PROJECT IGNIS – Quantifying Catastrophic Bushfires

Milestone two close-off report

May 2019

Executive Summary

Supporting electricity networks to have a better understanding of continued investment in activities that reduce the risks to their assets caused by natural events is important. This project is to develop a standardised methodology for networks to assess the cost of a major bushfire event involving powerlines and the benefits that may arise from management actions. The Project Implementation Committee have agreed to adopt the NERAG definition for Catastrophic bushfires noting this definition is used by Australian and State Governments and the Bureau of Meteorology. A methodology will be developed that has applicability nationwide while allowing for specific state and area analyses.

The following steps will be taken to produce the methodology:

» Phoenix Rapidfire will be used to model the fire

» The Phoenix modelled outputs will then be built on to estimate losses

» The loss values in combination with the economics will be combined to model the total costs from the loss cause by the bushfire event (tangible and intangible).

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Introduction/Background (as per ENA Business Case)

Currently there is no accepted approach to quantifying the consequences / benefits of undertaking bushfire mitigation investment.

Whilst it is relatively easy to assess the costs associated with an individual fire start event (e.g.: property damage, insurance claims, SAIDI and SAIFI impacts, cost of the fault response and repair, and fire penalty scheme costs, if applicable), these costs are typically inconsequential compared to the major bushfire event.

The challenge is made difficult given that a catastrophic bushfire event is very rare; however, it is widely acknowledged that it is a real risk to DNSPs.

The last known study in this area was undertaken in 2001 by the Bureau of Transport and Regional Economics (BTRE) and is referred to in the Regulatory Impact Statement undertaken by Acil Allen (dated 17 November 2015); see section *3.2 Costs related to Bushfires*:

https://www.energy.vic.gov.au/safety-and-emergencies/powerline-bushfire-safety-program/electrical-safety-bushfire-mitigation-further-amendment-regulations-2016

A comprehensive update to these two reports would also be particularly useful when submitting bushfire-related funding applications to the Australian Energy Regulator. An industry supported and credible reference for funding applications would provide a stronger basis for bushfire mitigation related investment (and therefore greater risk reduction).

DNSPs must also demonstrate that the ALARP principle is being addressed when it comes to their bushfire mitigation risk management. This is difficult when a credible and industry-accepted value ($) of a major bushfire is not available.

This available information is severely out of date to the point where its relevance is now questionable.

A more recent report by Deloitte Access Economics in 2013 updated some of the information highlighted above, but the focus remained on insured losses, while the vast array of un-insured losses and flow-on effects caused by catastrophic events were not taken into account.

Industry and University Partners

The following are members of the Implementation Committee:

Project Partners	Organisation Representing
Sarah Mizzi	BNHCRC
John Bates	BNHCRC
Trent Penman (Research Lead)	University of Melbourne
Veronique Florec	University of WA
Kate Parkins	University of Melbourne
Brett Cirulis	University of Melbourne
Monishka Narayan	ENA
Ian Fitzpatrick (Implementation Team Lead)	Essential Energy
Dene Ward	Powercor
Frank Crisci	SAPN
David Wilkinson	United Energy
Bill Woods	AusGrid
Amir Sherkat	Western Power
Michael Emmett	TasNetworks
Stephen Martin	Powerlink

Project Methodology

STAGE 1- Scoping and initiation

The first phase of the project was a workshop and discussions with all researchers, project scoping team, API and ENA to confirm and refine the scope of the project. In the workshop, we had a consensus on the fire simulation methodology, management actions that were to be tested, range of assets to be considered and case study areas. It was an opportunity to discuss how existing insights from research and industry can be incorporated into the project and build on current knowledge on bushfire mitigation activities. After the workshop, a summary was prepared in the form of a minutes document, which outlined the results of the workshop, including the regions in which the methodology will be tested.

STAGE 2- Fire simulation

Estimating the cost of a major bushfire event requires an understanding of the potential fire extent and associated fire behaviour i.e. intensity, flame height and rate of spread. Fire simulation provides the most efficient means of estimating those values in a consistent manner over large geographic areas. Phoenix Rapidfire is an established fire simulator (developed through CRC research) which is used extensively in south-eastern Australia to model bushfires; that builds on two common fire behaviour models for Australian ecosystems. Phoenix is used commonly by fire management agencies to model bushfires however there are some limitations to the simulator- this project aims to address some of these within the below methodology.

Phoenix requires inputs of ignitions, weather and fuel loads. The following were parameters input into the model:

- Evenly spaced ignitions along identified powerline easements.
- Each ignition point was ignited under a range of Fire Danger Index (FDI) categories which have the potential to cause "major bushfires" (Severe, Extreme and Catastrophic).
- Fuel loads will be based on the current predicted fuel loads at December 2017.

Management actions that are tested will be relative to this baseline. Management actions that are tested were determined by the reference group in phase 1. The methods have been developed in a series of projects such as Penman et al. (2014a) for the Sydney Basin, Penman et al. (2015) for the East Central Risk Landscape in the Fire Danger Rating Project (funded through the BCRC/BNHCRC) and by UOM during the Schedule 17B project with BNHCRC 2016/2017. For each fire simulated, we will estimate the impact on each of the assets of interest.

Previously, modelling of fires using Phoenix Rapidfire has been used to assess costs of catastrophic bushfires on houses by fire management agencies, electricity providers and researchers. However, there are limitations with the approaches that have been used for these analyses. Recent work by the University of Melbourne has built on previous work and greatly enhanced the capacity of Phoenix Rapidfire to contribute to the estimation of impact on a range of environmental and human assets. These include agricultural assets, infrastructure, biodiversity and ecosystem services. In this project, Phoenix Rapidfire will be used to measure the impact of catastrophic wildfires on the range of assets under current conditions and alternate management strategies.

STAGE 3- Cost estimations

To estimate the cost of major bushfires, it is crucial to have information on the assets affected by the fires, the value attributed to them and the length of time the assets are unavailable to deliver a service. Different types of assets (e.g. property, life, infrastructure, threatened species, etc.) have different values and are affected differently by bushfire events. The project will take this into account to produce accurate estimates of bushfire impacts. For this project, costs of impact and electricity supply management will build on the existing work of researchers from University of Melbourne (including research on Phoenix RapidFire) and integrate this knowledge with research undertaken by the University of Western Australia who have developed a database of values for intangible assets and have done extensive work on estimating the value of tangible assets affected by bushfires. Within this project, the existing work will be extended to develop regional cost values for relevant assets.

To understand the difference between projected economic losses and actual losses from the (tangible) assets affected, information on insurance payouts can be used as an indicator, provided that the data is available and accessible to this project. However, it should be noted that not all losses from major bushfires are captured by insurance payouts and a substantial proportion of economic losses remain outside the insurance sphere. Some important questions to consider are; what proportion of total losses is captured by insurance information? How does this vary between regions and states? These questions may be answered, if appropriate insurance data is obtained.

STAGE 4 - Application of a Bayesian Network

In the final stage of the project, fire simulation modelling and cost data will be brought together and analysed in a Bayesian Network (BN). BNs are an excellent risk modelling tool as they account for the distribution of potential values and uncertainty associated with those values. BNs have been used in fire risk modelling in Australia, Greece, southern Africa and the USA. These models can be extended to include the cost of management actions and the impacts on assets thereby allowing for comparison across multiple strategies. The model will estimate per fire costs and annualised costs when combined with the likelihood data of the agencies involved. Models will be specific to the geographic location for which it was developed. Outputs of the models will be a simple metric of cost (tangible and intangible) that will allow comparisons between locations or across electricity networks.

Results

Milestone 2 reflects phase two of the project's methodology. Supporting documentation has been provided as Attachment 1 and Attachment 2.

Highlights of the milestone are:

- A data request was sent to the implementation team to collect data for the four case study regions, as decided in milestone 1 of the project. Case study regions include, Mount Macedon (VIC), North Hobart (TAS), Adelaide Hills (SA) and Blue Mountains (NSW).
- The data request, requested the following:

i. Agreement on the location of priority 1 and 2 study areas, via an attached shapefile.

ii. Shapefile of powerlines with the potential to cause wildfire ignitions

iii. Shapefile of assets in the landscape relating to electricity

iv. Shapefile of other assets specific to the landscape

- Fire simulations were completed by the University of Melbourne with the following outputs:

State	Region	Ignition points	Weather streams	Total fires
VIC	Mount Macedon	1174	42	49,308
TAS	North Hobart	1999	26	51,974
SA	Adelaide Hills	1783	46	82,018
NSW	Blue Mountains	650	40	26,000

Next Steps

Phase three of the project has commenced (refer to methodology section). Milestone 3, which is in conjunction with phase three is currently in progress. Refer to the milestone table below, which reflects the milestone status within the project.

Milestone	Description	Status
Milestone 1	Stakeholder workshop	Complete
Milestone 2	Progress report	Submitted. Awaiting approval from ASTP-API committee
Milestone 3	Preliminary data analysis discussion via teleconference or face to face meeting	In progress
Milestone 4	Completion of final report	Not yet commenced

The next implementation team meeting is being organised for the June/July period. A variable period has been given to organise meeting #4, due to the end of financial year requirements within individual workplaces'.

Recommendations

Based on the evidence provided in Attachment 1 and 2, Milestone 2 has been completed and therefore the CRC recommends that approval and payment should be made accordingly.

Project Challenges

The Implementation team for the project have had three meetings to date. Throughout the second and third meetings for the project, the implementation team have begun to discuss utilisation approaches for not only the core networks that are involved in the project, but other stakeholders both within and external to the electricity industry. There have been a variety of robust discussions and suggested pathways to be support awareness, dissemination and utilisation of the methodology. Specifically, there has been significant discussion on the order and timing of engagement with certain stakeholders and the most appropriate personnel to represent the project in those discussions.

The implementation team have expressed that they believe ENA should play a key role in participating in these discussions with potential stakeholders when the time is appropriate. Due to the significant role that ENA plays in the electricity sector, in providing opportunities for knowledge sharing and raising awareness of critical issues of importance to networks, the project could really benefit from ENA's expertise on this aspect of the project. Unfortunately, an ENA representative has not been able to attend two out of three meetings, to contribute to the utilisation discussions and to help the Implementation team to understand ENA's preferences in their role in supporting awareness, dissemination and utilisation of the methodology with key organisations beyond the networks, such as the AER. The Implementation team is looking forward to ENA being part of future discussions and contributing their expertise accordingly.

Appendix

Risk Table (from original Project Plan)

Risk	Level (high/Medium/Low)	High level management strategy
Failure to recruit research staff	Low	Suitable staff have been identified. The Centre for Environmental Economics and Policy (UWA) is well connected and can bring other skills to support staff if needed.
Research staff leave the project	Low	Reallocation of workloads to other suitable project members.
Mismatch between economic and simulation data	Medium	Inception meeting to define project scope and assets. Regular meetings with UWA and UOM to ensure alignment of approaches.
Limited access to in-kind resources via Project Scoping Team	Low	CRC will work closely with the industry representatives to retain interest in the project and will seek advice from API and ENA as required.
Limited access to industry data	Medium	Develop a plan with all project stakeholders on suitable alternate sources of data to be used and circulate agreed data access.
Communication failure between UoM and UWA	Low	Establish a communication strategy in consultation with the BNHCRC and agree on a set of project communication tasks.
Failure to deliver project to budget	Medium	Clearly identify out of scope items and present them at initial scoping workshop. Flexibility to reallocate resources and prioritise outcomes based on the Project Scoping Team advise and direction
Failure to deliver project to schedule	Medium	Communicate from the start of the project data needs and clear task descriptions for obtaining data in the format required

Milestone report endorsement by all industry members

The Implementation Team is led by Ian Fitzpatrick (Essential Energy) and is a representative on behalf of the networks for this project. Through consultation with the Implementation team, Ian has approved the closure of milestone 2. On request an approval email can be provided.

Attachment 1

30 August 2018

Dear Sarah,

I am writing in regards to the workshop on Wednesday the 1st of August 2018. This letter outlines our understanding of the work to be undertaken by the University of Melbourne, the data we require from the electricity providers to complete this project and a list of any outstanding information/key contacts we require.

The aim of this project is to develop a standardised methodology for assessing the costs associated with a catastrophic bushfire events involving powerlines. This project will have four stages.

1) Scoping and initiation
2) Fire simulation and modelling (University of Melbourne)
3) Cost estimation (University of Western Australia)
4) Application of a Bayesian Network (University of Melbourne)

The aim of this project is to develop a methodology and step-by-step guideline for how to assess risks and costs associated with catastrophic bushfires occurring from or near powerlines.

Phoenix RapidFire will be used to simulate the spread and subsequent impact of fires igniting from or near powerlines. Four case studies were identified in the workshop to develop and test the methodology (see maps attached). These were: Adelaide Hills in South Australia (key contact-Frank Crisci), Mount Macedon in Victoria (key contact-Dene Ward), the greater Blue Mountains in NSW (key contact- Ian Fitzpatrick), and Hobart Tasmania (suggested key contact- Wayne Tuckett?). A series of second priority locations were identified if time allows (see map attached).

For each case study region we will set the following parameters on Phoenix:

1) Weather patterns
    a. A series of days will be selected from Automatic Weather Station (AWS) records based on the Forest Fire Danger Index (FFDI) from 1994 to 2015 to capture variation in weather and its effects on fire behaviour. We will use the closest AWS stations for each study region. FFDI is a composite measure that combines temperature, relative humidity and wind speed with a long term drying index to predict the difficulty of fire suppression

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(McArthur 1967; Noble et al. 1980). Three weather types will be selected within each of these categories based on the predominant FFDI driver – i) strong wind, ii) strong wind with a significant directional change or iii) high air temperature. Up to three different days will be chosen for each of these driver categories resulting in a total of 54 possible weather days (6 potential FFDI x 3 drivers x 3 replicates). Each weather stream will contain hourly data for air temperature, relative humidity, wind speed, wind direction, drought factor and curing. All weather streams will cover a 24-hour period beginning from midnight to allow the model to generate stable and realistic estimates of fuel moisture.

2) Ignitions
    a. Ignition locations will be constrained to the location of powerline. Powerline locations will be provided by the relevant organisation for each study region (see below). Density of ignitions to be determined.

3) Assets

   We will provide information through the simulations on the following:
    a. Area burnt/average fire size and intensity
    b. Building loss (residential, commercial, schools etc.)
    c. Life loss
    d. Major roads impacted (optional)
    e. Powerline length impacted above 10,000 kw/m
    f. Carbon released (optional)
    g. Water catchment area (ha) affected
    h. Agricultural losses (industries affected, livestock or crop losses, plantations, fencing etc.)
    i. Other area or point based assets (i.e. stations, power lost etc.) to be provided by the relevant organisation
    j. Other essential services can be included if provided by the relevant organisation they occur in the case study regions e.g.:
        i. Communications/electricity assets (supply loss, towers, state connections etc.)

4) Fuels
    a. Fuels will be considered at the maximum to look at maximum possible risk. The current project will not consider management actions in the landscape or around the powerlines but the methodology will be flexible to incorporate these in the future.

Where possible VF will estimate the replacement cost for the assets listed above and these will be used in the Bayesian Network analysis. Specific requests from VF will be provided in a separate email.

Attached is a shapefile containing the study areas. For each study area, we require the following:

- Agreement on the location of priority 1 and 2 study areas. If there are concerns, please return a map (digital or hand-drawn) with the revised extent.
- Shapefile of powerlines with the potential to cause wildfire ignitions
- Shapefile of assets in the landscape relating to electricity
- Shapefile of other assets specific to the landscape

We would request these were completed by 9 October 2018 to ensure we have sufficient time to complete the work in accordance with the contract.

If you have any questions, please don't hesitate to contact me.

Kind regards

Assoc. Prof. Trent Penman

Bushfire Behaviour and Management
School of Ecosystem and Forest Sciences
4 Water St, Creswick
The University of Melbourne, Victoria 3363 Australia

Figure 1. Location of priority 1& 2 locations in south eastern Australia.

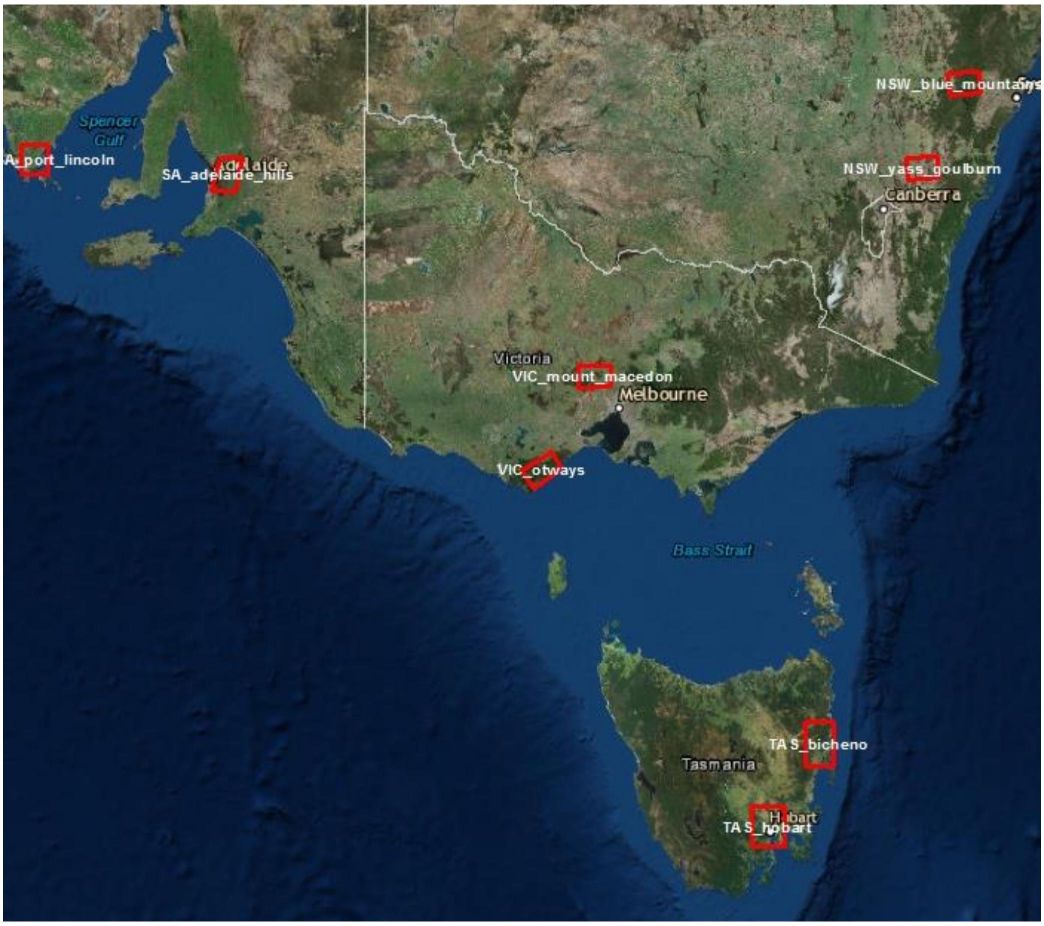

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Figure 2. Priority 1 – Adelaide hills, South Australia.

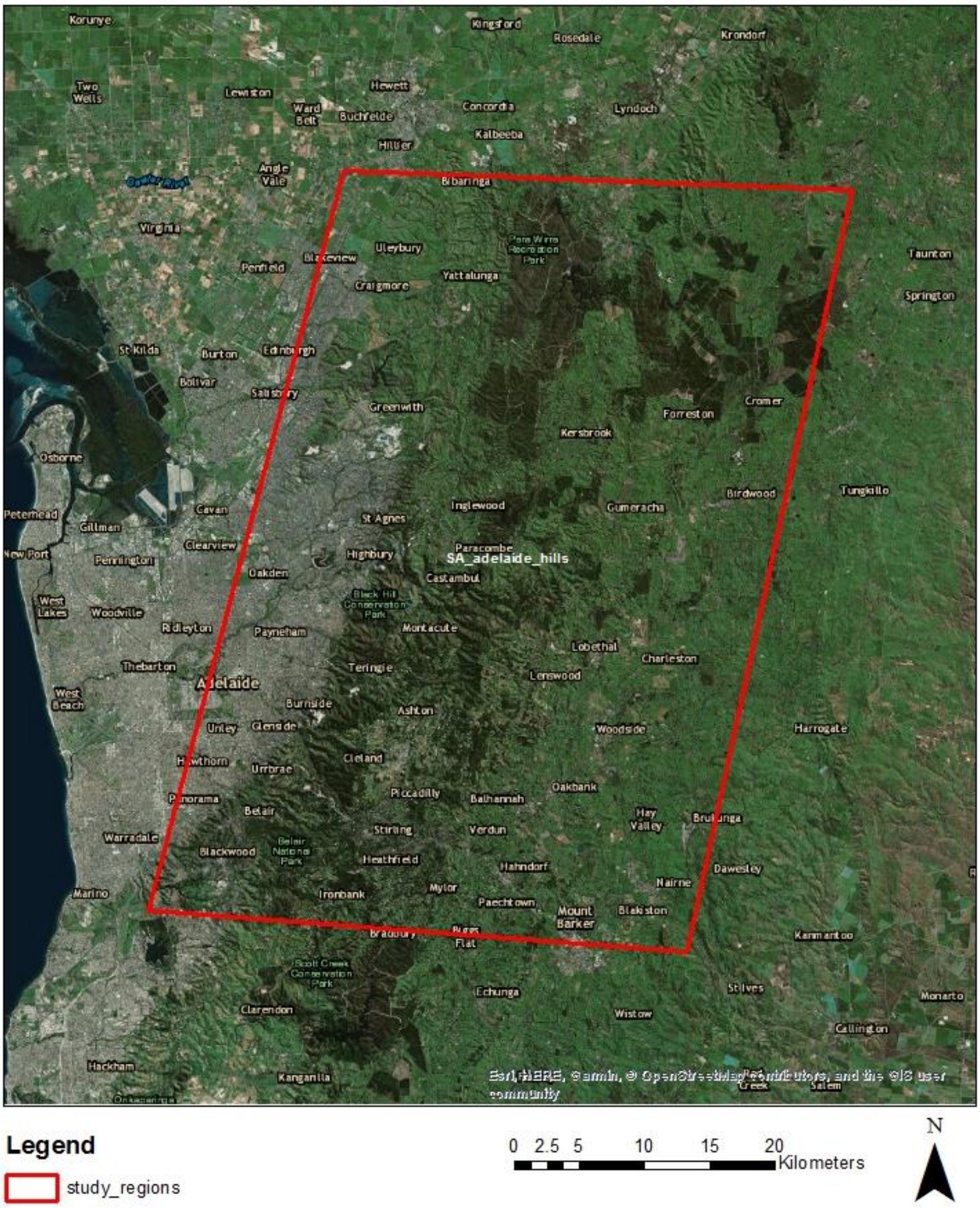

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Figure 3. Priority 1 – Blue Mountains, New South Wales

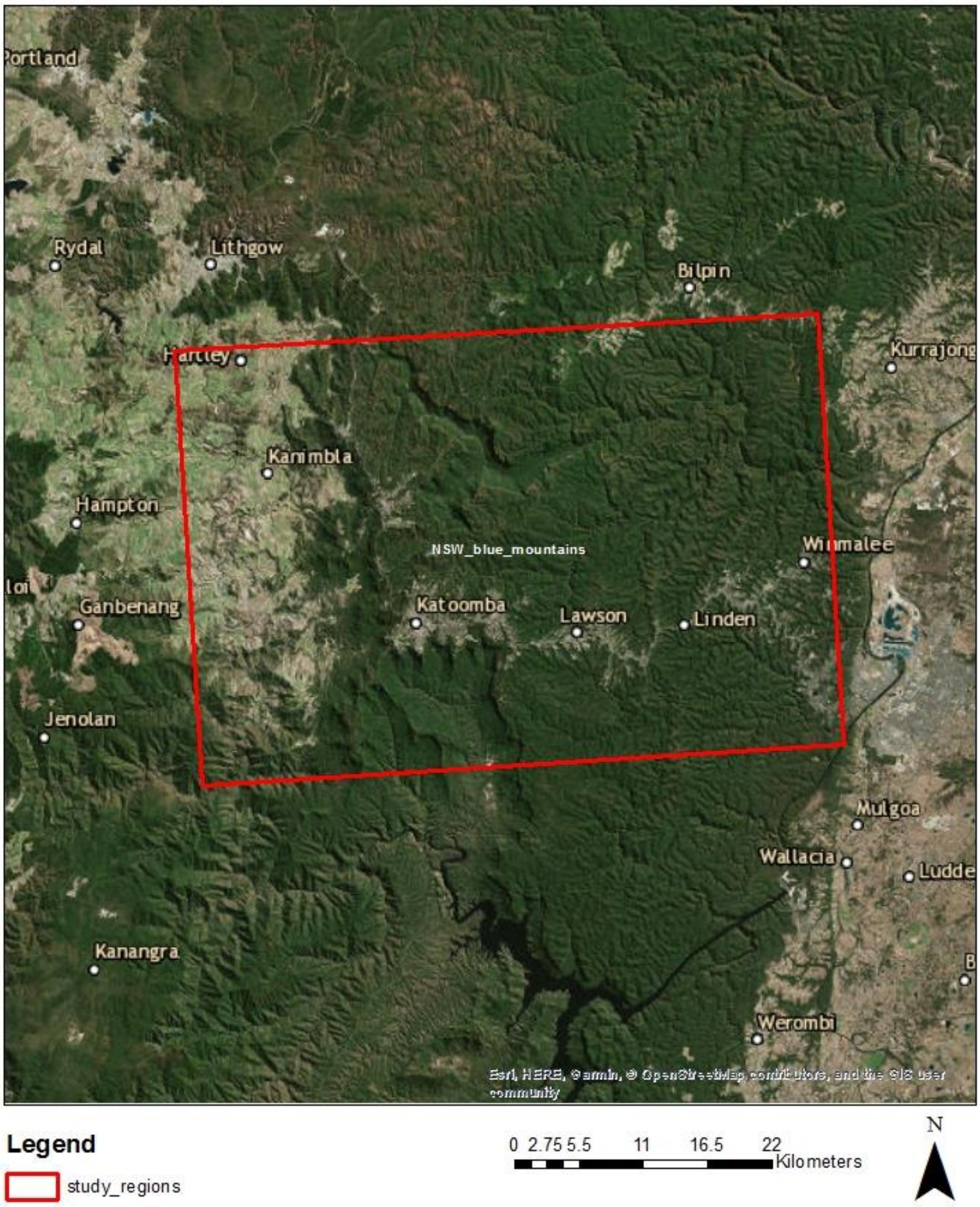

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Figure 4. Priority 1 – Mount Macedon, Victoria

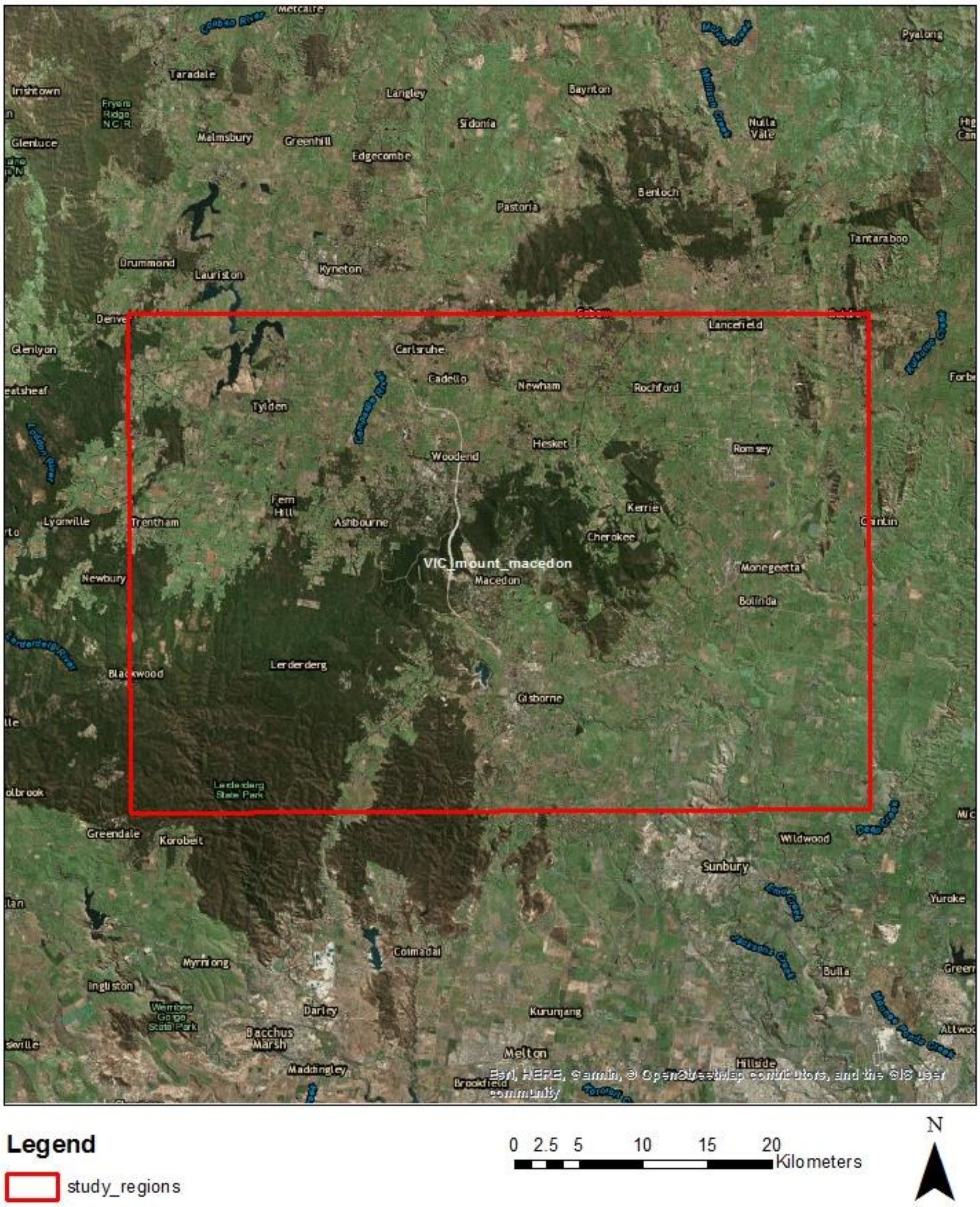

Figure 5. Priority 1 – Hobart, Tasmania

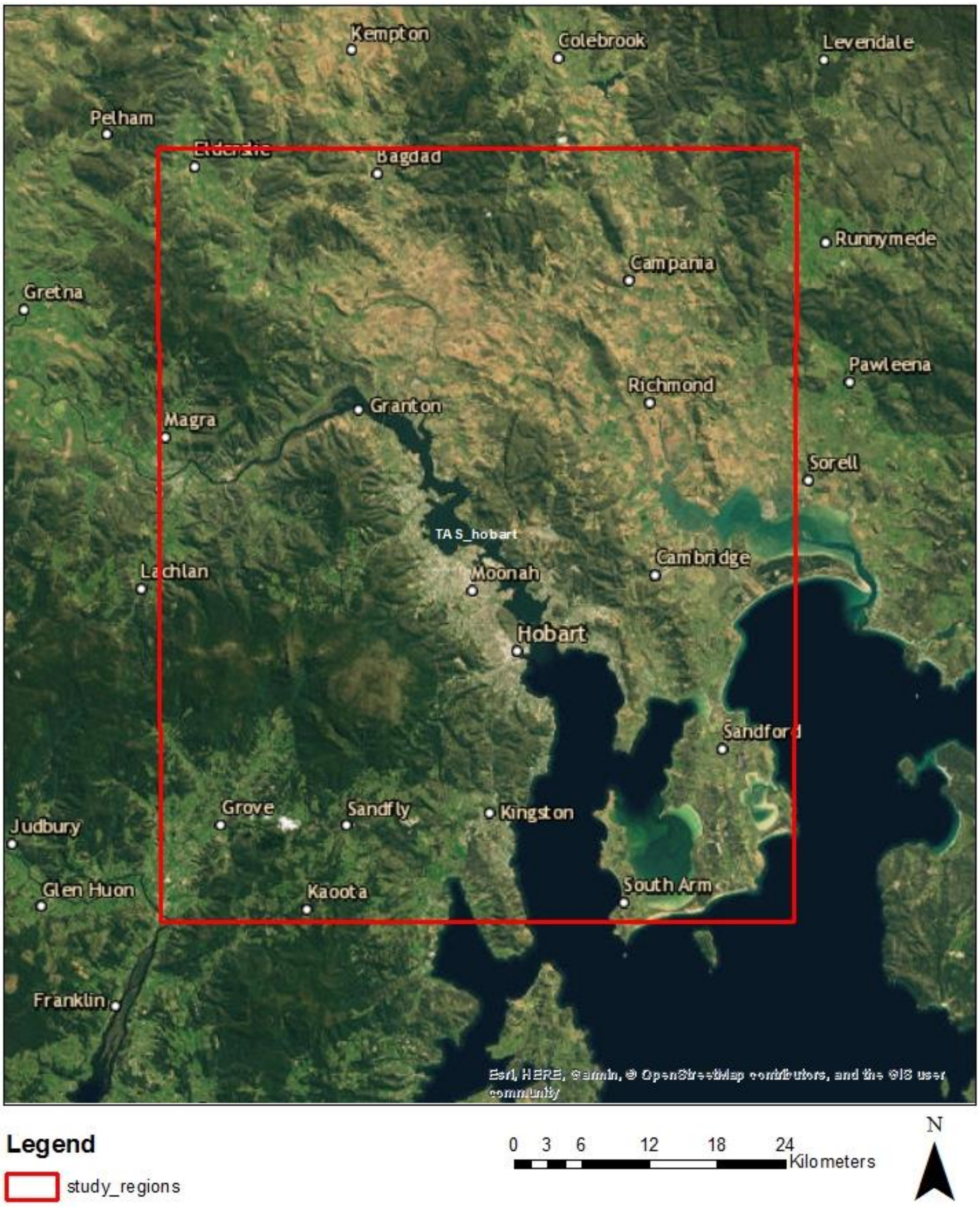

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Figure 6. Priority 2 – Bicheno, Tasmania

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Figure 7. Priority 2 – Otways region, Victoria

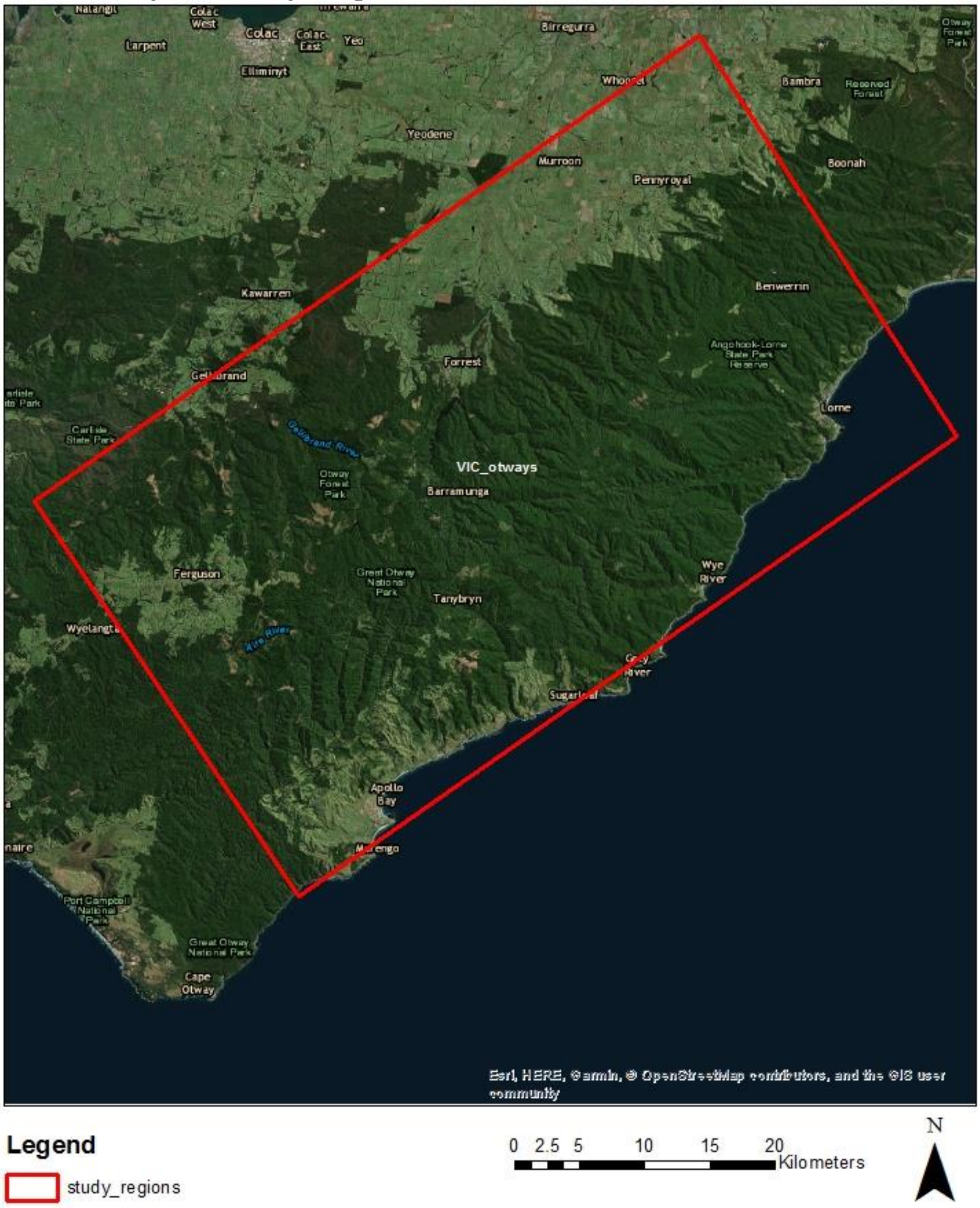

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Figure 8. Priority 2 – Port Lincoln, South Australia

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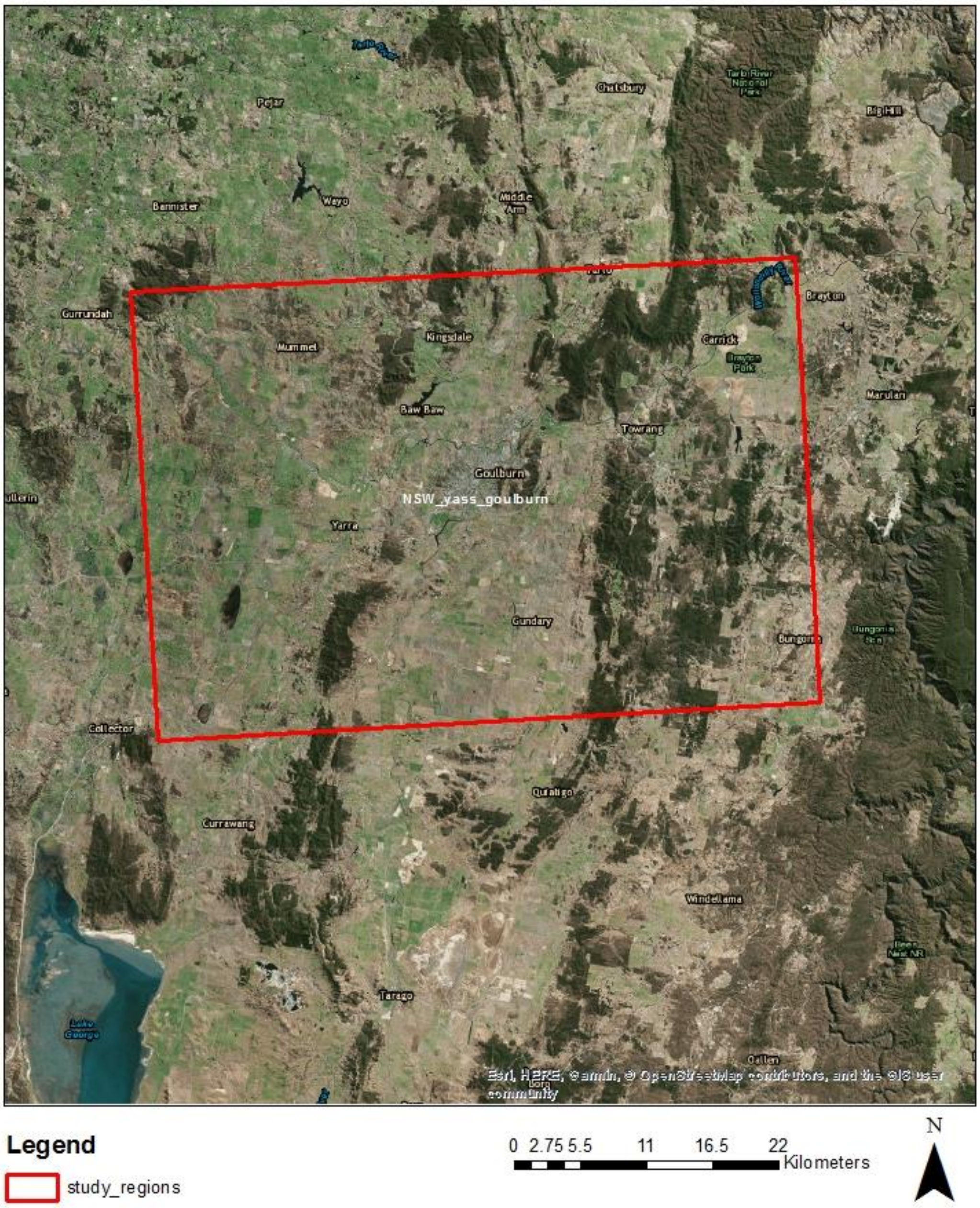
Figure 9. Priority 2 – Yass-Goulburn region, New South Wales



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Attachment 2

Sarah Mizzi
Director- Partnership Development
Bushfire and Natural Hazards CRC

20 December 2018

Dear Sarah,

I am writing to confirm the completion of simulation modelling as part of the ENA project. This letter outlines work completed by the University of Melbourne and future steps.

The aim of this project is to develop a methodology and step-by-step guideline for how to assess risks and costs associated with catastrophic bushfires occurring from or near powerlines. This project will have four stages.

1) Scoping and initiation (completed)
2) Fire simulation and modelling (University of Melbourne) (completed)
3) Cost estimation (University of Western Australia)
4) Application of a Bayesian Network (University of Melbourne)

Phoenix RapidFire was used to simulate the spread and subsequent impact of fires igniting from or near powerlines. Four case studies were identified in the workshop to develop and test the methodology (see maps attached). These were: Adelaide Hills in South Australia, Mount Macedon in Victoria, the greater Blue Mountains in NSW, and Hobart Tasmania.

For each case study region we set the following parameters on Phoenix:

1) Weather patterns
    a. A series of days were selected from Automatic Weather Station (AWS) records based on the Forest Fire Danger Index (FFDI) from 1994 to 2015 to capture variation in weather and its effects on fire behaviour. We used the closest AWS stations for each study region. Each weather stream contained hourly data for air temperature, relative humidity, wind speed, wind direction, drought factor and curing. All weather streams will cover a 24-hour period beginning from midnight to allow the model to generate stable and realistic estimates of fuel moisture.

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2) Ignitions
    a. Ignition locations were constrained to the location of powerline provided by the relevant organisation for each study region. The total number of ignitions varied per region (see table).

State	Region	Ignition Pts	Weather Streams	Total Fires
VIC	Mount Macedon	1174	42	49,308
TAS	North Hobart	1999	26	51,974
SA	Adelaide Hills	1783	46	82,018
NSW	Blue Mountains	650	40	26,000

3) Fuels
    a. Fuels were considered at their maximum to examine maximum risk.
4) Assets
    b. Impact on assets will be determined in the next phase of the project.

Veronique Florec will estimate the replacement cost for assets agreed upon in previous meetings. These data will be provided to the University of Melbourne to undertake the Bayesian Network analysis.

If you have any questions, please don't hesitate to contact me.

Kind regards

Assoc. Prof. Trent Penman

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