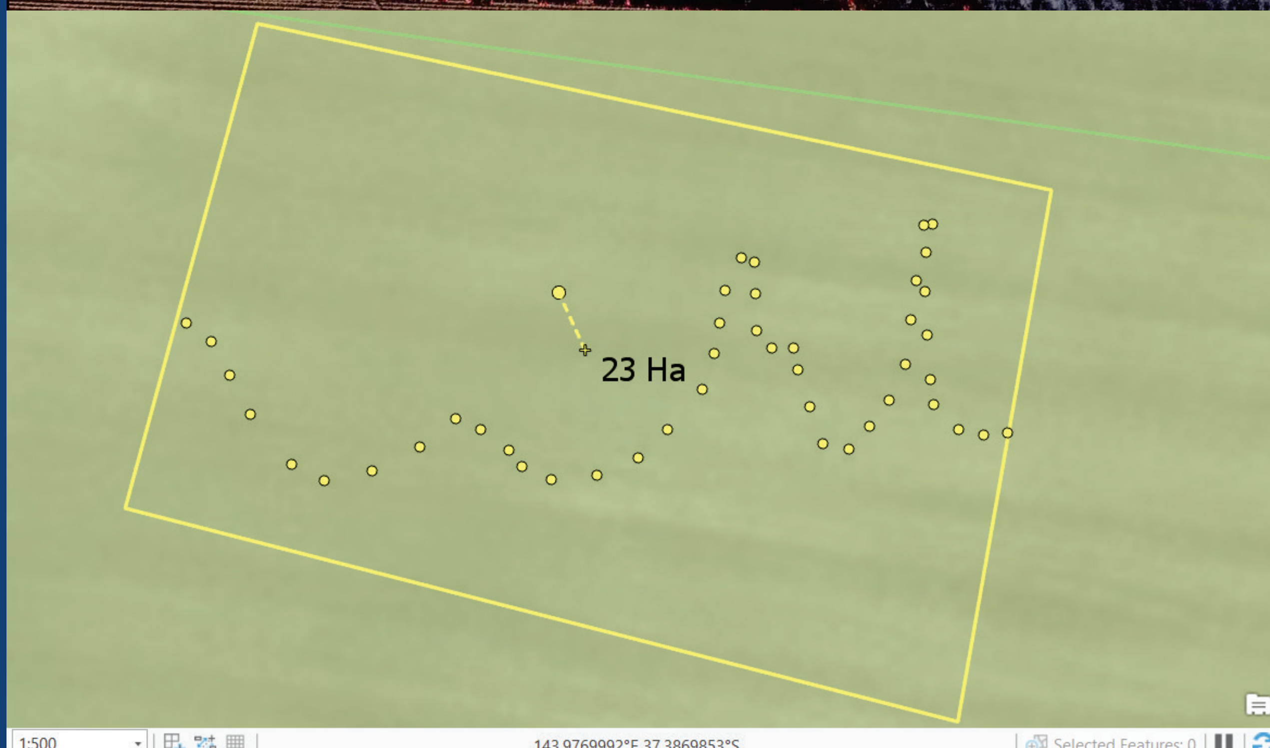


a) b) c

Merging fire fronts: a) Fire coalescence, b) Junction fire, c) Parallel fire fronts

Location of experimental plots. Green lines represent ignition lines


Microsoft Hyperlapse Pro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143.9769992°E 37.3869853°S
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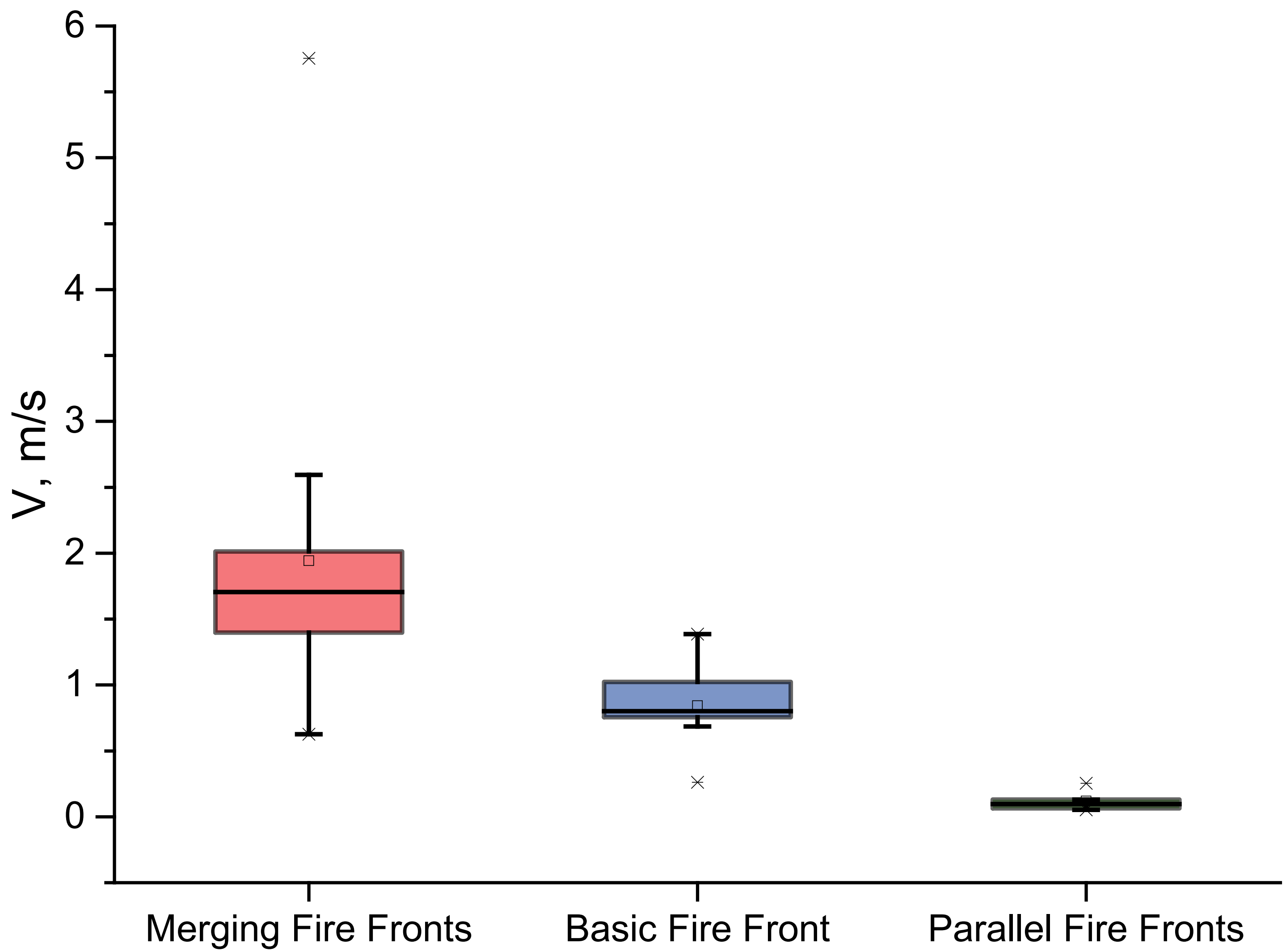
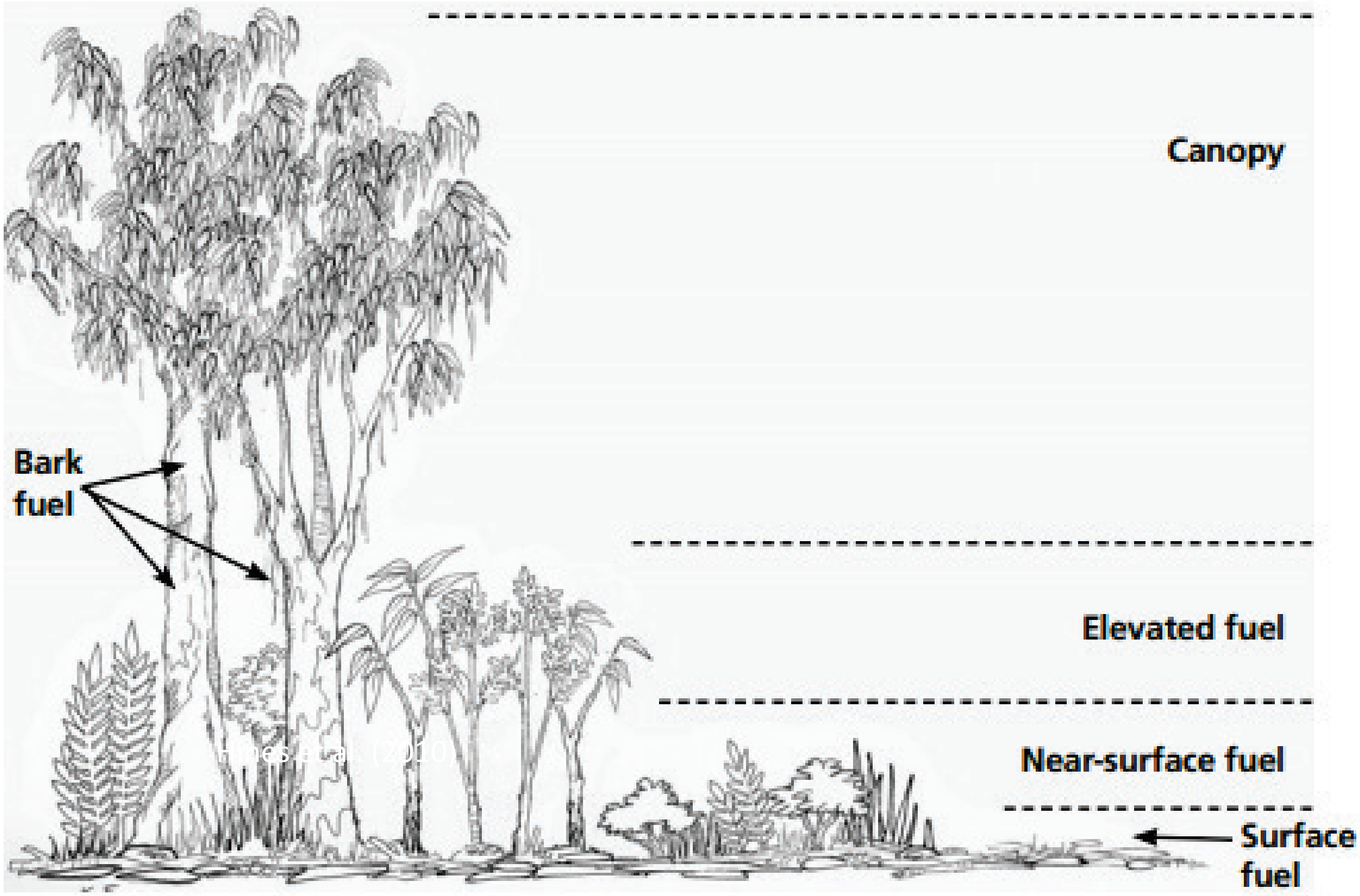


Filkov A., Cirulis B., Penman T. Quantifying dynamic fire behaviour phenomena using Unmanned Aerial Vehicle technology // MODSIM 2019. Canberra. (Accepted for publication)

Live Fuel Ignitability

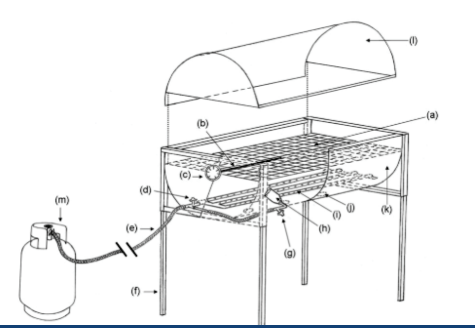
Context

Figure 2.1 Fuel layers and bark



Limitations of previous studies

- Extrapolation from leaf to whole-plant/fuel bed flammability
  - (Grootemaat et al. 2017, Dimitrakopoulos and Papaioannou 2001, Murray et al. 2013)
- Use of simple, uncontrolled and non-repeatable methods to measure shoot-level flammability
  - (References as pictured)
- Methods tested on building materials, not yet tested on live plants
  - (DiDomizio, Mulherin et al. 2016, Ji, Cheng et al. 2016, Vermesi, DiDomizio et al. 2017, Zhai, Gong et al. 2017, Kuznetsov, Filkov et al. 2015, Bilbao, Mastral et al. 2002)



Jaureguiberry et al. (2011)

Wyse et al. (2017)

Dent et al. (2019)

Aim

- to propose a new standardised methodology for testing ignitibility of live plant species and to determine the impact of different heating regimes and conditions on ignitability of live vegetation

Equipment

VHFlux:

1) Exhaust system
2) Shutter
3) Linear stage
4) Radiative panel
5) Control system
6) Power control box

Variable Heat Flux Apparatus (VHFlux)

Sample species

Acacia floribunda

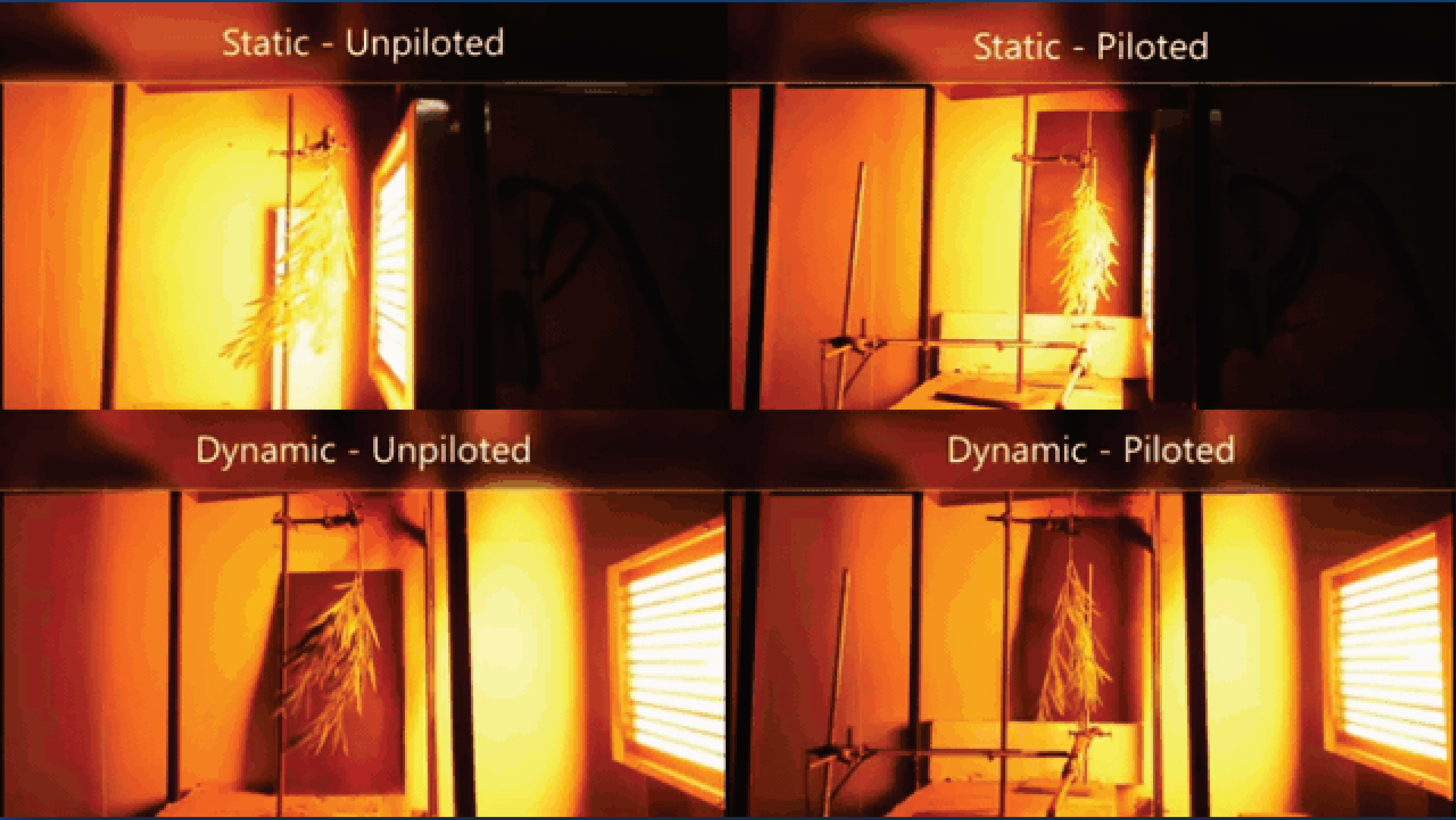
Cassinia arcuata

Pinus radiata

Bark from Eucalyptus obliqua

Species	Mean Moisture Content (%)	Porosity (φ)	Bulk Density (kg/m^3)
Acacia	52 ± 2.8	0.997	1.5
Cassinia	54 ± 1.6	0.996	1.3
Pine	66 ± 2.5	0.996	1.8
Bark	23 ± 16.9	0.167	166

Experiment types



Key results

- Time to flaming ignition for dynamic heating regime and piloted experiments were more than 4 times higher and 35% lower respectively
- A new standardised methodology for testing ignitibility of live plant species was proposed

An Alternative Approach to Test Fire Behavior of Construction Elements

AS-3959 – 2018 – Construction of buildings in bushfire prone areas

- AS-1530.8 – 2007 – Part 1 Radiant heat and small flaming sources
- AS-1530.8 – 2007 – Part 2 Large flaming sources
- 1530.4 – 2005 – Fire-resistance test of elements of construction

Limitations

- Heat flux profile
- Specimen size
- Effects of wind

Aim

- to analyse and compare the results of small- and large-scale fire test methods on engineered timber products to develop an intermediate test that accurately represents a large-scale test.

Test methods

- Small-scale radiant panel test (VHFlux apparatus, modified AS1530.3),
- Large-scale furnace test (AS1530.4 [1], section 3), and
- Control joint test (AS1530.4 [1], section 10).

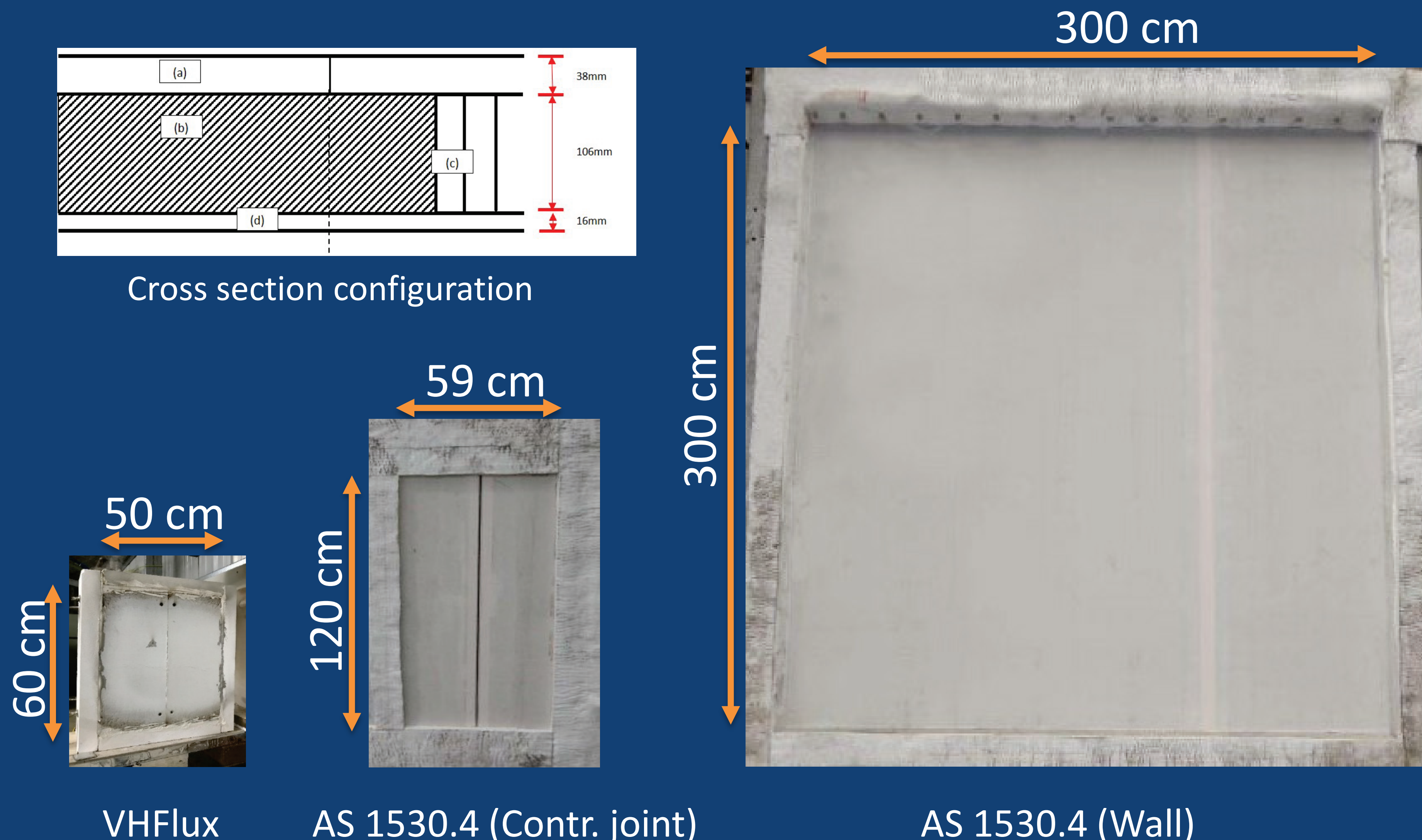


Fig. 1. Test samples: (a) Triboard, (b) Insulation, (c) Timber stud, (d) Cement renderboard

Results - VHFlux test

Test A

Test B

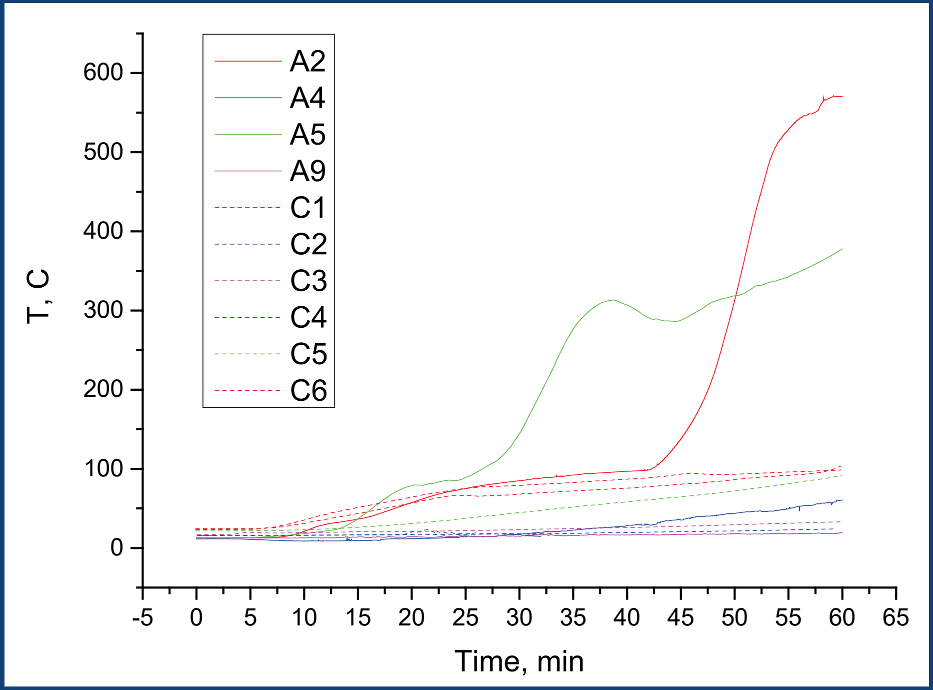
Photographs of the samples at the end of the tests

Results - AS 1530.4 test

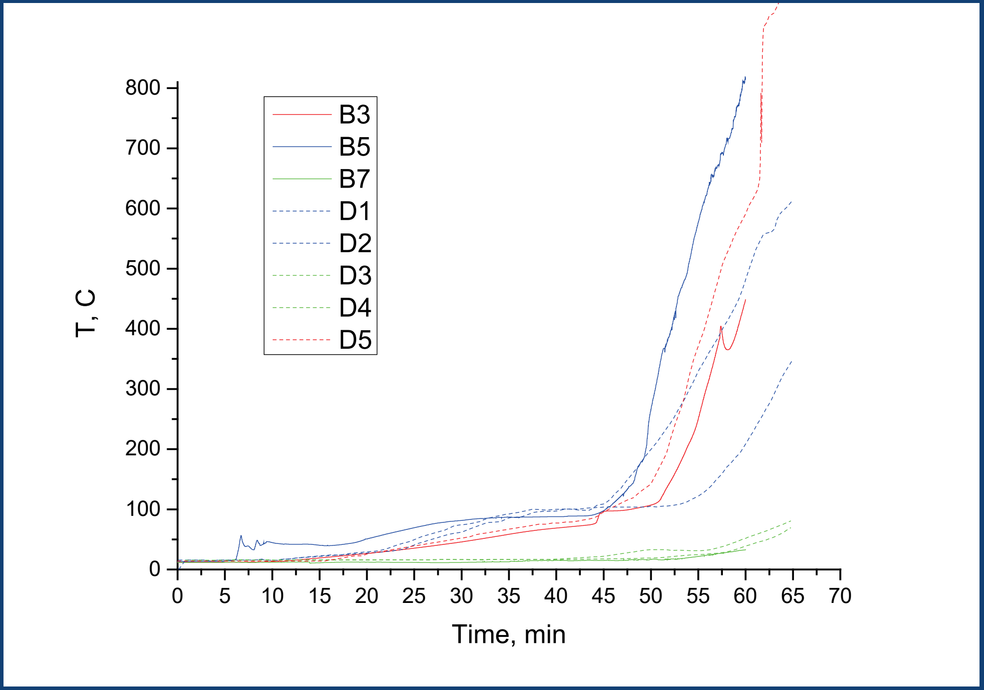
Test C

Test D

Photographs of the samples at the end of the tests



Tests A and C



Tests B and D

Comparison of temperatures between tests. Colour represents similar locations of the thermocouples and the type of line represents test.

Key results

- Dynamic heating is an important component of materials testing.
- Conducted research provides a preliminary foundation for the development of an intermediate fire test method.

UTILIZATION OUTPUTS

Obtained

- *Set of suggested optimal data collection protocols*
- *Prioritisation of dynamic fire behaviours*
- *Model for forecasting of crown fire potential at hourly to daily scales*
- *New method to test flammability and fire performance of natural and structural materials*

Expected

- *New tool to quantify fire behaviour phenomena for research, operation and management purposes.*
- *Development of guidelines for identifying environmental conditions causing the dynamic fire behaviour phenomena during operational fire behaviour analysis.*

Thank you for your attention!