Hazard Note

Natural Hazards Research Australia

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Bushfires and power networks – identifying areas of highest risk in Queensland

About this project

Quantifying major bushfire consequences: A Project IGNIS case study was undertaken for Powerlink Queensland (Powerlink) by Natural Hazards Research Australia (the Centre) in partnership with the FLARE Wildfire Research Group at The University of Melbourne. The project used fire risk modelling methods developed previously by the Bushfire and Natural Hazards CRC's Project IGNIS in 2019 to quantify the potential impacts of bushfires to and from Powerlink infrastructure. Outcomes from this research support Powerlink to identify higher-risk locations across the transmission network, as well as inform internal decision-making processes about bushfire risk mitigation strategies, policies and operational imperatives.

Authors

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Learn more about this project online
naturalhazards.com.au/research/quantifyingbushfire

Summary

With the extent, severity and frequency of bushfires increasing due to a range of factors including climate change, in 2022 Powerlink and the Centre collaborated with the FLARE Wildfire Research Group at The University of Melbourne to understand the potential impact of bushfires on people, the environment and Powerlink's electricity infrastructure.

While operating in a natural hazard prone state, Queensland's high voltage electricity transmission network provider, Powerlink, is more used to dealing with flood and cyclone risks than fire. However, following catastrophic fire weather conditions in 2018 and 2019, Powerlink wanted to better understand the impact of bushfires started by natural causes and by network assets. Powerlink also wanted to improve measurement and management of bushfire risk across its network to ensure a safer, more reliable electricity supply for its customers.

Above: This research helps power transmission network owners identify higher risk locations for bushfires, as well as support and inform internal decision-making processes regarding bushfire risk mitigation.
Photo: Powerlink Queensland

With a network covering more than 1,700 kilometres, spanning north of Cairns to the New South Wales border in the south, Powerlink's network crosses a wide range of landscapes covering tropical, flat river plains and dry deserts to rich agricultural belts, elevated terrain and densely populated urban areas.

This project expands on and localises data developed by the Bushfire and Natural Hazards CRC's Project IGNIS in 2019, which did not include Queensland-specific data to best serve its landscape and unique bushfire profile and was more focused on distribution network failure rates. The PHOENIX RapidFire bushfire simulator was used to determine:

- the theoretical risk and impacts associated with an ignition on Powerlink's network
- where fires were most likely to start, either caused by Powerlink's assets or due to natural causes

The simulations factored in likely and extreme weather behaviour to capture probable and worst credible scenario fire impacts.

The project's findings support Powerlink's ongoing prudent commitment and investment to reducing bushfire risk (noting it is relatively lower than Distributed Network Service Providers (DNSPs)) across its network, as well as ensuring additional and specific bushfire risk mitigation activities and resources are targeted in areas of highest risk, leading to a safer, more resilient transmission network in Queensland.

Background

The Australian Energy Regulator requires electricity transmission operators to deliver modern, reliable systems and infrastructure that will continue to safely deliver energy in Australia's changing climate. This includes understanding and reducing the impact of bushfire on transmission networks and more importantly, ensuring transmission networks can continue to supply power – or are out-of-action for the shortest time possible – when faced with major and cascading natural hazards.

Project IGNIS, funded by Energy Networks Australia and conducted by the Bushfire and Natural Hazards CRC in collaboration with the University of Melbourne and The University of Western Australia in 2019, developed a way to measure the full impact of bushfire on electricity networks. This model enables researchers to identify and calculate the cost of fixing or replacing assets due to bushfire, as well as the cost of intangible impacts, such as injuries, lives, biodiversity, amenity, stress and mental health.

While Project IGNIS gave energy providers a consistent, research-informed, replicable method to measure the potential impact of bushfire on networks and the surrounding landscape, the project also assisted the operators to demonstrate the value of their current bushfire mitigation activities to the Australian Energy Regulator as part of their five-year reset process. The original project IGNIS selected several case study sites in different states to test the replicability of the methodology, however a Queensland case study was not part of the initial project.

This project allowed for further refinement and application of the original IGNIS model to the unique qualities of Powerlink's network topography and environment to identify and measure network and surrounding losses during major bushfire.

Research methodology

A four-stage fire risk modelling approach was used to determine the likelihood of bushfire occurring and measure the impact on networks, communities, the local environment and infrastructure.

1. **Landscape setting**
   Layers of landscape data were provided by Queensland Fire and Emergency Services (QFES, now Queensland Fire Department), with additional data developed for the project by FLARE Wildfire Research including levels of fuel, topography and disruptions in the landscape such as fire history and land use. This stage developed additional local data, such as a wider range of weather and fire ignition models, which contributes to the wider knowledge base of QFES and other bodies.

2. **Fire simulation**
   Using the PHOENIX Simulator and the landscape data collected in Stage 1, key fire properties such as intensity, rate of spread and flame height were simulated for the areas covered in Powerlink Queensland's network. These simulations took into account the type and condition of the vegetation covered by the transmission network, as well as the terrain and weather to build a detailed picture of the likelihood and location of bushfire, as well as to then track the fires' probable subsequent behaviour and spread.

3. **Asset exposure and loss functions**
   Detailed Queensland-specific economic modelling was undertaken, including the integration of individual asset information (e.g., spatial location), impact assessments under different weather streams (from loss functions and simulation outputs) and key economic information (direct/indirect costs and tangible/intangible impacts). Combining this data with asset loss curves and the fire behaviour models created in Step 2 enabled the potential cost of bushfire to and within Powerlink Queensland's transmission networks to be calculated.
   Annualised loss from the power transmission network calculated the potential cost caused by a fire started by Powerlink Queensland's infrastructure, helping identify parts of the network of greatest risk of starting a fire and what the potential impacts might be.

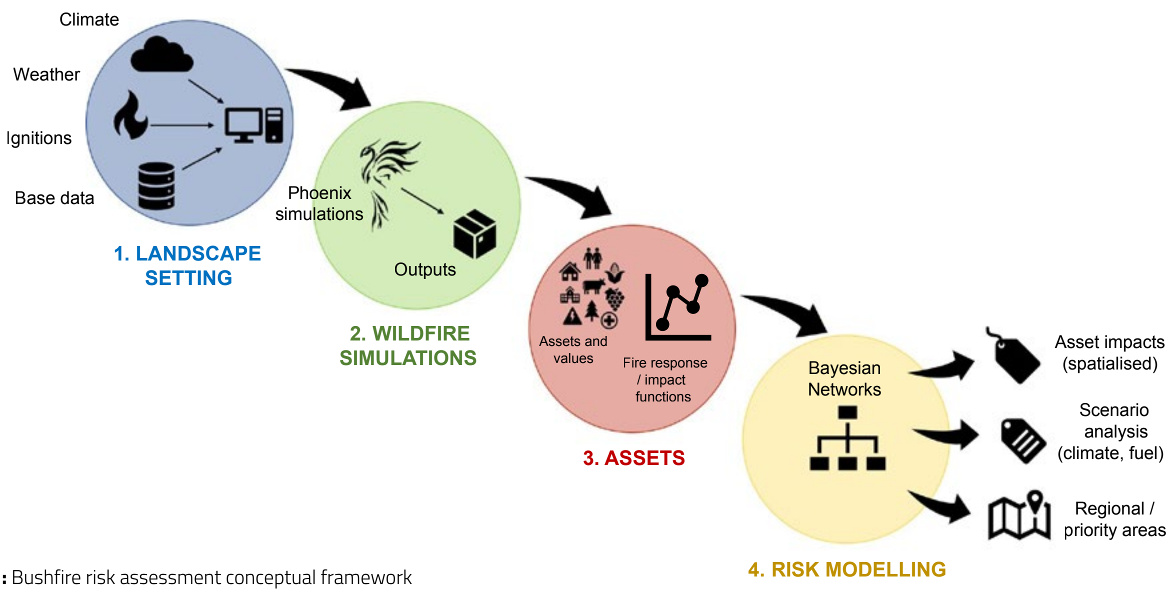

Figure 1: Bushfire risk assessment conceptual framework

Annualised loss to the power transmission network calculated the likelihood of bushfire damaging and/or disrupting Powerlink Queensland's infrastructure and transmission network, helping identify parts of the network most vulnerable to damage and/or disruption and what that might look like. Each annualised loss considered tangible and intangible costs, including houses, human, wildlife and stock lives, agriculture, environment and infrastructure.

4. **Risk characterisation**
   Bayesian networks are a statistical tool enabling the outcomes and benefits of different courses of action to be assessed and compared by showing the relationship between different variables. The research team developed a Bayesian network for each possible ignition point in Powerlink Queensland's network to map the probability of fire and its associated cost and impact. Bayesian networks developed for each probable ignition point included fire area, houses, lives, powerlines, crops, plantations and agriculture.

Findings

Risk from Powerlink's network

The highest consequence areas identified were often located in cities and towns with diverse topography and covered with fire-prone vegetation.

Bushfires with the largest burnt area were found to largely not correlate with the location of greatest economic impact, due to the density of assets, like houses and people, in towns and cities.

By burnt area

Figure 2 identifies locations along Powerlink's network with the largest predicted burnt area should bushfire occur. Lighter colour indicates larger burnt area, darker colour smaller burnt area.

By economic impact

Figure 3 identifies locations along Powerlink's network with the greatest economic cost due to bushfire. Lighter colour indicates higher cost, darker colour smaller cost.

The data identified locations where significant economic impact from bushfire started by Powerlink infrastructure could occur to inform additional and ongoing risk management and reduction activities. This identifies locations where Powerlink can put in place additional risk management and reduction activities to reduce potential losses from bushfire started by Powerlink infrastructure.

Risk to Powerlink's network

Locations identified with the highest consequence of damage to the Powerlink network from bushfire not started by network infrastructure are coastal areas to the north of the transmission network and highly urbanised areas.

Bushfires in and around urbanised areas were identified as more likely, however bushfires in more densely vegetated areas were identified as often resulting in larger, more severe fires due to the availability of fuel to burn and topography of the landscape making access and fire suppression activities difficult.

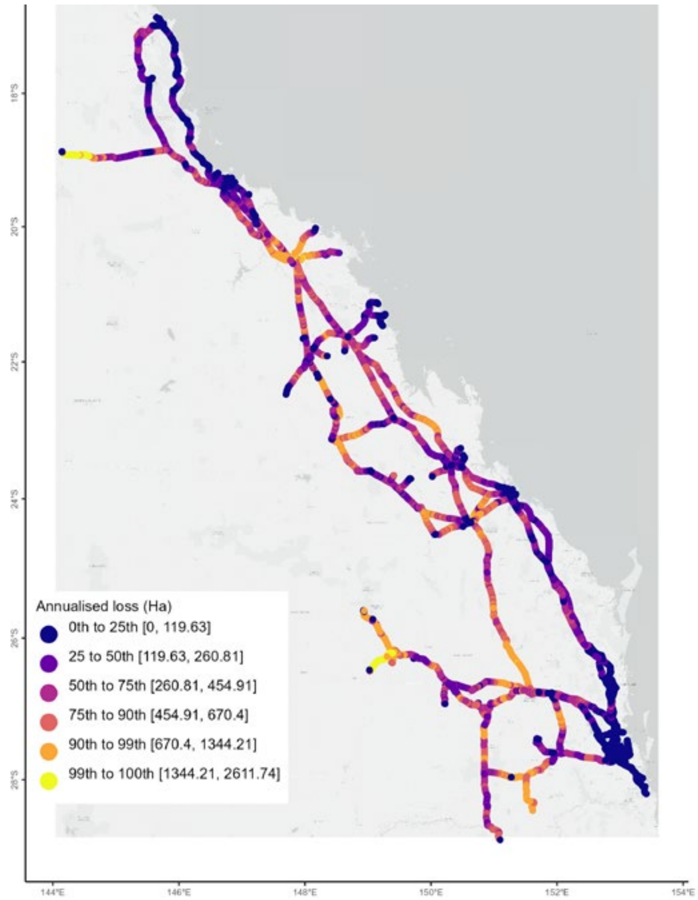

Figure 2: Asset loss by line ignition location – area burnt. Results are provided as annualised loss (hectares), with lighter colours indicating the higher risk locations.

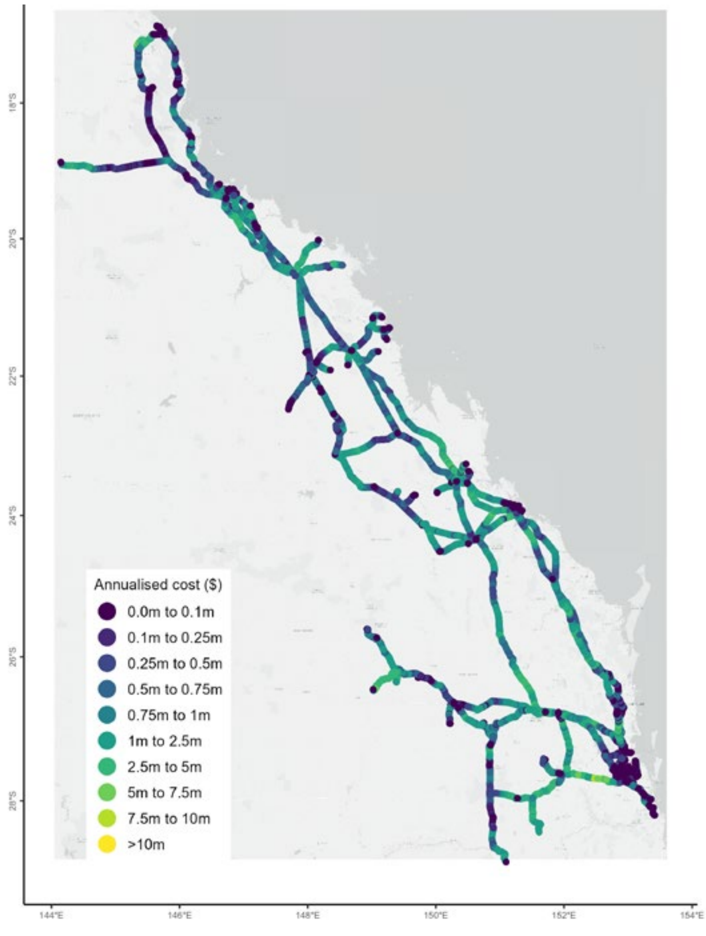

Figure 3: Total annualised cost ($) expressed as percentile classes, darker colours represent less cost, lighter colours represent higher costs.

Figure 4 identifies locations along Powerlink's network at highest risk of bushfire started in the landscape. Lighter colour indicates higher consequences, darker colour lower consequences.

While Powerlink isn't responsible for risk management and reduction in these areas, this data identifies locations of highest risk to the network where additional fire mitigation measures can be focused, as well as where future investments and network upgrades could reduce network disruption caused by bushfire.

Research impact

This project provided Powerlink with a methodology applicable across its network to identify areas at greatest risk of igniting bushfire, as well as a way to demonstrate its ongoing commitment and investment to bushfire risk mitigation activities internally and to regulatory bodies. The application of the original IGNIS model to Queensland's unique profile informs the development and delivery of consistent mitigation investment and planning activities, as well as adds to knowledge of the success of mitigation across Australia.

The research highlighted the resilience of the Queensland transmission network to and from fire.

Further reading

The following resources are available at www.naturalhazards.com.au/quantifyingbushfire

Parkins K, Bentley P, Cirulis B, Penman T, Florec V (2023) Power network bushfire risk characterisation – Powerlink Queensland final report, Natural Hazard Research Australia, accessible at Power Network Bushfire Risk Characterisation

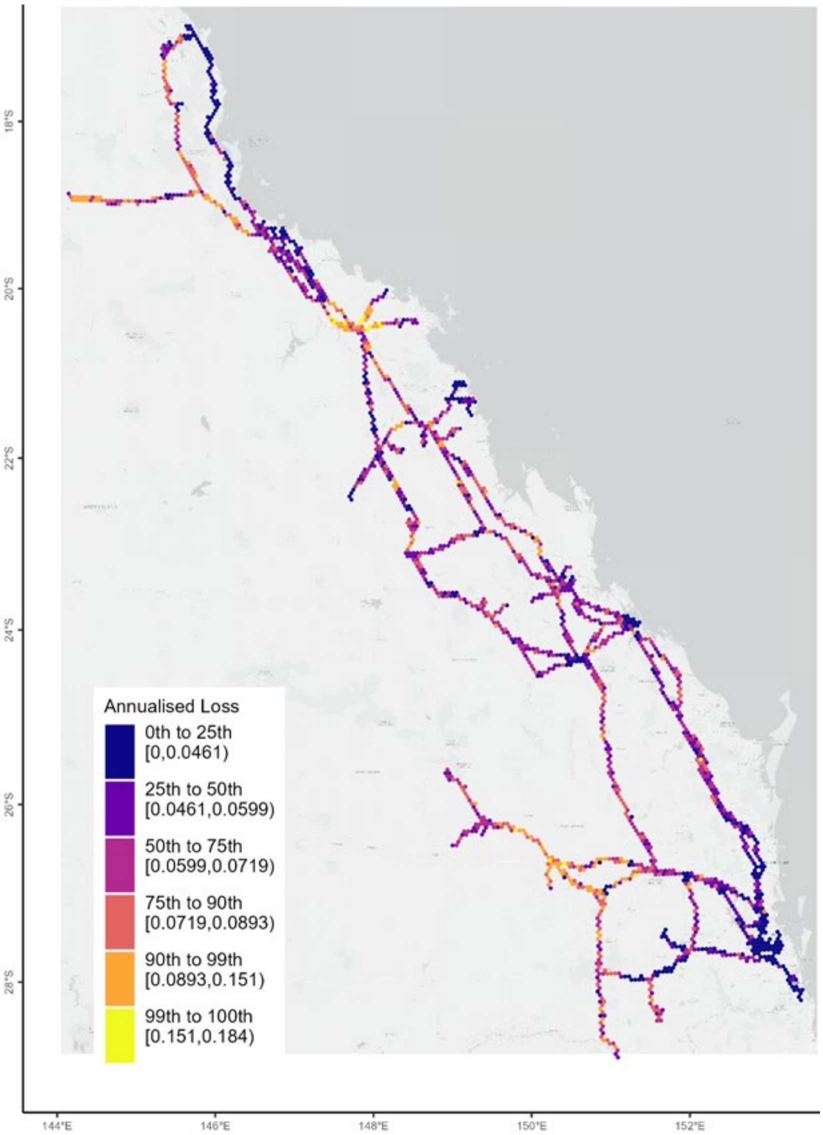

Figure 4: Total annualised cost ($) expressed as percentile classes, darker colours represent less cost, lighter colours represent higher costs.

End-user statement

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Powerlink Queensland highly regards the results of this research, and it will be applied directly to multiple use cases immediately across the business. Management of risks and assets are integrally linked to risks associated with bushfires, including investment, maintenance and operational decisions across the business. Our internal Bushfire Mitigation Working Group will review and coordinate the implementation of this research across the business. This will include consideration of integration with strategic partners including Queensland Fire Department and the Queensland Fire and Biodiversity Consortium. There are enhancements and additional questions that would add further value and we will explore further with Natural Hazards Research Australia and its research partners.

Natural Hazards Research Australia is the national centre for natural hazard resilience and disaster risk reduction, funded by the Australian Government and Participants.

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