

An integrated system to protect Australia from catastrophic bushfires

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Australia has experienced catastrophic bushfire conditions that exceed known firefighting technologies, leading to significant ecological, economic, health and social costs. We need a novel approach that harnesses modern technologies and that is successful in reducing the risk of large-scale bushfires under extreme conditions.

During the 2019–20 bushfire season, extensive areas were burnt largely because of an inability to detect and extinguish ignitions in remote areas before the fires spread and became uncontrollable. A large proportion of these fires were ignited by lightning strikes. The Australian National University (ANU) is undertaking advanced interdisciplinary research to develop an innovative national system to detect bushfires as soon as they start and extinguish them within minutes.

In collaboration with ACT Parks and Conservation Service and the ACT Rural Fire Service, ANU has developed an integrated research initiative encompassing 6 programs from fire prevention to suppression as illustrated in Figure 1.

Program 1: Prevention and risk reduction aims to evaluate the effectiveness of ecological fire-risk reduction strategies and develop the next generation of fire-risk models. Australian development of the ANU OzFuel infrared smallSat mission addresses the recommendations for efficient national monitoring of fuel conditions,

which are common to independent national and state inquiries while complementing national and international missions dedicated to rapid fire detection. This is the first step towards a coordinated effort to monitor eucalypt fuel conditions from space. OzFuel will provide critical bushfire earth observation data to support increased bushfire situational awareness and preparedness of government, frontline organisations and communities.

Program 2: Lightning forecasting and detection aims to develop capacity to rapidly identify which lightning strikes within an individual storm are most likely to cause an ignition. This allows for faster responses to fire detection and suppression. This capability relies on a revolutionary approach to both measuring and characterising lightning strikes and locating them accurately. Extensive research will be undertaken on the role of short- and long-term live and dead fuel moisture content together with other key factors that affect the probability of ignitions.



Figure 1: Key themes of the ANU Bushfire Research Initiative.

Program 3: Ignition detection is the core work being done by the ANU-Optus Bushfire Research Centre of Excellence, which is developing an optimised, integrated, layered, hi-tech solution to detect small fires. In the case of early fire detection, there is currently no single remote sensing platform that can do the job of surveying vast areas and detect a small fire. Geosynchronous equatorial orbit (GEO) satellites provide surveillance across Australia but may not identify small ignitions given current spatial resolution. Low Earth Orbit (LEO) satellites can detect smaller fires but only image the same location twice a day, at best. Optical and thermal detectors on both GEO or LEO satellites cannot ‘see through’ clouds. Drones have dynamic coverage and can be directed to high-risk areas, detect smaller fires than satellites and fly below cloud cover. Cameras on towers and on-ground sensors have limited spatial coverage per camera but can be strategically located in areas of elevated risk or conservation value. Given the advantages and disadvantages of each of the approaches, an approach that combines all these detection options is required for successful ignition detection.

This year, ANU has commenced the development and deployment of some of these technologies.

- The Ground-Based Low-Power IoT (Internet of things) Sensor Networks for Bushfire Detection and Situational Awareness project aims to design and implement a scalable ground-based IoT fire-detection system in the ACT using low-power wireless sensor devices. It will also provide situational awareness for reporting and predicting fire movement and risk.
- Automated detection using artificial intelligence (AI) and cameras on towers is being jointly developed with the Minderoo Foundation, the ACT Rural Fire Service, BushfireLive, Insight Robotics and the ANU-Optus Bushfire Research Centre of Excellence. Cameras have been deployed on 4 fire towers across the ACT to assess the viability of automated monitoring for early bushfire detection. In Australia the last major study of automated bushfire detection was conducted in 2010.¹ The trial showed early promise but demonstrated that automated bushfire detection was not ready for deployment. There has since been a revolution in imaging and image-processing technologies including high-quality cameras, a large expansion in parallel GPU computing and fast image processing and new techniques for deep learning. This has led to an exponential improvement in the performance of algorithms on vision problems such as detecting smoke or heat in an image using RGB and infrared cameras. Early results suggest that ANU methods leads to a higher rate of true positives than the baseline Faster R- CNN (Convolution Neural Network) object detection method.
- Drone networks are a cornerstone for fast identification, location and verification of bushfire ignitions due to lightning during dry thunderstorms. Drones provide enhanced detection and location of lightning strikes, detailed close-up sensor feedback to enable verification of ignition and tactical support for suppression activities following ignition verification. The current practice following dry lightning strikes is to deploy manned fire-spotting aircraft over

lightning strike areas the morning after a dry lightning storm. The delay in deployment relates to resourcing issues and restrictions on night flying. Drones can operate in time scales suited to successful ignition suppression. This project includes Beyond Visual Line of Sight of a single drone over the Brindabella Range in the ACT; onboard thermal camera technology; and an initial study capability to verify ignitions into the ACT Rural Fire Service data systems to provide situational awareness. The potential of drones to provide a communications hub for mobile firefighting services will be demonstrated.

- A comprehensive evaluation project compares different methods and technologies to determine the scenarios where each technology is most effective. This project will also establish a performance baseline of 000 emergency calls, observers in towers and current satellite capability. A comprehensive 5-year evaluation will include a substantial number of fires of different nature for purposeful results and conclusions.

Program 4: A data analytics and communications platform aims to create actionable intelligence by integrating high-resolution fuel availability information into the RedEYE FirePrep decision-support tool. This will identify areas where new ignitions are likely to result in rapid fire propagation that affects built and natural assets. Together with Zirkarta, the ANU-Optus



ANU-designed prototype water glider used to suppress fires while they are still small.

Image: Jack Gooday

