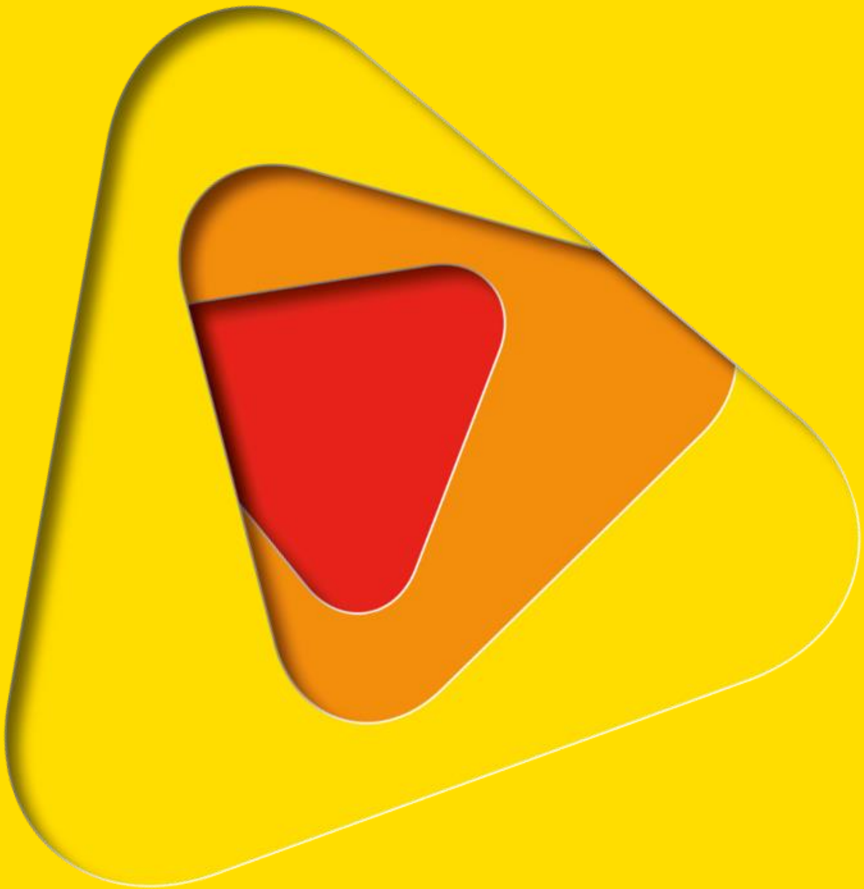
# MAPPING THE EFFICACY OF AN AUSTRALIAN FUEL REDUCTION BURN USING FUELS3D POINT CLOUDS

**Non-peer reviewed research proceedings from the Bushfire and Natural Hazards CRC & AFAC conference**
**Sydney, 4 – 6 September 2017**

**Luke Wallace[1,2], Karin Reinke[1,2], Simon Jones[1,2], Bryan Hally[1,2,3], Samuel Hillman[1,2] & Christine Spits[1]**
1) RMIT University
2) Bushfire and Natural Hazards CRC
3) University of Twente



| Version | Release history | Date |
|---|---|---|
| 1.0 | Initial release of document | 04/09/2017 |

**Disclaimer:**
RMIT University, the University of Twente and the Bushfire and Natural Hazards CRC advise that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, RMIT University, the University of Twente and the Bushfire and Natural Hazards CRC (including its employees and consultants) exclude all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

**Publisher:**
Bushfire and Natural Hazards CRC

September 2017

Citation: Wallace, L., Reinke, K., Jones, S., Hally, B., Hillman, S. & Spits, C. (2017). Mapping the efficacy of an Australian fuel reduction burn using Fuels3D point clouds. In M. Rumsewicz (Ed.), *Research Forum 2017: proceedings from the Research Forum at the Bushfire and Natural Hazards CRC & AFAC Conference*. Melbourne: Bushfire and Natural Hazards CRC.

# TABLE OF CONTENTS

# 1. INTRODUCTION

Fuel reduction burns are commonly used in fire-prone forests to reduce the risk of wildfire and increase ecosystem resilience. As such producing quantified assessments of fire-induced change is important to understanding the success of the intervention. Remote sensing has also been employed for assessing fuel hazard and fire severity. Satellite, airborne and UAV remote sensing, for example, have shown potential for assessing the effects of large wildfires and fuel hazard in areas of open canopy. Fuel reduction burns, however, often take place under dense canopy and result in little or no change to the canopy cover. As such terrestrial techniques are needed to quantify the efficacy of these burns.

This study presents a case study on the use of image based point clouds, captured terrestrially following the fuels3D methodology outlined in Wallace et al. (2016), for describing the change in fuel structure induced by a low intensity fuel reduction burn. The specific objectives of this study were to evaluate whether fuel structure maps produced from fuels3D point clouds are sensitive to the changes that occur during a low intensity fuel reduction burn, and how these changes may be quantified.

# 2. METHODS

## 2.1 STUDY AREA

The study was conducted in a lowland forest within Cardinia Reservoir, Emerald, Victoria (Figure 1). The overstory consisted of stringy and rough-barked eucalypts including Messmate stringybark Eucalyptus obliqua, Red stringybark E. macroyhyncha, and Narrow-leaf peppermint E. radiata The understory was dominated by Prickly tea-tree Leptospermum continentale), graminoid species (Thatch saw-sedge Gahnia radula, Spiny-headed mat-rush Lomandra longifolia) and Austral bracken (Pteridium esculentum).

An autumn prescribed burn was conducted by Melbourne Water on the 28 April 2016. Pre-burn field data and imagery was collected on the 11 March 2016 and post-burn data on the 5 May 2016. Three 10 m radius plots were subjectively located within the burn area. The plots were selected based on having varying levels of fuel hazard structure and to be close to known ignition points to increase the likelihood of the vegetation undergoing fire induced change.


(a) (b)

**Figure 1** – Images of the fuel state a) pre and b) post burn

## 2.2 POINT CLOUD GENERATION AND PROCESSING

Ten sets of approximately 38 images around subplots were collected with an Olympus OM-D EM-10 camera with a 14 mm lens within each plot. Each subplot was located pre and post burn based on distance and angle from the plot center to four control marks using a total station. Point clouds were generated from this imagery using Agisoft Photoscan Professional software version 1.2.3 (Agisoft LLC, Moscow, Russia). The high quality matching setting was used to generate a sparse point cloud. Following this, high quality and mild filtering settings were used to generate a dense point cloud. Scale and coordination of the samples was achieved by manually digitizing the location of the four control targets within 6 to 10 images per sample.

Metrics were then extracted from each point cloud to describing surface fuel height and cover, near surface fuel height and cover based on the three dimensional geometry of the point clouds. Near surface fuel fate was also calculated based on the spectral properties of the points.

## 2.3 FUEL LOAD AND FIRE SEVERITY ANALYSIS

Fuel load was estimated through a linear model which was created based on 10 post-fire samples for which dry weights measurements were made and aggregate vegetation volume (surface height*cover area + near surface volume*cover area) within the dry weight sample area. Four change metrics including; (1) total burnt area, (2) reduction in fuel load, (3) reduction in surface and (4) near-surface height and cover, were used to map and quantify the severity of the burn. The results were assessed against similar metrics collected following the Victorian Overall Fuel Hazard Assessment Guide (Hines et al. 2010) and Cawson and Muir (2008).

# 3. RESULTS

## 3.1 POINT CLOUD PROPERTIES

An example of a point cloud collected pre and post burn is shown in figure 2. Visually the point clouds appear to provide accurate representation of the fuel structure. The point clouds contain 67 points/cm$_2$ pre-fire and 110 points/cm$_2$. The collocated area captured between point clouds totalled 116 m 2 (or 37% of the measured area).

## 3.2 FUEL CONDITIONS

Visual assessment of the surface fuel layer indicated a "high" surface fuel hazard pre-fire, with an estimated litter depth of 35 mm and estimated fuel coverage at 80%. In comparison, the surface fuel height was estimated from the image based point cloud to be 14 +/- 2 mm (Figure 4), while fuel coverage was estimated at 83%. Post-fire visual assessment undertaken by the same observers also indicated high surface fuel hazard, with estimates of cover (80 – 85%) and litter depth (37 mm) slightly increasing. In contrast, the surface fuel height was estimated from the image based point cloud at 12 +/-2 mm, while fuel coverage also decreased to 76%. Following Hines et al. (2010) this suggests that the surface fuel represents a "moderate" to "high" fire risk as assessed by the point cloud method.

(a) (b)

**Figure 2 -** Example of a pre and post fire point clouds captured following the Fuels3D approach.

## 3.3 NEAR SURFACE FUEL CONDITIONS

Visual assessment of the near surface fuel layer indicated a high hazard both pre and post fire. Pre fire cover was estimated at 20% with an average height of 500 mm. 25% of this cover was estimated to be dead. In comparison, the near surface fuel height was estimated from the image based point cloud to be 40 +/- 10 mm (Figure 5). Cover was estimated at 41% with 33% of the near surface fuel indicated as being dead. Post fire cover was visually estimated at 25% with an average height of 500 mm, with 25 – 30% of the near surface cover estimated to be dead. In comparison, the near surface fuel height was estimated from the image based point cloud to be 24 +/- 7 mm (Figure 5). Cover was estimated at 35 % with 65% of the near surface fuel layer indicated as being dead.

## 3.4 FIRE SEVERITY AND CHANGE IN FUEL LOAD

The visual assessment of burnt area indicated 25 % of the area measured had been burnt. A slightly higher estimate of burnt area (37%) was derived from the image based point clouds (Figure 3). Utilising the model developed based on destructive samples the fuel load was estimated to have reduced by 12% between pre (7.87 t/ha) and post (6.91 t/ha) fire data capture.

# 4. DISCUSSION AND CONCLUSION

The fuels3D approach to quantify the efficacy of the prescribed burn suggests similar changes to fuel as those estimated through visual assessment. The new approach presented in this work, however, has several advantages over visual assessments. The approach allows data collectors to follow a simple method to quantify fuel hazard and severity metrics. In contrast to visual assessment, this removes subjectivity from the assessment process. Furthermore, the approach produces a quantified digital record of the landscape allows for decision rules to be revisited and the spatial products to be examined beyond those collecting the data in the field.

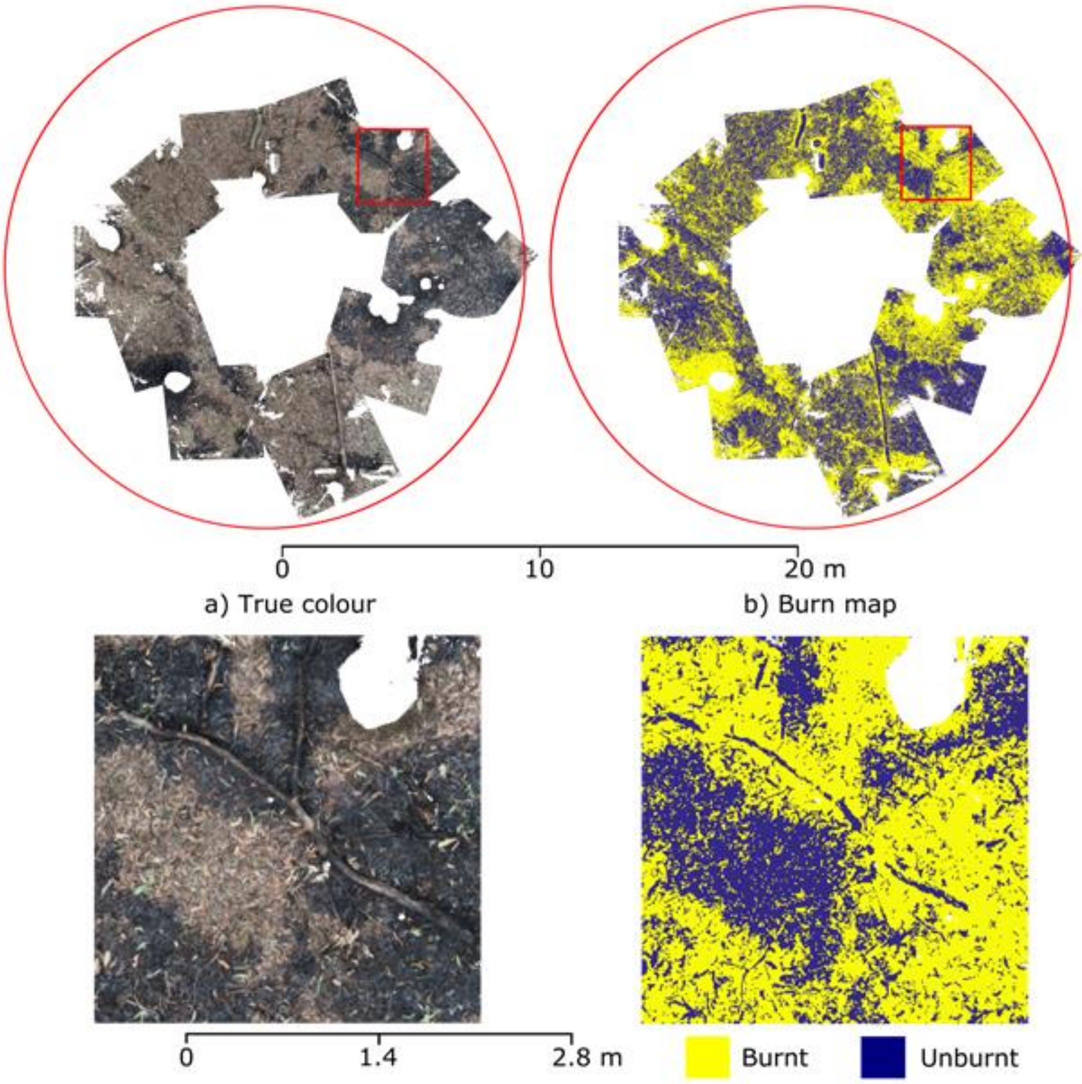


**Figure 3** - a) true colour orthophoto and b) map of burnt area derived from the post fire point clouds in plot 1. The upper images are of the entire plot while the lower images are taken from the red inset box.

# REFERENCES

Cawson, J., Muir, A., 2008. Flora monitoring protocols for planned burning: a users guide, *Fire and Adaptive Management Report No. 74.* Department of Sustainability and Environment, Melbourne.

Hines, F. Tolhurst, K.G. Wilson, A.A.G. & McCarthy, G.J., 2010. Overall fuel hazard assessment guide 4th edition, *Fire an adaptive management, report no. 82*.

Wallace, L. Hally, B. Reinke, K. Jones, S. & Hillman, S., Leveraging smart phone technology for assessing fuel hazard in fire prone landscapes. In *Proceedings for the 5th International Fire Behaviour and Fuels Conference*, International Association of Wildland Fire: Melbourne, Australia, 2016.