FIREWATCH: USE OF SATELLITE IMAGERY BY REMOTE COMMUNITIES IN NORTHERN AUSTRALIA FOR FIRE RISK COMMUNICATIONS.

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Abstract. This paper presents the contextual background and early findings from a new research project funded by the Australian Research Council titled *Using community engagement and enhanced visual information to promote FireWatch satellite communications as a support for collaborative decision-making*. FireWatch (provided by Landgate in Western Australia) is an internet-based public information service based on near real time satellite data showing timely information relevant to bushfire safety within Australia. However, it has been developed in a highly technical environment and is currently used chiefly by experts. This project aims to redesign FireWatch for ordinary users and to engage a remote community in Northern Australia in this process, leading to improved decision making surrounding bushfire risk.

1. Introduction

This paper introduces and reports on early progress from a research project funded by the Australian Research Council titled *Using community engagement and enhanced visual information to promote FireWatch satellite communications as a support for collaborative decision-making*. The project concerns FireWatch, an internet-based public information service based on near real time satellite and remotely sensed information relevant to bushfire safety within Australia. The service is produced by Landgate, a government statutory authority in Western Australia, and has been developed in a technical environment primarily for the use of fire and emergency services experts. The aim of the project is to redesign and repurpose FireWatch for use by ordinary users and to engage a remote community in northern Western Australia in that process.

The redevelopment of this product will extend the usability of the product from experts to ordinary users in order to facilitate community-based decision-making and action both before and during bushfire emergencies. The two main research questions this project poses are: how can FireWatch be integrated into communities as part of a holistic fire awareness program? and, how can Firewatch be redesigned to incorporate global best practice and modern principles of dynamic information design to develop a more intuitive version for ordinary users?

To this purpose the project has been broken down to two distinct, yet interdependent, strands. One strand involves purposive community collaboration using networks and associations which are formed to protect individuals and families in the face of life-threatening risk of bushfires in the Kimberley region in the north of Western Australia. These networks and associations will form the basis of a community-centred approach to product development in order to help ordinary users "extract and harness knowledge [that is] hidden in the collage of scientific data" (Zudilova-Seinstra, Adriaansen, & van Liere, 2009) making it more readily accessible to the general public in rural and remote Australia. The second strand involves the development of an intuitive and accessible web presentation of complex information in clear, unambiguous ways to inform action in stressful circumstances.

This paper will outline relevant background information about bushfires in the north of Australia and about Landgate's FireWatch service. It will then discuss the theoretical framework and research design of the project, with a special focus on the community collaboration aspects of the research, and report some early findings.

2. Background information

2.1. BUSHFIRES IN THE NORTH OF AUSTRALIA

Fire has shaped Australian history, both natural and cultural (Pyne, 1991) and bushfires continue to threaten human life, property and the diverse ecosystems of the continent. The most publicised and fierce bushfires occur in the southern regions of Australia. In 2009 over 170 people lost their lives in the Black Saturday Fires in rural Victoria in south-eastern Australia (Victorian Bushfires Commission, 2010). Last year (2011) in Western Australia many properties were lost and lives threatened in two major fires, one on the rural/urban fringe of the city of Perth and another in the tourist destination of the Margaret River area in the south-west of the state (Keelty 2011, 2012).

What many people do not realize, Australians included, is that the majority of large bushfires occur in the sparsely populated north of Australia (Figure 1). The sheer size of the Australian continent means that there is a variety of climate zones with significant biodiversity. This means that there is no specific time of the year or season in which Australia is free from the threat of bushfire (Tropical Savannas CRC, n.d.). In the north of Western Australia, Queensland and the Northern Territory the main bushfire season occurs May to September: which is also the dry season in the tropical and subtropical north. These bushfires occur more frequently and cover larger tracts of land than in the south of Australia, and they do not impact as many people.

In the north of Australia, bushfires are increasing in intensity and frequency due to a decrease in traditional fire management practices; a lack of fire mitigation practices in grasslands leased by graziers (farmers) and reduced occupation and access of Indigenous communities to their traditional lands (Tropical Savannas CRC, n.d.). Other reasons for the increase in the scale and frequency of bushfires in the north of Australia are the spread of introduced species which result in higher fuel loads and higher temperatures associated with climate change (Williams *et al*., 2001).
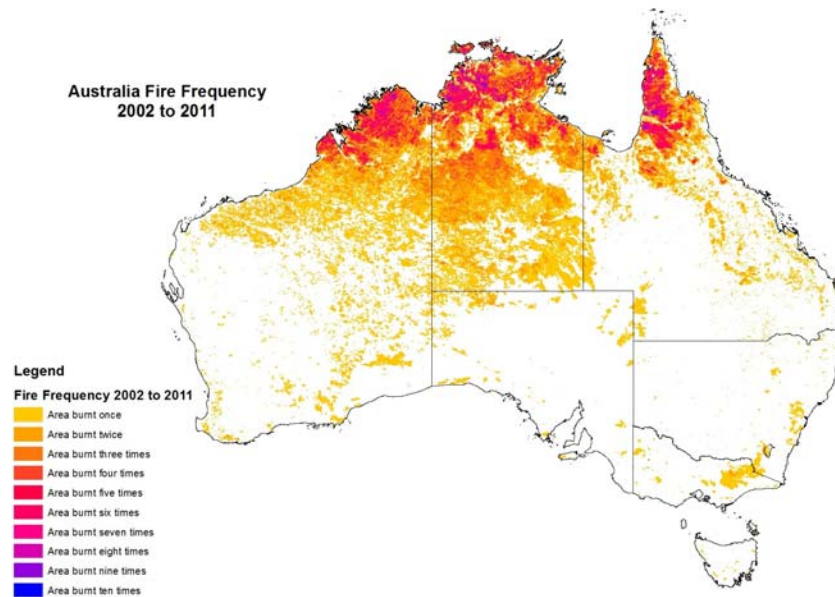
Figure 1. Frequency of burnt areas in the last ten years determined from NOAA satellite imagery. (*Calculated by Satellite Remote Sensing Services, Landgate*).

2.2. FIREWATCH

Raw satellite data, such as reflectance, is processed using algorithms based on known correlations (for example that reflected green light equals plant material) to produce images that are recognisable to us. Imagery sourced from multiple satellites processed quickly using fast computers, combined with presentation technology, has made possible near real time mapping of fires. FireWatch provides this near real time fire mapping together with information about lightning strikes, burned areas, vegetation coverage, aerial photography, meteorological observations and topographic information. A web-based interface allows queries and distance measurements. Historical data can also be accessed and searched. FireWatch therefore provides users with a range of information and tools relevant to safety decision making and emergency responses.

FireWatch has been operating for 12 years and is currently used by emergency services agencies in Western Australia, South Australia, Queensland and the Northern Territory. It is also used as a "fire monitoring system covering the whole of Indonesia to enable the generation of valuable fire monitoring information to effectively fight fires" (Landgate, n.d.).

To date, FireWatch users have predominantly been fire and land management teams which protect economic, social and environmental assets through the monitoring of fires. Although available to the general public, the current public interface is dense

with information, the result of a decade of requests by professional users for additional data sets and functionality. It is unclear how useful it is to those outside the emergency services; nor is it clear whether and how ordinary users might access and make sense of the data available.

Following the 2009 bushfire tragedies in Victoria, greater attention is being paid to Australia's bushfire readiness and the harnessing of available information for informed decision-making (Victorian Bushfires Commission, 2010). Recommendations from the commission suggest a new approach to bushfires involving greater co-ordination in which home dwellers, fire services and government work together and acknowledge that education, safety, planning and management can be effective responses to the threat of bushfire. Policy makers and community members are seeking to revise bushfire protocols and access new sources of authoritative information which may help guide public responses. Thus, FireWatch has a role to play in developing public engagement to enhance informed decision-making in protecting individuals, families, communities and their property in times of bushfires.

3. Theoretical Framework and Research Design

Although this project concerns an advanced technical service, its aim is to examine the technology from a social perspective. In doing this, the research team hopes to acquire new insights which will allow the development of FireWatch into a relevant service for the wider community. The project has two complementary strands: the first incorporating contemporary knowledge about communities and the internet, and the second utilising best practice information design. Theories about on-line communities will inform the first part (Rheingold, 2000), along with an understanding of the use and application of technology in everyday life (Green 2010). The second utilises best practice information design, specifically matters of visual and graphic design and display, and will be informed by developments in information design and visual communication (Nielsen, 2000; Norman, 2002; Tufte, 2001; Wurman, *et al*., 2001). Both parts of the project are framed within a social shaping of technology perspective (MacKenzie & Wajcman, 2003; Lievrouw, 2006) and both assume that public end users constitute an active audience who make choices about how they access information and what they do with it. As such, the project goes well beyond website design to critically examine the ways in which people integrate internet information within community decision-making and planned response strategies.

The separate strands to this project entail both purposive community collaboration using networks and associations which are formed to protect individuals and families in the face of life-threatening risk and also web design with intuitive and accessible presentation of complex information in clear, unambiguous ways to inform action by ordinary users in the community.

3.1. COMMUNITY PHASE

The community phase of the project involves an initial investigation into current approaches to community decision-making around fire awareness and response-

readiness. The study will occur in a defined geographical area in order to investigate and trial community integration of FireWatch at a sufficient level of detail. This community collaboration will involve working with community groups and individuals both online, and through visits to the geographical community. It will explore the developing awareness of the FireWatch service; identifying how it is currently used, or not used, and how useful people find FireWatch after it has been integrated within the community. Key areas of interest include identifying public information-seeking behaviours at times of fire-risk, and professional information-seeking when fire management decisions are pressing. This dual focus includes determining what information is required, how it is sourced and communicated and, finally, how decisions are made and who makes them. These questions are informed by findings from the community consultation meetings carried out by the Victorian Bushfires Commission (2010) after the Black Saturday bushfires in 2009.

Wellman *et al.* (2002) suggest that "rather than weakening community the internet adds to existing face-to-face and telephone contact" (p.151). In the case of communities in remote areas of Australia, mixed mode online/offline communications occur in a multifaceted communications system. Mobile telephones, satellite telephones, two way radios and the internet all combine to facilitate and enhance community communications, especially in times of emergency. This community phase will also research community networking in times of crisis and the mixed modes of communication used during these times. This will provide the basis for expanding FireWatch as a central location for information dissemination and community activity, supporting fire management and decision-making. It will also engage civic society, geographic community and organisational networks in supporting a successful and sustainable online community (Bonniface, *et al.*, 2005).

The research methodology used for this part of the project is broadly qualitative (Creswell, 2009). The intent of this phase of the research is to understand both the information-seeking and communication cultures of communities under threat of fire, and the culture of an online community which links people on the ground with core information.

3.2. DESIGN PHASE

In an investigation of digital decision making, Corrigan (2007) argued that people who make decisions about information systems for public use need to understand the technology in the environment in which the public will operate it. Ordinary people can work alongside technology experts to facilitate this understanding. In the context of persuading ordinary people that the technology offers uses and benefits, it is the non-experts who may hold the true expertise. Wurman (2001) says people understand new things in terms of, and in relation to, other matters which are already understood. Landgate's FireWatch can be re-examined in light of existing community knowledge about fire awareness acquired through the community phase of the project. However, the development of the service to address issues of community engagement, everyday use and social inclusion requires the involvement of those that use and will benefit from the technology in a participatory process. An iterative, participatory design methodology will therefore be central to the project (Simonsen and Hertzum, 2010).

Although it is often assumed that users prefer realistic representations; schematic representations, or infographics, may be easier to understand (Grimwade, cited in Errea, 2003, p. 17). The optimum way in which information can be presented schematically, however, needs to be developed through research with users from the communities concerned. In this project we will not assume that there is a universal way of seeing things and will consider the local and temporal understandings of visual messages and signs (Lupton & Miller, 1999). An understanding of the audience, and what will motivate the audience to become familiar with the FireWatch website, are both critical aspects to be explored. Such understandings will inform the development of a prototype website capable of delivery via multiple devices (for example desktop and hand held tablet computers). Information from the community phase of the project will feed into the design phase to be followed by iterative, face-to-face user testing of the site and the collection of website analytics. A final phase will involve the launch of a pilot version of a new FireWatch Community site.

4. Early Findings

Differing cultural attitudes to technology have been significant in the startup of the research project. Emergency services, government service providers, volunteer organisations and academics working in bushfire research all have different perspectives. At the time of writing the proposal for this project, The Victorian Bushfires Commission (2010) report had just been released. During the commencement of the project, two enquiries into fires in Western Australia were underway (Keelty, 2011; 2012). In this politically charged environment, early meetings with stakeholders about this research have been characterized by talking at cross purposes until it became clear that the project is not designed to produce a broadcast emergency alert system.

It appears that the concept of a web-based tool for longer term management and decision making needs promotion in relation to bushfire, particularly in a nation where fire and emergency services have been held to account for loss of life and property. Concern about ordinary members of the public receiving a clear message from one source dominates conversations about fire. This is despite recent fire events in Australia showing that the public can rarely depend on a single message and indeed are vulnerable to one mode of transmission (Victorian Bushfires Commission, 2010). Confounded with this problem is fear of non-expert users making the wrong decision and of the public receiving false alerts resulting in evacuation chaos. It has also been difficult to focus attention on the needs of rural, remote dwellers whose emergency response and rescue options are more limited than those in the city and peri-urban settlements. For rural dwellers in remote areas, traffic congestion due to evacuation is not an issue and a precautionary evacuation may be a reasonable choice from limited options. For urban Australians, who can call a nearby fire brigade, it is hard to understand the scope of fires in the north of the country, and that for rural dwellers prediction and preparation are paramount to survival. There is a divide between urban and rural attitudes to fire and a further divide between the north of Australia and the

south. Changes in the traditional fire practices of Indigenous people (Pyne, 1991) further complicates common understandings about fire management.

The idea of fire emergency alert is so pervasive that it has been difficult to enter into discussions about the many features of FireWatch which could be useful in non-alert situations. One for example, is the ability to view previously burned areas and vegetation which might provide information for planning evacuation routes for humans and stock prior to an actual fire event. Another is the inspection of lightning strikes which can give advance warning of where fire hotspots may occur after several days. The *embeddedness* of FireWatch within a largely determinist fire emergency network may be hampering the contingencies which could occur with wider public access (Lievrouw, 2006). It is our contention that rural dwellers have a different relationship to the land and are less reliant on one way messages. Hence, they may use the information available from FireWatch in unanticipated ways. One possibility is that the people with differing attitudes to fire management may be able to communicate in more effective ways when able to access information directly, and not filtered through the perspective of a group with an opposing perspective. The development of the FireWatch interface may be shaped by such communications, for example through social networking linkages.

At the startup of the project, we were immediately confronted with our loosely articulated concept of *public* or *ordinary* users. In retrospect we were seeking to open up the use of technology to *other than emergency services professionals* without really knowing who these people were. We have subsequently begun to explore possible types of users in a trial community centered around a regional town, Kununurra, in the east Kimberley region of Western Australia. This location has been chosen as it is a regional centre with a large population by rural Australian standards (3748 with about 30% Indigenous residents; Australian Bureau of Statistics, 2006) and a node for a range of community groups from volunteer fire and rescue services to the Country Women's Association. Key contacts accessible through the project team will include the regional Fire and Emergency Services Association (FESA) and Department of Environment and Conservation (DEC). A separate approach will be required to canvass the views of Indigenous people. The town of Kununurra has 3G mobile phone coverage, ADSL internet and will receive fibre optic broadband cabling as part of a national program. Mobile phone coverage is a significant factor in rural Australia and a possible impediment to delivery of FireWatch via mobile devices.

A feature of this project is the freedom to completely redesign FireWatch. It does not have to simultaneously meet the needs of both professional and ordinary users at this stage of the research. However, there are limits to what can be delivered from the data available, and the frequency of satellite passes over Australia, and hence limits to what users can request. Some difficulties have arisen in conceiving of a completely participatory design methodology based on *ordinary* users. Firstly, as a professional version of the service exists, and is under constant amendment, it would be difficult to reinvent the service within the network of service provision which includes Landgate and the regional emergency services. Secondly, the boundaries between *ordinary* users and local land management and emergency services are not clear cut in rural areas. People charged with protecting the community from fire can also be involved in lighting fires for management purposes. The Margaret River fires in Western Australia

in 2011 were caused when a controlled burn escaped containment lines leading to damage to homes and property in a significant tourist region. In examining the situation, Keelty (2012) acknowledged that some of the people managing the controlled burns were members of the community and deeply affected when things went wrong.

To counter charges of exporting representations of good user experience and usability, a user-scenario design process is being investigated (Carroll, 1995). The intention is to develop a range of user-scenarios from the trial community that will guide the development of a revised public access version of FireWatch. Further modifications will be carried out in an iterative, participatory design process which will commence through face to face contacts in the geographical community and be extended through online research.

A recent event near to our trial community illustrates some of the problems, and also opportunities, for community decision making in relation to fire. In 2011 an international footrace event, RacingThePlanet, was held between Kununurra and the El Questro Wilderness Park. Five runners were injured and two received burns to up to 80% of their bodies when they were engulfed by fire in the remote location of Tier Gorge. At the time of writing, a Western Australian Legislative Assembly inquiry into the incident is underway. A key question is why the race was not cancelled when fires were known to be burning in the area. A detailed submission to the enquiry by the race organisers suggests that, although they had observed smoke and spot fires in the area, they were unaware of the real danger of fire in the region and had repeatedly been assured that such fires were normal occurrences in this region. The race competitors were apparently unable to see the main fire front which was obscured by the Tier range. Public submissions to the inquiry include topographic maps with hand drawn annotations showing where smoke was observed, etc.

Figure 2 shows information that could have been obtained from FireWatch on the morning of the incident. The red and yellow zones show areas which had already been burned and the diamonds show hot spots still burning at the time of the satellite pass. Viewing this image in retrospect it appears unwise to have continued with the event route within 20km of an actively burning fire. FireWatch on the previous two days showed fires burning at a greater distance from the race route, but easterly winds on the day suggested the fire would move toward the route. Although the extent of communication between the race organizers and local authorities is being questioned, FireWatch and other internet based fire monitoring systems, such as North Australia Fire Information (NAFI), are freely available to public users. Why such systems are not are not being used will become a key question for our project.
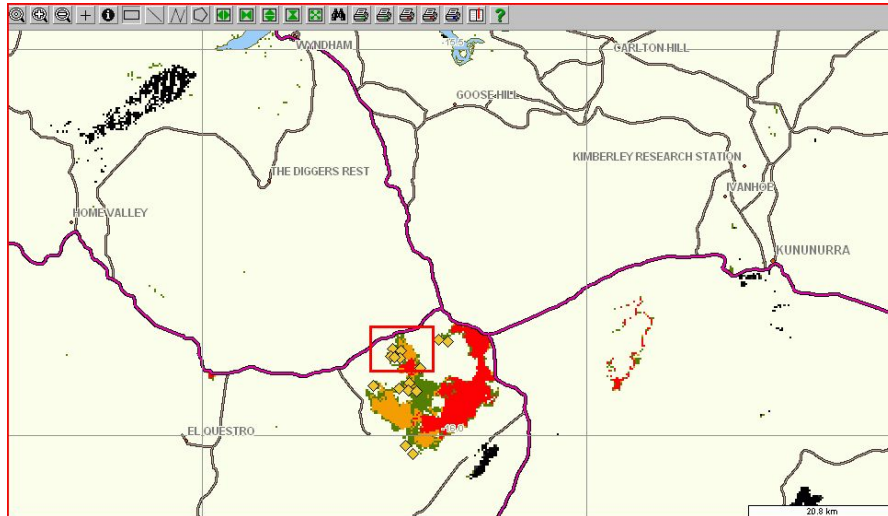
Figure 2: FireWatch image derived from satellite pass at 9.55 WST on 2nd September 2011 showing the region between Kununurra and El Questro Wilderness Park. It shows burned areas (yellow and red) and current hotspots (gold diamonds). The red box shows the area in which marathon runners were injured between 1-2 pm on that day.
(*Captured 29/4/2012 from Landgate's public access FireWatch site http://firewatch.landgate.wa.gov.au*).

5. Conclusion

The aim of this research project is to research ways in which remote and regional publics can be engaged and mobilised with the development and use of FireWatch, a public information service based on near real-time satellite data. The research project aims to involve purposive community collaboration using networks and associations which are formed to protect individuals and families in the face of life-threatening bushfire risk, in order to maximise the usefulness of FireWatch to ordinary users. In the sparsely populated north of Australia, where emergency organisations cover large areas prone to regular seasonal fires, there is clearly a role for the kind of information which can be provided by FireWatch. This is particularly relevant where different agencies are responsible for adjoining areas and people from outside the community, such as tourists, are exposed to risk, making seamless communication difficult.

An early finding from this project is that perceived expertise is a factor in provision of information to ordinary users and to information-seeking by such users. Our task is not simply to make the information more user friendly and accessible, but perhaps to validate and promote the use of web-based imaging technology for the purpose of individual and community information-seeking and decision-making outside an emergency context.

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