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Is a picture worth a thousand words? Evaluating the effectiveness of maps for delivering wildfire warning information

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ABSTRACT

Maps are a sensible approach for communicating wildfire early warnings to the public as such warnings often contain a multitude of spatial information. However, a reluctance of agencies was found in using accurate and timely wildfire maps for public warnings, a sentiment potentially fuelled by beliefs that the public are not fluent map-readers and may be overwhelmed by the large amount of information. To test the validity of these beliefs, this study empirically compared the effectiveness of maps versus traditional text-based approaches for communicating spatial-related wildfire warning information. Through an online survey, 261 residents from wildfire prone areas in Western Australia were asked to view multi-dimensional spatial information regarding a simulated wildfire scenario presented as either text messages or maps, and were subsequently queried for their comprehension, their risk perceptions, and the attractiveness of the presentation format. Additionally, the survey captured the time required to interpret the varied information representations. The results showed that appropriately designed maps prevailed over text messages for the communication of most wildfire warning information by improving comprehension, elevating risk perceptions, and increasing appeal to the public. However, an optimal communication approach would be to couple map designs with several imperative textual descriptors. Especially, the textual description of safe shelters in the community (i.e. location names and addresses) yielded indispensible meaning when the locations were well-known landmarks, and hence should not be replaced by map-based depiction. Furthermore, several heuristics were identified to facilitate the design of effective warning maps across hazards in general.

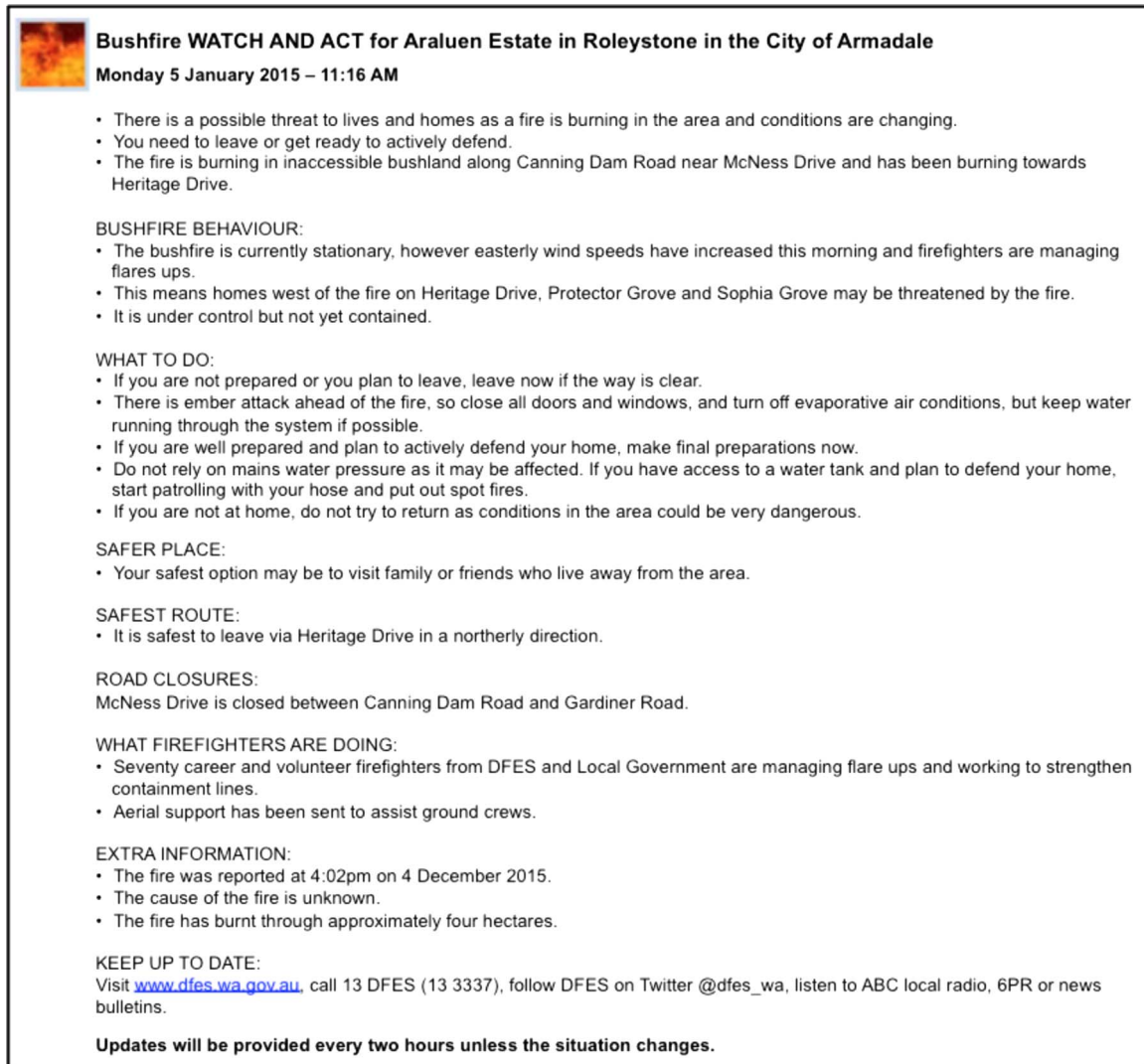© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

Recent decades have seen an increase in the amount of people and assets exposed to wildfire (or bushfire, in the Australian context) risks due to the decentralisation of cities and amenity-driven population growth along urban fringes [25]; [10]. By definition, wildfires originate in rural landscapes but can spread to threaten nearby human habitations. Fortunately, the lead-time before impact on human habitations often enables the provision of early warnings, which play a critical role in raising threat awareness ahead of impact in the at-risk communities. The ultimate goal of public early warnings is to save lives by stimulating protective behaviours, such as early evacuation. Yet, despite the substantial improvement in warning dissemination over the past decade supported by advanced and diversified information and communications technologies, wildfire catastrophes involving significant numbers of fatalities and injuries continue to occur [23]. Research has demonstrated that the majority of those fatalities are attributable to late evacuation [26,29]. Hence, in addition to assuring the timely issuance of warnings, emergency management authorities should scrutinise the 'effectiveness' of these warnings in motivating protective behaviours, especially timely evacuation.

Currently, local emergency management agencies often publish wildfire warnings using their website, coupled with propaganda through multi-media channels [18]. The content of such warnings tends to cover a variety of information elements. Taking the Australian example, inquiries into the 2009 Victorian Black Saturday wildfires [62] have driven the adoption of a Common Alerting Protocol Australian Profile (CAP-AU-STD) that stipulates the provision of warning information delineating the exact location of the fire and its likely impact, direction of fire movement, wind conditions, time remaining before impact for a community, and guidance for protective behaviours. The assorted warning information

Bushfire WATCH AND ACT for Araluen Estate in Roleystone in the City of Armadale

Monday 5 January 2015 – 11:16 AM

- There is a possible threat to lives and homes as a fire is burning in the area and conditions are changing.
- You need to leave or get ready to actively defend.
- The fire is burning in inaccessible bushland along Canning Dam Road near McNess Drive and has been burning towards Heritage Drive.

BUSHFIRE BEHAVIOUR:
- The bushfire is currently stationary, however easterly wind speeds have increased this morning and firefighters are managing flares ups.
- This means homes west of the fire on Heritage Drive, Protector Grove and Sophia Grove may be threatened by the fire.
- It is under control but not yet contained.

WHAT TO DO:
- If you are not prepared or you plan to leave, leave now if the way is clear.
- There is ember attack ahead of the fire, so close all doors and windows, and turn off evaporative air conditions, but keep water running through the system if possible.
- If you are well prepared and plan to actively defend your home, make final preparations now.
- Do not rely on mains water pressure as it may be affected. If you have access to a water tank and plan to defend your home, start patrolling with your hose and put out spot fires.
- If you are not at home, do not try to return as conditions in the area could be very dangerous.

SAFER PLACE:
- Your safest option may be to visit family or friends who live away from the area.

SAFEST ROUTE:
- It is safest to leave via Heritage Drive in a northerly direction.

ROAD CLOSURES:
McNess Drive is closed between Canning Dam Road and Gardiner Road.

WHAT FIREFIGHTERS ARE DOING:
- Seventy career and volunteer firefighters from DFES and Local Government are managing flare ups and working to strengthen containment lines.
- Aerial support has been sent to assist ground crews.

EXTRA INFORMATION:
- The fire was reported at 4:02pm on 4 December 2015.
- The cause of the fire is unknown.
- The fire has burnt through approximately four hectares.

KEEP UP TO DATE:
Visit www.dfes.wa.gov.au, call 13 DFES (13 3337), follow DFES on Twitter @dfes_wa, listen to ABC local radio, 6PR or news bulletins.

Updates will be provided every two hours unless the situation changes.

Fig. 1. An example of current textual wildfire warnings issued within Western Australia. Source: Department of Fire and Emergency Services (DFES).

is often conveyed in textual form (see Fig. 1 for an Australian example). Still, the majority of the information elements are location or direction based, and as wildfires often occur amidst rural lands and cover a large area that is difficult to be explicitly depicted in words, the text-based warnings tend to contain a high degree of spatial ambiguity [18].

An alternate communication approach to delivering the spatial-related wildfire warning information is through the use of cartographic representations. Such an option has become technically viable due to advancements in Remote Sensing, Geographic Information Systems (GIS), and wireless communication. Nowadays, a wealth of the wildfire information can be captured, processed, and visualised in a near real-time manner for communication within and between emergency management agencies [1,60]. In line with the increase in cartographic information availability, a topical discussion has started to arise on whether such accurate and timely spatial information portrayal should also be used for public warnings [18].

Unfortunately, no research to date has sought to examine the suitability of map-based communication to the public with empirical evidence. With no scientific knowledge available to them, local agencies currently adopt diverse approaches. For example, some take a conservative approach by only presenting cursory point locations of incidents on a map to supplement comprehensive text-based warnings (e.g. [14]; [11]. In contrast, others have started to use a more pioneering approach, and use a web-based interactive mapping environment to visually present more specific locational risk-related information, such as fire perimeters, weather monitoring data, and warning polygons. Examples of the latter approach include the VicEmergency developed by the Australian state of Victoria [19], AlertSA launched by South Australia (Government of South Australia, 2015), and the parallel US Wildfires application supported by Google Crisis Map [20]. VicEmergency and AlertSA have been employed as the default interface for the Victorian and South Australian fire agencies' online warning portals, with conventional textual warnings accessible through hyperlinks for specific incidents. However, these mapping tools are currently more focused on providing a visual facade to increase appeal, and less concerned with the timeliness of the data shared on the platform. For example, the critical geographic information pertinent to advancing incidents (e.g. incident perimeters and warning polygons) appears to only be updated on a daily basis during emergencies. This means that people seeking comprehensive wildfire information still need to refer to the text-based messages, rendering the wildfire maps inappropriate for comprehensive warning purposes. Overall, it appears agencies are still reluctant to communicate warnings through maps, which raises the question 'why? '.