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IMPROVED ASSESSMENT OF GRASSLAND FUELS IN MULTIPLE JURISDICTIONS ACROSS AUSTRALIA

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Cover: Firefighters and a helicopter black out a grass fire. Photo by CFA Communities and Communication.

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ABSTRACT

IMPROVED ASSESSMENT OF GRASSLAND FUELS IN MULTIPLE JURISDICTIONS ACROSS AUSTRALIA

The degree of grassland curing (senescence) is an essential component in Australian fire behaviour models and Grassland Fire Danger Index (GFDI) calculations. Throughout Australia, techniques used to assess grassland curing and fire behaviour vary between states and territories. The variations in techniques may cause inconsistent GFDI values across the continent, and may inhibit the continuity of GFDI values at state/territory borders. Additionally, inaccurate assessments and poor spatial coverage of curing measurements provide imprecise information for modelling fire behaviour and determining fire danger ratings.

From 2010 to 2014, the Victorian Country Fire Authority (CFA) improved and automated methods to more accurately assess grassland curing. A network of over 200 observers was established and supported by online training to produce accurate ground-based curing observations. A new satellite-based model and an automated online system were developed and deployed. The system combines satellite and ground-based data to produce weekly curing maps used operationally during the fire season. Finally, experimental grassland burns were conducted to improve the understanding of the curing function for grassland fire behaviour models.

Since 2014, CFA has collaborated with fire agencies from multiple jurisdictions, supported by the Commonwealth Attorney General's Department National Emergency Management Projects (NEMP), to improve techniques for grassland fuel assessment across Australia. As a trial to improve GFDI calculations, grassland curing datasets have been produced for multiple states and territories, and will be accompanied with a pilot trial of the online system. In collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), further experimental burns have been conducted to improve assessments of fire behaviour at different levels of curing.

The combined efforts of the project will improve the accuracy and continuity of GFDI calculations across Australia, and will result in more accurate and spatially representative grass fuel information being used in fire behaviour prediction and fire danger indices.

INTRODUCTION

In Australia, the Grassland Fire Danger Index (GFDI) is determined from a number of inputs including fuel load and the degree of grassland curing (senescence), which is also an essential component in many grassfire behaviour models (McArthur, 1977a, McArthur, 1977b, Cheney *et al*., 1998). Methods used to assess grassland curing, fuel load and fire behaviour vary between states and territories. Such variation may cause inconsistent GFDI values across the continent, and may inhibit the continuity of GFDI values at state/territory borders. Additionally, inaccurate assessments and poor spatial coverage of curing and fuel load provide imprecise information for modelling fire behaviour and determining fire danger ratings.

From 2010 to 2014, the Victorian Country Fire Authority (CFA) developed and deployed an automated technique for operational curing assessment that entails the amalgamation of satellite and ground-based observations. The automated technique has since been trialled for other jurisdictions to improve the assessment of grassland curing across Australia. To also improve the understanding of the curing function for grassland fire behaviour models, CFA has collaborated with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to conduct experimental grassland burns in Victoria. Further experimental burns are being conducted in other states and territories to develop a robust curing function to be used in Australian grasslands.

BACKGROUND

CURING ASSESSMENT

Previous Methods

Fire management agencies across Australia have historically used either ground-based visual observations or satellite observations for operational curing assessment. These techniques alone have inherent limitations providing imprecise information for modelling fire behaviour and determining fire danger ratings. From the ground, visual observations are subjective, and therefore have high variability in accuracy. As indicated by Anderson et al. (2011), Levy rod observations (Levy and Madden, 1933) are more accurate than visual observations however the Levy rod technique is not operationally feasible for weekly estimates by volunteer observers. Regardless of which ground-based method is used, ground-based observations do not capture variation in curing levels across the whole landscape (Anderson et al., 2011). Satellite observations provide a curing value for every pixel across a state or territory; however, changes in curing may not be captured entirely by satellite in the event of consecutive days of cloud cover. Satellite models, developed through research supported by the Bushfire Cooperative Research Centre (named Maps A, B, C and D) (Newnham et al., 2010), provide observations every eight days, which is not a feasible time-frame for operational use. Satellite models may underestimate curing owing to woody vegetation and secondary grass growth, and may overestimate curing owing to water-bodies, urban areas, sand dunes, bare soil and even landscapes covered by yellow flowers which result in inaccurate curing estimates (Newnham et al., 2010, Martin, 2009).

Current Methods in Victoria

In Victoria, from 2010 to 2014, an improved automated technique for grassland curing assessment was developed. The inherent limitations of previous practices were lessened by merging ground-based observations with 'MODerate resolution Imaging Spectroradiometer' (MODIS) satellite data. To collate accurate ground-based observations, CFA established a network of 200+ observers supported by online training and field-based products including a field card and a revised grassland curing field guide (CFA, 2014). To collate accurate satellite observations, two products were developed: (i) a satellite model, named MapVictoria, based on historical MODIS satellite data and ground-based visual observations, and (ii) the application of the MapVictoria model in an integrated model named the Victorian Improved Satellite Curing Algorithm (VISCA), combining near real-time MODIS satellite data (provided by the Bureau of Meteorology) with weekly observations of curing from the ground (Martin *et al*. 2015). In contrast with the eight-day window of previous satellite models (Maps A, B, C and D), satellite observations are now provided in near real-time. Also, the VISCA model allows ground-based observations to minimise any under- or over-estimation of curing derived from satellite. The integration of data from the ground and satellite has been automated using a newly developed online system. The online system collates ground based observations and runs the VISCA model to produce operational curing maps on a weekly basis during the fire season. In 2013, the MapVictoria and VISCA models, delivered by the online

system, were deployed in operations in Victoria. See Figure 1 for an example of VISCA curing data. The MapVictoria model (alone) has also been deployed operationally in Queensland (A. Sturgess, pers. comm.), New South Wales (S. Heemstra, pers. comm.), Australian Capital Territory (M. Gale, pers. comm.) and Tasmania (M. Chladil, pers. comm.).

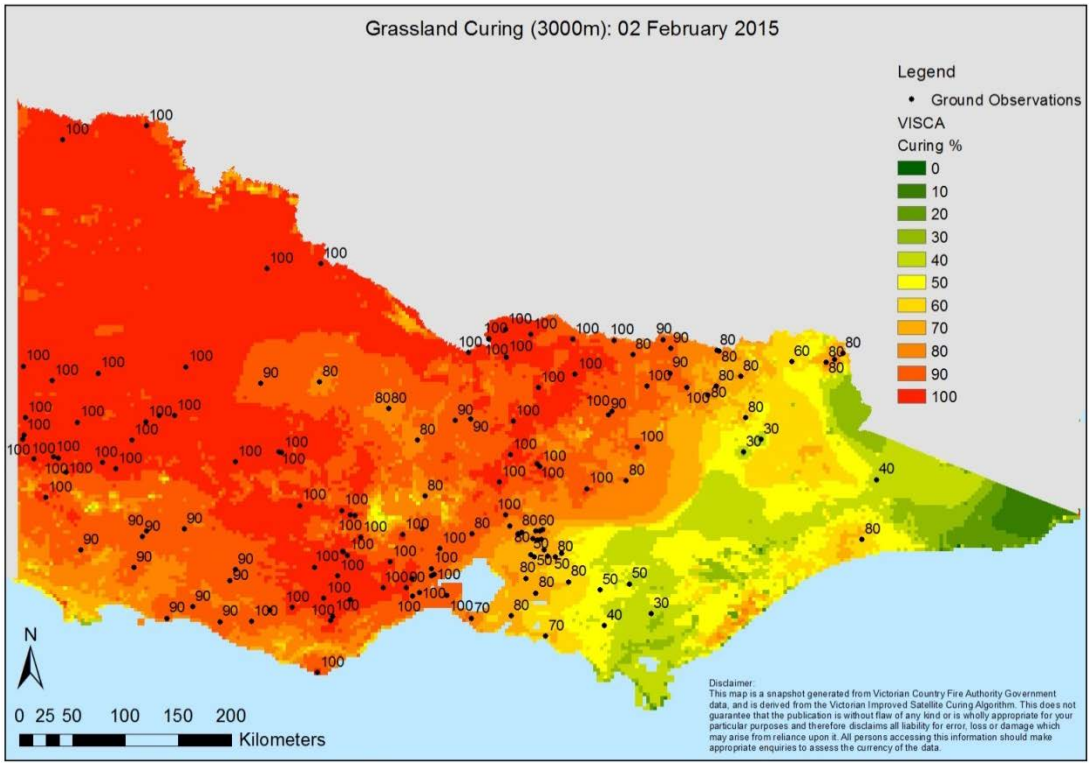

FIGURE 1 VICTORIA GROUND OBSERVATIONS AND VISCA CURING DATA 02/02/2015

VISCA Trial in Multiple Jurisdictions

Since 2014, with support from the Commonwealth Attorney General's Department NEMP, CFA has collaborated with multiple fire management agencies to improve assessment of grassland curing across the continent. Participating agencies include the Bureau, CSIRO, the University of Melbourne, Queensland Fire and Emergency Services (QFES), Australian Capital Territory Rural Fire Service (ACT RFS), ACT Parks and Conservation Service, New South Wales Rural Fire Service (NSW RFS), Tasmania Fire Service (TFS) and the South Australia Country Fire Service (CFS). In the first phase of the trial, VISCA curing datasets have been produced for Queensland, ACT and NSW. See Figure 2, Figure 3 and Figure 4 for examples of VISCA data for Queensland, the ACT and NSW respectively. During the 2014/2015 fire season, the ACT also utilised VISCA for operational curing assessment (M. Gale, pers. comm.).

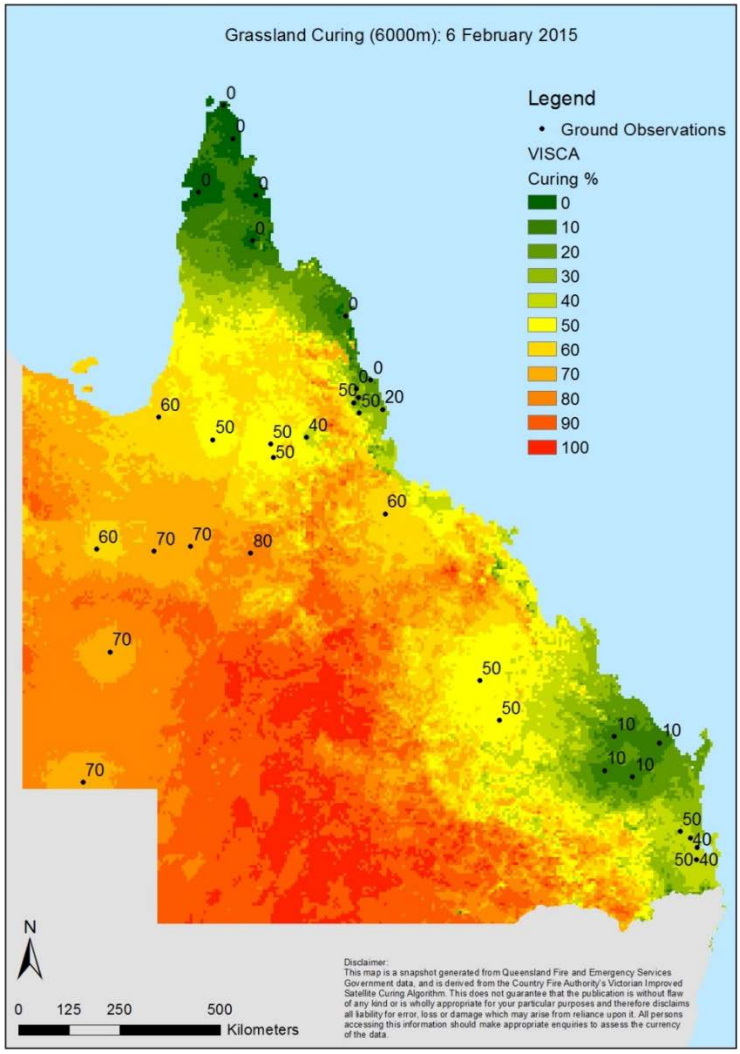

FIGURE 2 QUEENSLAND GROUND OBSERVATIONS (SOURCE: QFES) AND VISCA CURING DATA 06/02/2015

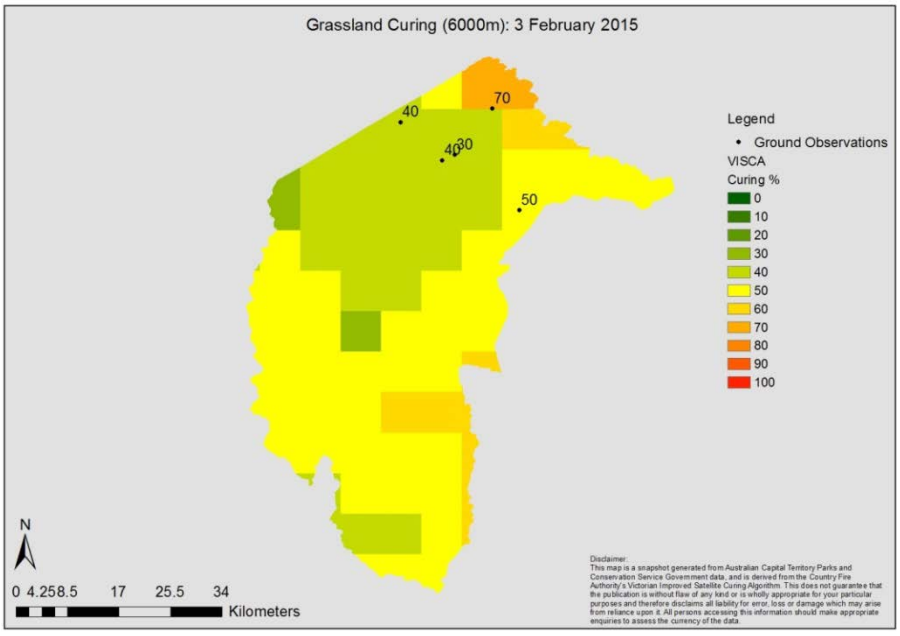

FIGURE 3 ACT GROUND OBSERVATIONS (SOURCE: ACT PARKS AND CONSERVATION SERVICE) AND VISCA CURING DATA 03/02/2015

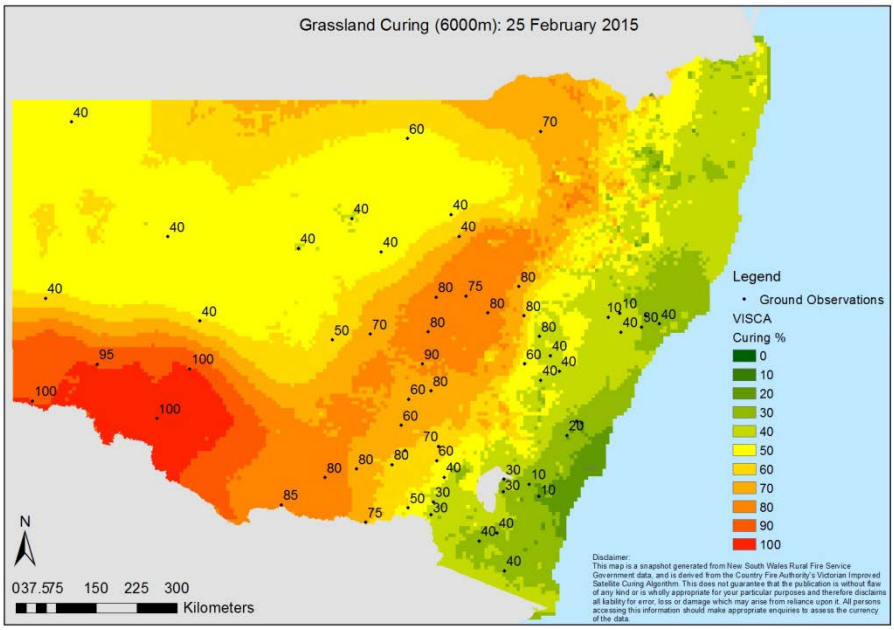

FIGURE 4 NSW GROUND OBSERVATIONS (SOURCE: NSW RFS) AND VISCA CURING DATA 25/02/2015

DEVELOPMENT OF THE AUTOMATED ONLINE SYSTEM

In 2013, the online system was developed and deployed to Victoria's CFA website to facilitate an automated operational workflow for VISCA curing map production. The system's workflow progresses from signing up new observers, to capturing and collating field observations, to producing a VISCA curing map of Victorian grasslands. The system can be accessed using various web browsers on different platforms including personal computers, tablets and smartphones. As part of the National NEMP project, CFA will trial the automated online system for data entry and automated VISCA map production for all participating states and territories for 2015/2016. A prototype of the online system comprises a web application, cloud-based database and a geo-processing service, residing in a low-cost, low maintenance, and scalable cloud computing platform.

Like the Victorian online system, the prototype for other jurisdictions provides a role-based login for users to access the system. Each role is given a different level of access to various functions of the system.

- Observers collecting ground observations can add and access their associated observation site(s) and can report weekly observation data.
- Validators can validate all curing values reported by observers.
- Administrators have full access to all system functions such as data validation, site and user access management, executing the VISCA model and managing data delivery.

It is envisaged that for 2016 onwards, QFES, NSW RFS, ACT Parks and Conservation Service, ACT RFS, TFS and CFS will deploy the online system and VISCA model into operations for weekly assessment of curing.

GRASSLAND FIRE BEHAVIOUR MODELLING

From 2013 to 2014, CFA collaborated with CSIRO to test the relationship between grassland curing and fire behaviour through a series of experimental grassland burns at two improved pasture sites in Victoria (Cruz *et al*., 2015; Kidnie *et al*., 2015). Simultaneous burns of (i) treated, fully cured plots and (ii) natural, partially cured plots meant the effect of curing on spread rate could be isolated. The techniques used in the experimental burns are a world first and will ultimately improve fire behaviour prediction in partially cured grasslands. CFA and CSIRO researchers investigated: (i) the degree of curing threshold above which sustained fire propagation is expected to occur and (ii) the damping effect of live grass fuels on the relative rate of fire spread. To measure curing and fuel moisture content, a modified destructive sampling technique was used. Rather than categorising grass fuels as live or dead, the grass fuels were partitioned into four categories; green, senescing, new dead and old dead (thatch) (Kidnie *et al*., 2015). This method allowed for detailed analysis of curing dynamics throughout the curing season as well as insight into how to better visually estimate curing.

Findings from the experimental burns suggest that the curing function used in fire behaviour prediction in Australia under-predicts rate of spread in partially cured grasslands, and fire spread can be sustained at a lower degree of curing than previously believed (Cruz *et al*., 2015). A new curing function has been proposed, but further research is required to implement the function operationally. CFA and CSIRO have recently collaborated with QFES and NSW RFS to conduct further experimental grassland burns in Queensland and NSW using the same experimental design as the burns in Victoria.

FUEL LOAD ASSESSMENT

In addition to accurate assessment of grassland curing, GFDI calculations and fire behaviour models require accurate estimates of fuel load. In Australia, a modified version of the Mk IV meter is used which incorporates fuel load into the prediction of grass fire spread and Fire Danger Ratings (FDRs) (Purton, 1982). In Victoria, a constant fuel load of 4.5 t/ha is used throughout the entire state, but in other states, variable fuel loads are incorporated into FDR calculations. Like curing, methods used to estimate fuel load vary from one jurisdiction to the next. As part of the NEMP national project, CFA and the University of Melbourne are trialling non-destructive methodologies for fuel load assessment in Victoria and are planning to expand fuel load testing in other states and territories in 2015/2016. Methods to incorporate point fuel load observations and satellite data or pasture growth models are also being explored. Improved estimates of fuel load will provide more accurate GFDI calculations and fire behaviour predictions.

CONCLUSIONS

In Victoria, CFA has contributed to improved GFDI calculations through the development and deployment of an effective automated technique (that is, VISCA) for operational curing assessment. In conjunction with CSIRO, a series of experimental burns have resulted in an enhanced prediction of fire behaviour in improved pastures. Further improvements of GFDI calculations and fire behaviour predictions will also be supported by more accurate assessments of fuel load. Across Australia, methods used to assess grassland curing, fuel load and fire behaviour vary between states and territories. Inconsistent methods can result in inconsistent GFDI values at state/territory borders. Inaccurate assessment of grassland fuels result in inaccurate FDRs and fire behaviour prediction. To support the standardisation of these grass fuel measures, multiple state fire and land management agencies are participating in the NEMP project. By trialling the VISCA model and the online system in multiple jurisdictions, the project will provide accurate and consistent GFDI calculations across multiple states and territories. Thus far, in the 2014/2015 fire season, consistency with curing has improved across the Queensland/NSW, NSW/ACT and NSW/Victoria borders with all four jurisdictions using curing data derived from MapVictoria. Access to near real-time satellite data has also improved the temporal accuracy of curing. Further experimental burns in NSW and Queensland will further progress the curing function and its applicability to various grass types and climatic conditions. The combined efforts of the NEMP project will result in more accurate and spatially representative grass fuel information being used in fire behaviour prediction and fire danger indices across the country.

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