ABSTRACT

Location-based telephone warning systems are a relatively new tool for emergency managers to distribute warnings and emergency information to targeted populations. Although some research has examined their impact on how they support action and decision making by community, there are gaps in the literature for many use cases. This paper presents research examining the impact of a large-scale use of a location-based telephone warning system on awareness of and preparedness for a severe weather event in the Australian state of Victoria.

It's raining news: exploring the impact of mass-SMS on preparedness for a severe weather event

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Introduction

The distribution of warnings and information to communities likely to be affected by an emergency are highly important. This has been acknowledged at an international level as one of the Seven Global Targets of the Sendai Framework for Disaster Risk Reduction (United Nations 2015), and in the State of Victoria as the second of its State Emergency Management Priorities (State of Victoria 2017). Across Australia there has been a dramatic improvement across most elements of the total warning system over the past decades (Dufty 2014). There is also an increasing recognition that systems to disseminate warning information to communities, and an understanding of how individuals interpret and act on warning information are key to total warning system performance (Anderson-Berry et al. 2018). At the same time there has been an intense focus on warnings in Australian disaster reviews and inquiries with 14.6% of communication-related findings from reviews between 2010 and 2016 relating to warnings (Ryan 2017). New technologies have enabled a range of new distribution channels for warnings (Sorensen & Sorensen 2007; Martin & Rice 2012). A particular focus over the last decade has been the development and use of fixed line and mobile telephone-based warning systems such as Wireless Emergency Alert in the USA (Bean et al. 2015) and NL-Alert in the Netherlands (Gutteling et al. 2018). The international literature has demonstrated that telephone warning systems can prompt protective behaviour.

After the 2009 Victorian Bushfires the Council of Australian Governments agreed to develop a national telephone-based emergency warning system known initially as the National Emergency Warning System and subsequently as Emergency Alert (EA). This system initially sent alerts to community via landline and mobile telephones based on the service address of the subscriber and became operational in December 2009 (Handmer et al. 2011). Despite a number of challenges associated with location-based warnings (Aloudat & Michael 2011; Aloudat et al. 2011) the system was upgraded to be able to deliver location-based warnings to mobile telephones in 2013 (Federal Minister for Justice et al. 2013).

In the first years after the introduction of Emergency Alert a range of grey literature reports on its performance were published (Handmer et al. 2011; Torrens Resilience Institute 2011). These studies have generally found high levels of awareness of and satisfaction with Emergency Alert, that respondents intended to comply with any directives in an EA message, and that in actual emergencies receiving EA messages was associated with greater levels of action and seeking of further information. However, since the introduction of location-based warnings in 2013, there has been limited publication of research and evaluation of Emergency Alert.

The authors are also not aware of any unpublished work that has been conducted immediately after an emergency event in recent years.

In late November 2017, the Bureau of Meteorology forecast that a significant rain event would impact Victoria in the coming days. As a result of this forecast, a Flood Watch was issued for the entire State of Victoria on Wednesday 29 November. In preparation for this event, the State Control Centre, 10 Incident Control Centres and eight Regional Control Centres were activated. The high confidence and extreme nature of the forecast rainfall led to an unprecedented public information effort which included extensive traditional and social media messaging, tactical advertising and the largest Emergency Alert campaign in Victoria to date. This involved the distribution of 7.4 million text messages on the evening of Friday 1 December using location-based technology to a large swathe of Victoria including metropolitan Melbourne, representing approximately 88 per cent of the Victorian population (Figure 1).

Unlike most other uses of Emergency Alert which are coincident with warnings, this message was intended to promote readiness and awareness in advance of the expected flood and rainfall event. Unlike messages connected to warnings, the calls to action in this message were intended to support general awareness and preparedness:

> *SMS from VicSES. Flooding is expected across Victoria this weekend. Heaviest rain on Saturday. Check on family and friends. Stay informed. www.emergency.vic.gov.au*

Emergency Alert message sent by Victoria State Emergency Service (VICSES) on 1 December 2017.

The deployment of Emergency Alert in this mode presented a unique opportunity to understand whether it can increase community awareness and preparedness immediately before a flood or severe weather event. This was also an opportunity to undertake a rare evaluation of location-based mobile telephone warnings in the Australian context. VICSES rapidly commissioned Colmar Brunton, a commercial social research provider, to undertake a community survey to understand the role the emergency alert messages played in the event, whether perceptions or actions changed on receiving them, and whether this was affected by the time of receipt, number received, or message content.

Methods

3,804 Victorians were surveyed between the 18th and 23rd December 2017 using a combination of telephone and online survey tools. Areas that were more impacted by the heavy rain event or received targeted warnings were oversampled, including Euroa, Mansfield, Myrtleford and areas around the Elwood Canal in southeast Melbourne.

A dual Computer Assisted Telephone Interviewing (CATI) and online methodology were used to complete the fieldwork. n=599 CATI interviews were administered and n=3,205 online surveys were completed, totaling n=3,804 completed surveys. The online fieldwork was conducted between the 18th and 22nd of December while CATI took place between the 20th and 23rd of December.
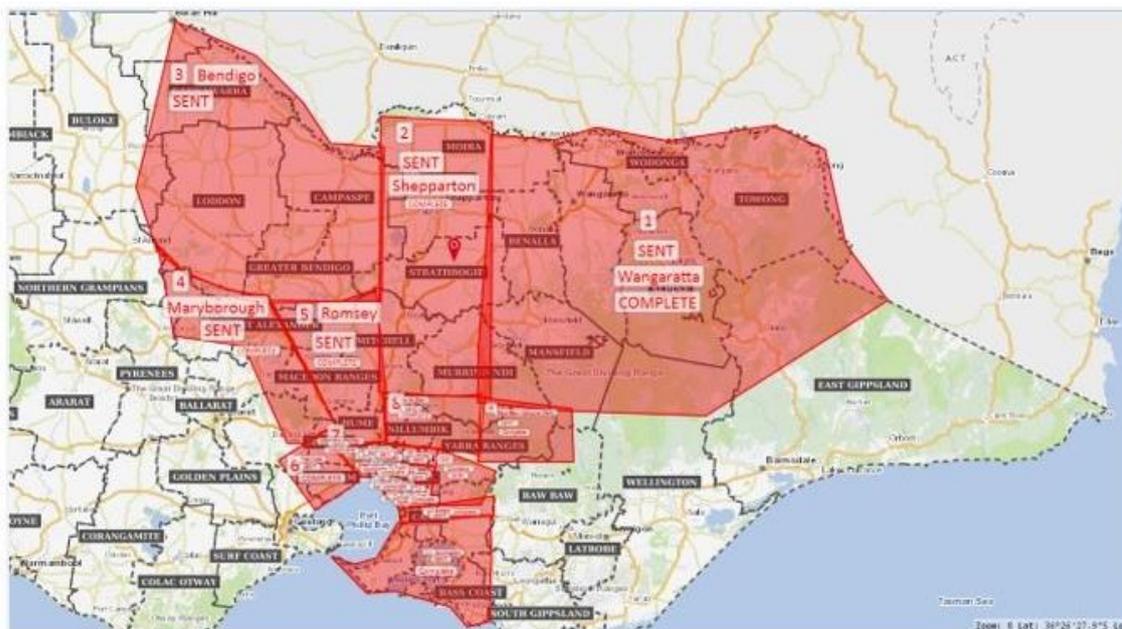

Figure 1: Map showing areas Emergency Alert was distributed.

Table 1: Sample frame.

Area	Phone - n	Phone %	Online - n	Online %
Euroa	42	1.1%	1	<0.1%
Mansfield	36	0.9%	4	0.1%
Myrtleford	32	0.8%	1	<0.1%
Elwood Canal	6	0.2%	200	5.3%
Rest of Vic	483	12.7%	2,999	78.8%
Sub-total	599	15.7%	3,205	84.3%
Total	3,804			

Colmar Brunton and VICSES collaborated on writing the quantitative questionnaire for this project. Respondents were asked up to 28 questions across relevant topics including awareness of the flood event and warnings, sources of additional information about the event, preparation for the event, experiences of the event and personal demographics. Fieldwork collection was scripted, administered and managed via Sawtooth Software.

Analysis of the data file was primarily conducted via Q Research Software and SPSS 15.0 for Windows. Statistical significance testing was conducted via Q Research Software. All tests were performed at 95 per cent confidence ($p = 0.05$). The False Discovery Rate (FDR) assumption was assumed for the purposes of multiple comparison correction, when comparing three or more sub-groups such as the four key locations of interest to the rest of Victoria. Subgroups analysed include respondents who received the Emergency Alert message (n=1805), had previously experienced a flood (n=721), thought the event would be severe (n=2494), considered the Emergency Alert welcome (n=1406) and unwelcome (n=78) and important (n=1228) and unimportant (n=203), and the four oversampled areas (Euroa n=43, Mansfield n=40, Myrtleford n=33, Elwood canal n=206). Not all subgroups were analysed on all questions.

Weighting was applied to the final data file to ensure maximum representativeness. Rim weighting was used based on gender, age and location from the 2016 Census conducted by the Australian Bureau of Statistics, weight factors range between 0.73 and 1.40.

Results

While 18 per cent of survey respondents said that they weren't sure when they became aware of the impending heavy rainfall event, 77 per cent of respondents recalled being aware prior to the Emergency Alert messages being sent on the evening of the Friday December 1. Television (50%) and Radio (25%) were the primary information sources for this initial awareness.

Of the entire sample, 48 per cent recalled receiving the Emergency Alert message. Due to the use of multiple Emergency Alert campaigns, some individuals received multiple messages (see Figure 2) with 6 per cent receiving 4 or more messages and 1 per cent receiving 10 or more.

Of Victorians who recall receiving an Emergency Alert message, comprehension of the message and its contents was high with 98 per cent believing they understood the message and 94 per cent understanding who it was from. Recall of elements of the Emergency Alert message was also high, as shown in Figure 3, with 93 per cent recalling at least one element.

Figure 2: Number of alerts received.

Figure 3: Recall of elements of the Emergency Alert message.

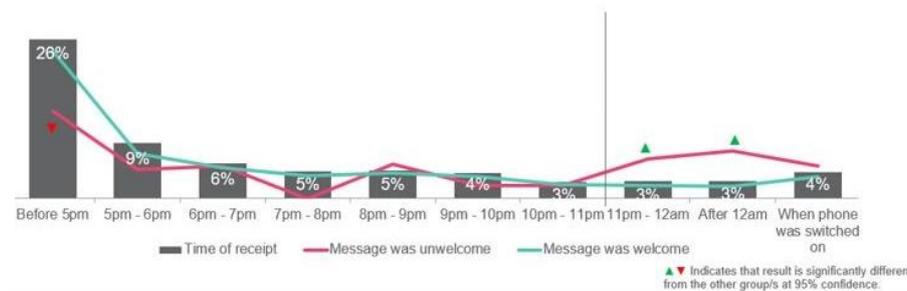**Figure 4: Perceived importance of Emergency Alert SMS and perceptions of welcomeness.**

Figure 5: Time of Alert receipt and perceptions of welcomeness.

A majority of those who received the Emergency Alert believed it was important (67%) and welcomed it (78%) with only a small proportion of respondents reacting negatively as shown in Figure 4.

The recalled time of receipt of the Emergency Alert message didn't affect its perceived importance. However, those who recalled receiving the message after 10pm were more likely to consider it unwelcome as shown in Figure 5. The subgroups of individuals who considered the Emergency Alert unwelcome,

and who received it in the hours after 10pm was proportionally small compared to the overall sample.

The majority of the recipients of the Emergency Alert followed its advice with 22 per cent responding that they checked on their family and friends and 56 per cent that they listened to the radio for warnings and advice. 60 per cent of respondents who received an Emergency Alert took some other action after receiving the message with 43 per cent seeking or sharing information, 29 per cent changing plans to avoid the event and 19 per cent taking action to prepare their property.

The proportion of respondents who took any sort of preparedness action was higher among those who recalled receiving an Emergency Alert message (74%), than it was for those who recall not receiving an Emergency Alert message (61%).

Similarly, higher rates among those who took preparedness actions was also observed in the groups of respondents that had previously experienced a flood (77%) and those who believed the event would be severe (73%). This was consistent across all actions that were surveyed. Table 2 shows the proportion of respondents who took a range of preparedness actions in these three groups; those who received an Emergency Alert message, those who had prior flood experience and those who thought the event would be severe. This tables shows that the rates of action-taking were similar for a vast range of preparedness actions across these three groups. Differences in the rates of action-taking between these three groups were not statistically significant. Note that these groups are not mutually exclusive.

There is evidence to suggest that the respondents may have interpreted the survey questions on flood warnings to include the Emergency Alert message. Although no Flood Warning or Prepare to Evacuate Warning was issued through Emergency Alert, 73 per cent of people who recalled receiving a warning believed they'd received it via SMS. Furthermore, 59 per cent of those who had received an Emergency Alert message also recalled receiving a Flood Warning or Prepare to Evacuate Warning versus 18 per cent of those who didn't receive an Emergency Alert message.

Table 2: Rates of preparedness actions for those who received the Emergency Alert, had previously experienced a flood and expected the event to be severe

Preparedness action	Received Emergency Alert	Prior flood experience	Thought the event would be severe
Listened to radio for warnings and advice	28%	28%	28%
Cancelled my plans to avoid travelling and leaving home	24%	28%	24%
Ensured family and neighbours were aware of the situation	20%	22%	19%
Cleared gutters	16%	20%	17%
Checked Vic Emergency Website (emergency.vic.gov.au) or App for flood warnings	14%	16%	12%
Changed my plans to avoid flood affected areas or adverse conditions	12%	14%	12%
Secured objects that were likely to float and cause damage	11%	13%	12%
Left work early to avoid travelling in adverse conditions	9%	9%	8%
Cleared drains in the street outside my home to ensure water would flow away	8%	11%	8%
Safely placed valuables and important documents up as high as possible	7%	10%	6%
Ensured adequate supply of water and food	7%	10%	6%
Got prepared to evacuate if advised by authorities	6%	8%	5%
Went over my emergency plan and located my emergency kit	5%	7%	4%
Checked local council or Catchment Management Authority (CMA) website to find out if I was in a flood prone area	3%	4%	2%
Laid sand bags to protect the property	3%	4%	2%
Turned off water, gas, electricity at the mains	2%	3%	2%
Raised chemicals and oils well above ground level	2%	3%	1%
Other (specify)	7%	10%	8%
NET: Took some sort of preparatory action	74%	77%	73%
None of the above	26%	23%	27%
Column n	1805	721	2494

Discussion

Emergency Alert provided a valuable and appreciated method of providing information to the community who both welcomed the message and thought it was important. Understanding of the message content, in this instance, was high. Prior research has shown a high level of satisfaction with the Emergency Alert system and strong support for mobile phones as a delivery mode (Handmer et al. 2011). This has been reflected in this study with a very high proportion of respondents indicating they welcomed the Emergency Alert message and thought it was important. There was a small increase in the proportion of respondents who did not welcome the Emergency Alert, when it arrived after 10pm, however this did not affect assessments of its importance. While 'warning fatigue' and 'warning dependence' have not been identified in this study, continued monitoring across jurisdictions is recommended.

Depending on how Emergency Alert is used, it is possible for recipients to receive multiple messages. Though the proportion of people who received many messages in this event was small, the absolute number would have been significant due to the total number of messages distributed. This may have implications for future use of Emergency Alert in the location-based mode for a large population.

The results show that two thirds of respondents took some form of action to prepare for the heavy rainfall and flooding event. Previous research commissioned by VICSES has found that only 48 per cent of Victorians had any interest in preparing for emergencies (New Focus 2015). Significantly, 60% of respondents to this survey reported taking some form of preparedness action upon receipt of the Emergency Alert message. This validates findings from previous studies of Emergency Alert which found that a majority of respondents would follow the intended call-to-action in an Emergency Alert message (Handmer et al. 2011). This is consistent with other research indicating that preparedness action increases when an emergency is forecast. Just-in-time preparedness behaviour has been observed in other emergencies, most notably in website visits and disaster app downloads immediately before and during Hurricane Sandy (Kirsch et al. 2016).

The results also indicate that receipt of a simple text message may increase preparedness behaviour in a population already aware of a forecast emergency. The preparedness rate of those who recalled receiving an Emergency Alert message was higher than those who did not and similar to those who had previously experienced a flood. Prior disaster experience as a correlate of preparedness behaviour has been well demonstrated in the literature (Kohn et al. 2012). The robustness of this relationship has led emergency services to explore the use of simulation and virtual reality in efforts to increase preparedness (Oaten 2018; University of South Australia 2018). The results of this study suggest that a simple text message prior to a forecast emergency may be just as effective.

The high rates of recall demonstrated throughout the survey showed the utility of conducting the fieldwork within three weeks of the conclusion of the event. Recall rates can vary substantially based on the length of time research is conducted after an event of interest (Kjellsson et al. 2014; Jenkins et al. 2002). This survey only sampled at a single point

in time so it is not possible to estimate the recall decay that would have occurred. However, it's likely that the rapidity with which the fieldwork was conducted improved data quality and reliability.

This research has also demonstrated the value of large sample survey. The proportion of respondents who did not welcome the Emergency Alert message and the proportion of respondents who received it late in the evening were both small. The findings regarding the welcomeness and importance of the message versus the time of receipt would likely not have been detected in a smaller sample, due to inadequate statistical power.

One further implication for both research and practice are the results suggesting the respondents may have interpreted the survey questions on flood warnings to include the Emergency Alert message. In the emergency management sector the term warnings can have very specific meaning (Emergency Management Victoria 2017), however the general public may ascribe different meanings to the term. This has implications for both practice, for example designing communications that aim to improve public understanding of warning systems, and research where responses are already highly dependent on question and answer wording. Further research into public perceptions of warnings and public information including the importance of different information in driving decision making would help understand this better.

Conclusion

A large sample survey of Victoria was conducted after the December 2017 heavy rainfall event to examine how people responded to an Emergency Alert message and other media and warnings surrounding the event, and how people prepared.

This study has demonstrated the benefits of conducting post-event research with large sample sizes and as soon as possible after an emergency has concluded. The high rates of recall and ability to analyse small sub-groups has improved the quality of the research and the level of findings that is has produced. To support the implementation of rapid post-event research agencies that may commission it should prepare pre-written research briefs and establish or utilise panels of research providers where possible. Research also needs to account for the emergency management sector interpreting terms, such as warnings, differently to the general public. This issue of interpretation could be accounted through further research into community perceptions of warnings and other public information.

This research supports guidance for practitioners on the use of Emergency Alert to support preparedness. Key points supported by this research include using brief messages that contain clear calls to action. Where avoidable, non-time critical messages that are intended to support general event preparedness shouldn't be sent after 10pm to minimise the chance that recipients may not welcome the message.

The Emergency Alert messages prompted people to act and prepare for the heavy rainfall event and may have been effective at promoting action in people who would otherwise not have taken it. Further work is required to explore how emergency services may facilitate this just-in-time

preparedness in communities and whether it's associated with improved outcomes after an emergency.

References

Aloudat, A & Michael, K 2011, 'Toward the regulation of ubiquitous mobile government: a case study on location-based emergency services in Australia', *Electronic Commerce Research*, vol. 11, pp. 31-74.

Aloudat, A, Michael, K, Abbas, R & Al-Debei, M 2011, 'The value of government mandated location-based services in emergencies in Australia', *Journal of Information Technology Research,* vol. 4, pp. 41-68.

Anderson-Berry, L, Achilles, T, Panchuk, S, Mackie, B, Canterford, S, Leck, A & Bird, DK 2018, 'Sending a message: How significant events have influenced the warnings landscape in Australia', *International Journal of Disaster Risk Reduction*.

Bean, H, Sutton, J, Liu, BF, Madden, S, Wood, MM & Mileti, DS 2015, 'The Study of Mobile Public Warning Messages: A Research Review and Agenda, *Review of Communication*, vol. 15, pp. 60-80.

Dufty, N. 2014, 'Progress made with early warning systems in Australia since 2005', *Australian Journal of Emergency Management*, vol. 29, pp. 43-47.

Emergency Management Victoria 2017, *Victorian Emergency Operations Handbook*, 1ed. Melbourne: Emergency Management Victoria.

Federal Minister for Justice, Victorian Minister for Police and Emergency Services 2013, *Location-based emergency warnings broadcast to mobile phones*. Available from: http://www.mfb.vic.gov.au/News/Location-based-emergency-warnings-broadcast-to-mobile-phones.html.

Gutteling, JM, Terpstra, T & Kerstholt, JH 2018, 'Citizens adaptive or avoiding behavioral response to an emergency message on their mobile phone', *Journal of Risk Research*, vol. 21, pp. 1579-1591.

Handmer, J, Whittaker, J, Mclennan, B, Ratajczak-Juszko, I & Towers, B 2011, *Systematic Review of Reports on Emergency Alert*. Melbourne: RMIT University.

Jenkins, P, Earle-Richardson, G, Slingerland, DT & May, J 2002, 'Time dependent memory decay', *American Journal of Industrial Medicine*, vol. 41, pp. 98-101.

Kirsch, TD, Circh, R, Bissell, RA & Goldfeder, M 2016, '"Just-in-Time" personal preparedness: downloads and usage patterns of the American Red Cross hurricane application during Hurricane Sandy', *Disaster medicine and public health preparedness*, vol. 10, pp. 762-767.

Kjellsson, G, Clarke, P & Gerdtham, UG 2014, 'Forgetting to remember or remembering to forget: A study of the recall period length in health care survey questions', *Journal of Health Economics*, vol. 35, pp. 34-46.

Kohn, S, Eaton, JL, Feroz, S, Bainbridge, AA, Hoolachan, J & Barnett, DJ 2012, 'Personal disaster preparedness: an integrative review of the literature', *Disaster Med Public Health Prep*, vol. 6, pp. 217-31.

Martin, N & Rice, J 2012, 'Emergency communications and warning systems: Determining critical capacities in the Australian context', *Disaster Prevention and Management: An International Journal*, vol. 21, pp. 529-540.

New Focus 2015, *VIC SES Community Awareness Final Report*, Melbourne.

Oaten, J 2018, 'Virtual reality bushfires recreate nightmare scenarios to encourage disaster planning', *ABC Online*, 5 January 2018.

Ryan, B 2017, 'The significance of communication in emergency management: What's changed since 2010?', *Australian Journal of Emergency Management*, vol. 32, p. 24.

Sorensen, JH & Sorensen, BV 2007, *Community Processes: Warning and Evacuation, Handbook of Disaster Research*, New York, NY: Springer New York.

State of Victoria 2017, *State Emergency Management Priorities*, Melbourne: State of Victoria. Available from: https://www.emv.vic.gov.au/StateStrategicControlPriorities.

Torrens Resilience Institute 2011, *Assessment of the Effectiveness of Emergency Alert: Final Report,* Torrens Resilience Institute.

United Nations 2015, *Sendai Framework for Disaster Risk Reduction 2015-2030*, United Nations.

University of South Australia 2018, 'Curious to know what it's like to be in the line of fire?', *University of South Australia*. Available from: https://www.unisa.edu.au/Media-Centre/Releases/2018/Curious-to-know-what-its-like-to-be-in-the-line-of-fire-/.