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DETERMINING THRESHOLD CONDITIONS FOR EXTREME FIRE BEHAVIOUR

Annual project report 2014-2015

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Version	Release history	Date
1.0	Initial release of document	26/10/2015

Australian Government
Department of Industry and Science

Business
Cooperative Research
Centres Programme

Publisher:
Bushfire and Natural Hazards CRC

October 2015

Citation: Duff T, Penman T, 2015, Determining threshold conditions for extreme fire behaviour: Annual project report 2014-2015, Bushfire and Natural Hazards CRC

Cover: Flames bear down on the Siding Springs observatory in NSW in 2013.

Photo: NSW RFS

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EXECUTIVE SUMMARY

This document summarises work undertaken by the University of Melbourne for the financial year 2014-2015 on the project 'Determining threshold conditions for extreme fire behaviour'. The project aims and general strategy are described, however as the project was authorised in June, 2015, there has been limited opportunity for achieving project goals.

END USER STATEMENTS

Dr Simon Heemstra, *A/ Group Manager Community Resilience | Operational Services, Rural Fire Service, NSW*

I am pleased the project contract has been signed and look forward to the project commencing work soon.

Dr Neil Burrows, *A/Director Forests and Ecosystem Management, Parks and Wildlife WA*

A better understanding of threshold condition for the transition of 'surface' bushfires to 'extreme' bushfires is crucially important for hazard management, bushfire suppression and the safety of firefighters. I'm pleased to see this important project is underway and encourage all jurisdictions to provide relevant data to the researchers.

PROJECT SUMMARY

Fire behavior models that predict the progression of bushfires are becoming increasingly important in management. Most existing models have been developed based on data and observations of fires burning under relatively mild conditions. If the models are to be relied upon for fires that occur under extreme weather conditions (where fires are fast moving and more intense), these conditions must also be considered in their design.

There is increasing evidence that there are particular fire phenomena that occur only in extreme fire conditions. These include fire tornados, atmospheric coupling, ember storms and vorticity driven lateral spread. Research into such phenomena is limited, there is still much to learn about when they occur and what their effect is on fire behavior. Currently there are no operational fire spread models that can accommodate these important effects. To account for these phenomena, it is first necessary to describe them and the conditions under which they occur, including fuel conditions, surface weather and atmospheric profiles.

This project is designed to build on our knowledge of the unique features of extreme fires by a) Collating observations of extreme fires that have occurred in Australia in recent years, b) Analysing fire phenomena in conjunction with accessory information (ie. Weather, fuel and topography) and c) Developing mathematical relationships to describe important fire phenomena.

PROJECT STRATEGY

The objectives of this project will be achieved by undertaking three overlapping research activities:

Collation of fire Behaviour observations

This activity aims to create a database of observations of extreme fire behaviour for use in model development and verification.

This will be achieved by working directly with Governement Agencies to develop reconstructions of past fire events. This will include structuring a database, standardising data formats and processing historic reconstructions. This will involve collating both fire data and accessory data (weather observations, forecasts etc.) This part of the project will include an audit of existing datasets, including analysing the work of Monash University and the Highfire risk project.

The information collected as part of this process is expected to be useful for other Bushfire and Natural Hazards CRC projects, in particular those focused on understanding extreme fires.

Understanding extreme fire weather and fire behaviour

This activity is intended to determine the existence of thresholds in fire and environmental conditions (weather, fuel, topography) that lead to fires exhibiting extreme phenomena such as fire tornados and ember storms.

This will be achieved by using data pertaining to past fires to identify processes that lead to extreme pheomena. This will include analyzing smoke plume observations obtained from Bureau of Meteorology Weather Radar, 3D numerical weather predictions and impact maps. These sources will be used to determine a number of fire related parameters including the strength of convective winds, spotting patterns and profiles of fire energy release through time. This information is expected to allow an understanding of the processes and thresholds behind the occurrence of extreme phenomena.

Determination of factors associated with extreme fire behaviour and development of predictive functions

The aim of this activity is to develop simple statistical equations to represent dynamic fire phenomena that can be integrated into existing fire behaviour models.

An analytical approach will be used to determine relationships between specific characteristics of extreme fire behaviour and the conditions under which they occur. This will include analysing the conditions on the ground (fuel, surface wind observations, temperature and relative humidity), fire properties (observed fire flame heights, rates of spread, spotting characteristics, smoke plume properties and suppression activity) and atmospheric conditions. Statistical methods will be used to determine if thresholds exist for which extreme fire activity occurs and to describe the nature of activity when it does occur. The approach will recognize the differences in fire size classes and incorporate effects that are relevant to the scale of the fires. These statistical models are intended to act as a substitute for complex physics based models to enable faster than real-time prediction of extreme fire behaviours.

EXPECTED OUTCOMES

The project is expected to produce outcomes of relevance to both the research and operational management communities.

It is expected to greatly improve the stock of knowledge of extreme fire events. 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 these to describe empirical relationships between fire phenomena and the key environmental conditions that drive their occurence. These relationships can potentially be incorporated into existing fire simulation systems. They can be also used as drivers for further research, including the verification of physics based models and the development of new theories of fire propagation.

The creation of a fire behaviour archive is also likely to be a valuable source of information for ongoing research. This information may be suitable for the evaluation of fire prediction models as part of the multi-agency predictive services project

CURRENT TEAM MEMBERS

UNIVERSITY OF MELBOURNE

Dr. Thomas Duff

Dr. Duff is a forest scientist in the Bushfire Behavior and Management Group at the University of Melbourne who works on applied problems in landscape fire management. He works on a broad range of topics, including fire simulation, ecology and operational research.

His doctoral research focused on methods to better understand the way plants vary through the landscape in response to environmental pattern, including fires, variation in weather and soil. Prior to returning to study, Thomas worked in native forest management (with a focus on fire), a development project in Vietnam, and more recently, as a consultant in native and plantation forestry throughout the Asia-pacific.

Dr. Trent Penman

Dr. Penman is bushfire risk modeller working on all aspects of bushfire management at the University of Melbourne. His role covers a range of theoretical and applied aspects of bushfire behaviour and management.

A key focus of his research is optimising management expenditure to reduce the risk of detrimental fire impacts on people, property and the environment. A secondary focus is examining landscape drivers of fire behaviour. Involving fire researchers from Australia and the USA, this work seeks to the relative influence of the four main drivers of fire extent – fire weather, ignitions, biomass and fuel moisture. Results of these studies are being used to determine the extent to which humans influence fire regimes.

His also fulfills a substantial teaching role at The University of Melbourne, teaching undergraduate and masters level subjects on bushfire science.

PROJECT END USERS

Dr. Simon Heemstra - A/ Group Manager Community Resilience | Operational Services, Rural Fire Service, NSW

Dr. Neil Burrows - A/Director Forests and Ecosystem Management, Parks and Wildlife WA