Peer-reviewed article

# Science in operations: QFES response to the 2018 Queensland fires

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## ABSTRACT

In late November 2018, Queensland experienced an unprecedented fire event, with more than 1,000 bushfires burning across the state. Fire weather conditions peaked on Wednesday 28 November, with 'Catastrophic' fire danger observed at Rockhampton Airport for over three hours. Over 1 million hectares of land were burnt, 479 post-fire damage assessments were completed, with nine homes destroyed and a further eight damaged.

Queensland Fire and Emergency Services (QFES) requested national resources to support both tactical firefighting and operational roles. In anticipation of forecast conditions on 28 November, QFES Manager of Predictive Services, Fire Behaviour Analyst (FBAN) Andrew Sturgess requested Bureau of Meteorologist (BoM) meteorologist and Bushfire and Natural Hazards Cooperative Research Centre (CRC) researcher Mika Peace provide support to the State Operations Centre FBAN team. In this paper, we share our personal experiences and reflections as well as those of the FBAN team.

In summary, we consider how the Queensland learnings may inform future events. Challenges include resourcing to develop teams with the appropriate capabilities and the ability to identify extreme conditions in advance.

## Introduction

The demand for meteorological information during the November 2018 Queensland bushfires was prodigious, particularly for real-time interpretation relating to fire behaviour. The BoM Embedded Met provided high-level briefings at the synoptic scale, while Mika as FBAN support provided weather intelligence relevant to fires at a meso- and micro-meteorology scale.

Inter-agency collaboration showed the benefits of multidisciplinary teams, as FBANs and meteorologists discussed specific weather impacts on fire behaviour at individual fires. These included variable wind conditions and potential plume development given consideration of vertical stability and available fuel. Inputs to Phoenix simulations were objectively assessed and adjusted to examine alternate scenarios and risks, including potential credible worst-case impacts to communities.

Frequent, detailed briefings were provided to the Queensland Disaster Management Committee chaired by the Premier, QFES Commissioner and Executive, the State Disaster Coordinator, Deputy Commissioner Queensland Police Service and Regional Operational Centres. These communications linked meteorology and fire behaviour, underpinned by scientific interpretation of real-time data, which was extremely valuable in informing operational decision making.

## The fire and weather situation

Preceding the November fires, conditions across Queensland had been hotter and drier than normal, with below average rainfall for several months, and above average temperatures for several years. This led to lower than average soil moisture and dry fuels, resulting in climatological conditions favourable for high intensity fires. The 'Northern Australian Seasonal Bushfire Outlook' identified above normal fire potential for the Central Coast, Whitsundays and the Capricornia parts of Queensland.

In late November there was an unprecedented extreme heatwave over northern Queensland coastal areas, with several locations breaking long-standing temperature records by a considerable margin. The heat, in combination with wind, elevated the fire danger well above climatological expectations. Several hundred fires burned across Queensland over two to three weeks during November and December.

On Wednesday 28 November 'catastrophic' fire danger was observed at Rockhampton, driven by westerly winds with a maximum of 51.8 km/h at 1500

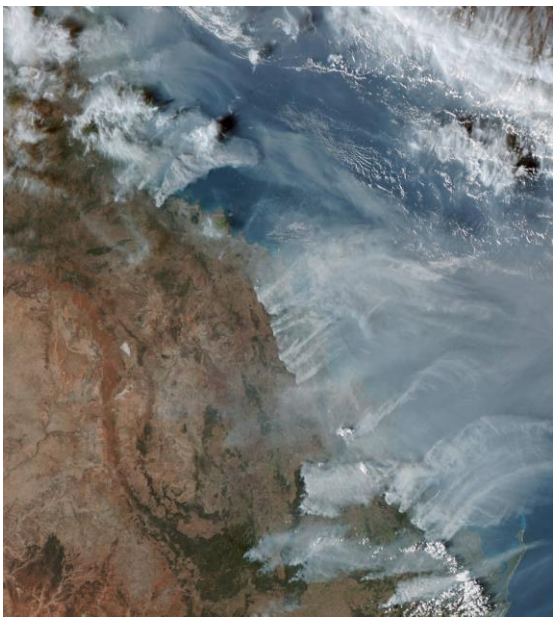

**Figure 1: Himawari satellite image showing smoke plumes from fires across Queensland on Friday 30 November 2018. Courtesy Bureau of Meteorology satellite team.**

hours. The winds circulated a low pressure system that was unusually intense for Queensland latitudes and the strong, dry, offshore winds were favourable for rapid fire spread across the dry landscape. Wednesday 28 November was the worst day in a protracted period of a campaign fire-fighting effort; the Gracemere fire, which had the potential to impact Rockhampton was just one of the fires of concern. Fortunately, no lives were lost; however several homes and a number of buildings were destroyed.

## Interagency collaboration and multidisciplinary teams

Detailed briefings and elevated emergency response started on Sunday evening 25 November. On Monday evening, Andrew contacted Mika to request assistance and on Tuesday evening she arrived in QLD to support QFES operations on Wednesday morning.

Over the following three days, Mika provided broadscale, mesoscale and microscale meteorological information, with direct interpretation on likely fire behaviour. Fire behaviour elements discussed included plume depth, organisation, structure and development. Spotting potential and direction were assessed, along with wind speed and direction and timing and variability of changes to wind fields. Other considerations included fuel moisture, topographic and coastal wind and fire interactions and potential risks to ground crews.

QFES FBANs used the Phoenix simulation software on the fires of most concern across the state. Mika worked with the FBANs, providing meteorological information, suggesting modifications to fuel moisture content and testing alternative 'credible worst-case scenarios' for wind speed and direction for the highest priority fires with regard to local assets and communities. Australian Digital Forecast Database grids were verified in real time against observations and the results were used to modify subsequent Phoenix simulations. Alternative scenarios based on local topographic effects and plume entrainment processes were tested. Phoenix perimeter outputs were verified against linescan imagery when available and this identified fire perimeter that were most likely to grow under changing wind conditions.

The information was relayed to firegrounds through mechanisms considered appropriate by the State Operations Centre (SOC) representatives, mostly through phone and video calls. Interpretive briefings were provided on request to all and sundry, including the SOC, Premier, Deputy Premier, Police Commissioner and QFES Commissioner.

The demand for meteorological information, tailored and repeat briefings, and interpretative assistance was prodigious.

### Andrew's reflections: the importance of relationships

> *Mika and I provided expert advice to a group that had had limited exposure to a fire event of this magnitude. Contemporary disaster management is inclusive of political leaders. Politicians routinely rely on briefings to assist them with their preparedness from people they know and trust. This event involved extreme pressure with minimal time to build relationships. QFES staff, politicians and the State Disaster Managers needed to rapidly determine who they would trust to provide expert advice to assist them making time critical, high consequence decisions. We played a key role in turning this team of experts into an*

*expert team. Mika and I provided complementary strengths as well as the requisite skills, knowledge, temperament and experience to support managers making these critical decisions. Communication underpins successful operations. I requested Mika's support because I was confident in her ability to communicate the fire science concisely to the executive managers and provide expert input to assist our FBAN team to make the most robust predictions possible. Our relationship in turn engendered trust from our FBANs. So, although they had never met Mika, they very quickly accepted her as part of the predictive team.*

### Mika's reflections: the role of science

*My main focus was to support the FBAN team and provide meteorological interpretation, with the primary objective of 'no surprises'. Much of my research over the last decade has been on identifying the ingredients that led to unexpected extreme fire behaviour. We knew the fires were going to be extreme, the challenge was anticipating their behaviour in advance, and ensuring all the ground crews and emergency management teams were briefed as to what fire activity was possible before it happened, so people were as prepared as possible for the impending conditions. How would the weather drive the fire behaviour and, of the hundreds of fires in the landscape, which ones did we need to focus on? I worked closely with the FBAN team to address these questions and shared information through them and with Andrew, who initiated a cascade of further briefings.*

*I had a head full of science, with the primary method of sharing it being verbal communication through discussions and briefings (I didn't even have PowerPoint presentations). Everything I shared was evidence-based science drawn from a wide research and operational knowledge and communicated in context against the decisions and challenges in predicting the fire activity and appropriate response. It isn't necessary for science to be published or pretty to be useful, it just needs to be applied through clear communication and in context. It was very rewarding to be part of the response team and to use the science when it really mattered.*

## Meteorological support during extreme events

The Bureau of Meteorology has 'Embedded Mets' in most states and territories (Victoria, NSW, WA, SA and QLD but currently not Tasmania or Northern Territory). The Embedded Mets typically work at fire and/or emergency services headquarters, with a primary role of providing weather briefings and interpretation during routine and high impact events, including media on request. The Embedded Mets are all highly qualified meteorologists with excellent communications skills. However, their training is not multi-disciplinary and fire science or fire behaviour knowledge is not required. The distinction between the Embedded Met briefings; which describe synoptic and mesoscale weather patterns, interpretation of observations (i.e. of radar and satellite) and timely relay of warning information and forecast uncertainty; and the support provided by Mika, was the shift in focus to mesoscale and microscale meteorology with a strong focus on how the weather was likely to affect fire behaviour.

The roles and skill set of meteorologists is evolving as the Bureau transitions to a new service model, with a stronger focus on customer engagement and understanding and responding to the needs of clients. In future this will mean stronger partnerships, deep customer insights, high impact services and briefings that are tailored according to specific requirements. This model will require a high level of training in order to develop the depth and breadth of knowledge required to perform in a multidisciplinary space at Incident Management Teams and the Bureau looks to input from partners on how best to provide the optimal customer-focused experience.

## Measuring the value: testimonials

In such events, the benefits are somewhat intangible and therefore difficult to measure, but in this case the positive feedback was considerable, including an article prepared by the Bushfire and Natural Hazards Cooperative Research Centre (Fire Australia 2019).

The testimonials below are from the QFES FBANs, Rusty, Kent and Ben, who worked on Andrew's team preparing the fire predictions using Phoenix. Their comments show firstly; the importance of communication in distilling complex information into an understandable and highly relevant message, where context and prioritisation was critical in real time delivery of products and secondly; meteorology and fire behaviour are two quite separate fields of expertise; the value was in Andrew's decision to assemble a team with complimentary skills and the ability to work cohesively. Together, we had a deep appreciation of the complexity of the situation and the skills and insight to add value where it was of most benefit and then communicate the key messages to the SOC.

Mika was all about the communication of a complex topic into a language that I can understand. I am not a Meteorologist and Mika was talented in providing only what I needed to know at the time in a format that I could understand. I appreciated that I could feel safe enough to ask potentially over simple or perceivably dumb questions of Senior Specialist Meteorologist, who could then respect my level of understanding.

Russell Stephens-Peacock, QFES FBAN

Mika's experience and knowledge was of great benefit on an unprecedented fire weather day. Having a meteorologist with Mika's skill sets working side by side with us as Fire Behaviour Analysts led to more honed forecasts, better prepared prediction products and in turn, a better service to the community.

Kent Barron, QFES FBAN

The Agnes Waters and Deepwater fire was along the coastal strip. As the inland westerly weather approached the coast, the coastal sea breeze and the resulting convergence zone was very difficult to time and account for in predictions. My training in fire weather as an FBAN did not equip me to deal with such nuance. Mika was able to apply her expertise and provide personalised amendments to forecast weather data to account for this providing increased rigour and traceability in fire spread predictions.

Ben Twomey, QFES FBAN

## Learnings for future events

Australia will continue to experience extreme weather events with increasing frequency and intensity and concomitant increasing impacts, due to the influence of climate change and a growing population. Our national fire and emergency management agencies will be under increasing pressure and scrutiny to provide the optimal response to support the Australian community in the face of these challenges. This will include advising decision-makers in government and policy, using the most accurate and informed and effectively communicated guidance, underpinned by world-leading, evidence-based science.

In Queensland in 2018, there were no fatalities and property loss was minimal. There is always an element of luck that sits alongside good management.

It is not possible to anticipate and plan contingencies for all possible future scenarios. It is likely that the worse-case scenario is beyond what we can imagine, and it is probable that cascading and overlapping events will present response challenges that stretch resources beyond capacity. A structure that supports organic response and enables well-connected people to call in any available assistance when faced with predicted and escalating situations is imperative to providing optimal response to emerging disasters.

Advances in Numerical Weather Prediction over the past decade means that forecasts provide sufficiently accurate guidance to be useful with a 7-10 day lead time. The burgeoning quantity of ensemble information means that the uncertainty in predictions can be assessed and operational use of ensembles is expected to reduce uncertainty in forecasts in coming years. The consequence is that extreme weather events will be forecast several days in advance with greater accuracy, with detail refined during the short lead time. This will enable mobilisation of resources days ahead of a weather event.

In Queensland, Andrew made a call on-the-spot to fly-in Mika as an additional resource. Similar actions should be encouraged and supported in response to inevitable future events. The Bureau of Meteorology recognises the opportunity to provide science and communication capacity to incident management teams and establish networks in advance. This includes identifying capabilities across research and other non-operational spaces and managing the challenges of having a surge-ready team. It is inevitable that some individuals will not be suited to transition from the slow-burn research space to the adrenalin-charged immediate-response of operations. The ability to bring current and emerging science and a new perspective to real-time decision-making will be imperative.

There are bilateral benefits as ultimately, such an approach will build stronger research utilisation links and trusted relationships and accelerate the uptake and adoption of research findings which are focussed on high impact outcomes, as well as focus research efforts toward real-world issues.

Our operational resources are becoming increasingly tight and supporting front-line responders with the science knowledge and capability held in researchers will realise the benefits of research investment in critical periods, ultimately strengthening operational decisions. Future success will require processes that enable people like Andrew to call on whomever and whatever resources they consider appropriate and to have funding flexibility and discretionary decision making to enable rapid, non-bureaucratic response.


### Acknowledgements

With thanks to Bureau of Meteorology, Queensland Fire and Emergency Services, the Bushfire and Natural Hazards Cooperative Research Centre and our colleagues. Particular thanks to Bruce Gunn, who supported the initiative.


## References


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