Lessons from NSW RFS trial of the Australian Fire Danger Rating System

Laurence McCoy
David Field

NSW Rural Fire Service

Abstract

The Fire Danger Rating System is the cornerstone of community warnings, messaging and preparedness, fire agency operational readiness and decision-making. It reflects the legislative controls over activities that could potentially cause the ignition of fires. The system underpins decision-making by private enterprise and other 'non-combat' government agencies and departments. It is critical that fire danger ratings are readily understood, appropriate and accurate. The science that underpins the system hasn't changed in more than 50 years. A new Australian Fire Danger Rating System (AFDRS) provides the framework to significantly improve the way fire danger is calculated and communicated in Australia. During the bushfire season of 2021–22, the NSW Rural Fire Service trialled the AFDRS alongside the existing McArthur-based Fire Danger Rating System. Due to decreased fire activity during the 2021–22 fire season, live trials were supplemented with retrospective analysis. Several insights were gained as well as lessons learnt about how fire danger should be calculated and determined. The NSW Southern Operational Trial highlighted the quality of work and progress made so far in building the AFDRS. Although ongoing adjustments to the systems and the Fire Behaviour Index may be required, the trial found the AFDRS is fit-for-purpose and shows clear advantages over the previous system. This paper outlines operational testing undertaken in NSW.

Introduction

Australia's Fire Danger Rating System used in NSW is largely based on past research and practices. New technology and research have greatly improved our ability to accurately predict fire behaviour and the potential threats to the community. The AFDRS uses current scientific understanding about how fires behave in different types of vegetation to improve the reliability of fire danger forecasts. Instead of the Fire Danger Index, the new system is based on the Fire Behaviour Index. The index is calculated by fire behaviour modelling for 8 fuel types as opposed to 2 as is the current situation. Considering the scale and significance of the proposed changes, all jurisdictions were asked to undertake testing to prepare for implementation of the AFDRS scheduled for September 2022. This involved both live trials and retrospective applications of the AFDRS system over the 2021–2022 fire season.

Key elements of testing included:

- the suitability and error free function of new systems - Fuel State Editor and Fire Danger Viewer
- the appropriateness of the new Fire Behaviour Index for regulatory and operational decision-making.

The AFDRS Fuel State Editor is a national web application that supports the workflow associated with updating of jurisdictional fuel-type mapping, fire-history mapping and grass-fuel state. This data is critical to the AFDRS to generate fire behaviour indices.

The AFDRS Fire Danger Viewer is a web application that enables fire personnel to view and interrogate

forecast weather and fire danger information to support operational decision-making.

The Bureau of Meteorology also established a pilot registered users web page to help users view and interrogate forecast weather and fire danger information to support their decision-making.

Methods

The NSW trial ran between 1 September 2021 and 31 January 2022 and was led by the NSW RFS in collaboration with other NSW combat agencies including Fire and Rescue NSW, National Parks and Wildlife Service and Forestry Corporation of NSW. Tests were performed on the AFDRS web applications of the Fuel State Editor, Fire Danger Viewer and the Bureau of Meteorology registered user's page. The trial also assessed the appropriateness of the AFDRS Fire Behaviour Index for decision-making including operational readiness decisions, the issuing of cease-harvest advice and suspension of fire permits as well as legislative instruments such as a Total Fire Ban (TOBAN).

Operational testing of the Fuel State Editor was performed by the NSW RFS Predictive Services Team, Area Planning and Fire Behaviour officers, district staff and RFS volunteer members. A total of 805 tests were completed.

During the trial, all aspects of the Fuel State Editor were tested including:

- management of reporting locations
- submission of field observations of grass-fuel state (curing and fuel load)
- validation of grass-fuel state field observations
- editing of grass-fuel state data in-line with validated field observations
- Approval of data for upload to the Bureau of Meteorology
- uploading fire-history and fuel-type data.

The Fire Danger Viewer was tested in conjunction with Fire and Rescue NSW, NSW National Parks and Wildlife and Forestry Corporation NSW. These agencies were introduced to AFDRS through a series of 1.5-hour online training seminars. Within the NSW RFS, there were many briefings and discussions that used the viewer during the trial period. Overall, 52 tests were conducted in accordance with the testing plan devised to test the AFDRS.

Results and discussion

Fuel State Editor trials

The Fuel State Editor trial was considered successful with all aspects of the system tested and clear advantages identified:

- Increased ease of use - the Fuel State Editor provides a user-friendly interface that steps observers through the process and the rest of the system is clearly labelled and easily navigated.

- Improved quality of intelligence – the Fuel State Editor allows for the upload of photos of observation sites that vastly increases contextual understanding, especially at a head office level
- Streamlined process – the Fuel State Editor allows for observations, validations, edits and authorisations to all be done on the one platform, whereas the current process requires data to be taken off an observation system, edited on a local computer then uploaded, manually to the Bureau of Meteorology.

The trial found that due to the size of the state and density of the NSW observer network, particularly in Western NSW, continued monitoring and intervention will be required to ensure accurate and consistent fuel-curing maps.

Fire Danger Viewer and Bureau of Meteorology products

NSW agencies participating in the trial were able to undertake testing with limited training and minor adjustment. There were minimal bugs identified with the Fire Danger Viewer. The Fire Danger Viewer pages provides a vast range of practical information and layers. The layout is clean, simple and easy to navigate with minimal experience.

At the time of testing, the Bureau of Meteorology products were in development and required formatting and fixing of bugs before they were ready for implementation. A key improvement identified to the Incident Weather Forecast product was the ability for a requesting officer to choose 'fuel type' for calculation of the FBI.

Appropriateness of the Fire Behaviour Index for decision-making

Due to widespread and consistent rainfall, fire activity across NSW decreased significantly in the 2021–22 fire season. During the trial period, NSW experienced a wetter-than-average spring and its wettest November on record. This weather continued throughout summer, which led to unseasonably high soil moisture during a time when soil and fuel conditions would typically dry out. As a result of decreased fire activities, the AFDRS Project Team supported the NSW RFS to supplement its live testing with retrospective data.

Despite the reduced fire activity, the existing system and live trial the AFDRS reached TOBAN thresholds on a number of days. At times, it was evident that the use of modern fire spread models in AFDRS generally makes that system more sensitive to strong wind speeds and low relative humidity and less sensitive to temperature. This is a significant improvement to address the existing McArthur-based Fire Danger Rating System's sensitivity to high temperatures. Table 1 shows the TOBAN results that occurred in the live trial.

Table 1: Live trial results for TOBAN-threshold decisions.

Date and fire weather area	McArthur-system TOBAN	AFDRS-system TOBAN	RFS-declared TOBAN
02/09/2021 – South Western	No	Yes	No
17/09/2021 – South Western	No	Yes	No
04/10/2021 – South Western	No	Yes	No
18/12/2021 – Northern Riverina	Yes	Yes	Yes
18/12/2021 – Southern Riverina	Yes	Yes	Yes
18/12/2021 – Lower Central Western Plains	No	Discretionary	No
19/12/2021 – Northern Riverina	Yes	Discretionary	Yes
19/12/2021 – Southern Riverina	Yes	Yes	Yes
19/12/2021 – South Western	No	Yes	No
26/12/21 – Southern Riverina	Yes	Yes	Yes
26/12/21 – Northern Riverina	Discretionary	Discretionary	Yes
Total	**5**	**8**	**6**

During the live trial, it was noted that the AFDRS would have triggered the consideration of TOBANs in the South Western Fire Weather Area on 3 occasions in September and October (Figure 1). This was attributed to the AFDRS consideration of spinifex and mallee fire behaviour, compared to the existing system generalising and considering these areas as generic grassland. While the proper consideration of vegetation types is a major improvement on the existing system, the danger depicted for these fuel types was still assessed as being slightly overestimated by the AFDRS. Based on NSW and other feedback from intensity with a wind reduction jurisdictions, adjustments were made to the way the Fire Behaviour Index was calculated for these fuel types.

It was observed that there may be additional scope to improve fire danger calculations for other fuel types by improving the way fire spread models resolve the effects of recent rainfall. Discussions with operational fire managers identified that the AFDRS was overestimating the risk for vegetation types such as

grassland, heath, wet forests, softwood pine plantations and arid vegetation types after recent rainfall.

Retrospective analysis (Figure 1) showed an increase of the frequency of reaching TOBAN thresholds for some fire weather areas and reduced in others.

Insights from the state-wide retrospective analysis of total fire ban decision-making thresholds:

• The frequency of TOBANs in the AFDRS was 5–6% higher than the existing system.

• From 2017 to 2020, the AFDRS did not reach TOBAN thresholds in grass-dominated fire weather areas. Consultation with fire managers in those areas confirmed that due to low grass-fuel loads or benign weather during these periods, this was more appropriate than ratings provided by the existing system.

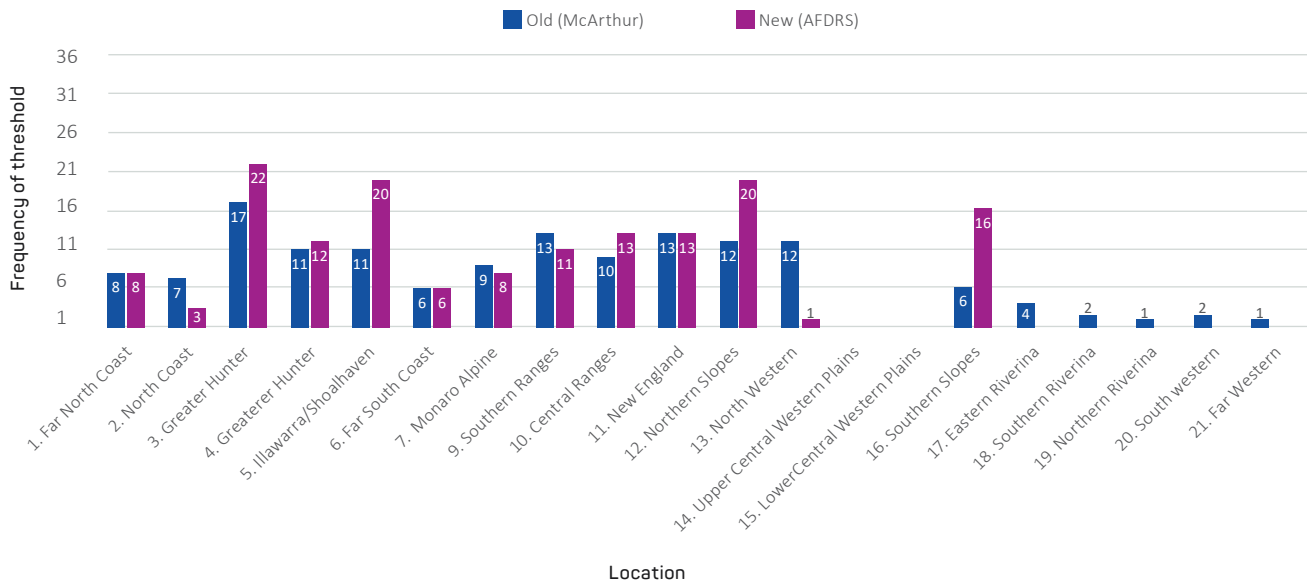### 2019 –2020 Fire Weather Area – TOBAN thresholds McArthur vs AFDRS

Figure 1: Count of the number of times TOBAN thresholds were retrospectively reached by McArthur and AFDRS systems across during the 2019–2020 fire season.

- The frequency of TOBANs in the current combined fuel (forest/grass) dominated fire weather areas was 14% higher in the AFDRS than the existing system.
- Eight fire weather areas showed an increase in the number TOBAN thresholds reached in AFDRS.
- Eleven fire weather areas showed fewer TOBAN thresholds reached in AFDRS.

Overall, the AFDRS Fire Behaviour Index performed better in comparison to the current system and improved the operational readiness decisions. However, there remains a need for research and adjustment to the way the Fire Behaviour Index is calculated. The AFDRS Fire Behaviour Index is generally more sensitive to wind than temperature compared to the McArthur system, which appears appropriate. The fuel-driven Fire Behaviour Index categories provide the much-needed accuracy with finer details at the local government level that will assist with preparations and warnings.

It should be noted that following the Southern Operational Trial, several adjustments were made to the calculation of the Fire Behaviour Index particularly with respect to fuel moisture in wet sclerophyll and pine forests. These adjustments resulted

in the difference between the number of days reaching TOBAN thresholds for the old and new systems.

Summary

- No critical errors or bugs were found in the system to prevent implementation in NSW.
- The new system will change the frequency and occurrence of Fire Danger Thresholds for TOBANs in NSW.
- AFDRS is a significant improvement delivering quality systems and national consistency.
- Nine recommendations are:
  - functionality improvements to the Fuel State Editor and Fire Danger Viewer applications
  - ongoing support for the systems
  - development of the Fire Behaviour Index model performance in grass, wet forest, heath and pine areas
  - adaptation and calibration training for personnel about the changes in the fire rating system and fire danger rating.