TO FLEE OR NOT TO FLEE – AN EVALAUTION OF WARNING AND EVACUATION EFFECTIVENESS

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Abstract

Substantial flooding occurred in communities of the North Coast of New South Wales and South East Queensland on the 30th of June, 2005. The SES in response to flood warnings issued by the Bureau of Meteorology conducted warning and evacuation operations. The flood posed the first test to the new Lismore levee. Of concern to the SES was the community's understanding of the level of protection provided by the levee; whether or not warnings provided were effective; and how previous community education programs had influenced the community's response to flooding. The SES initiated a community survey to investigate these points and was strongly involved in debriefing following the flood. This paper summarises the results of debriefs and the community survey and provides recommendations on how local government and the SES can work closer together to overcome deficiencies.

Key Words: Flood Warning, Flood response, Evacuation

Introduction

On the 30th of June 2005, substantial flooding occurred in communities of the North Coast of New South Wales and South East Queensland, including Lismore City and Byron Shire communities.

Flooding occurred as a result of widespread rainfall occurring from the 26th to the 30th of June. The rainfall was triggered by an inflow of moist air from the Tasman sea into a slow moving upper low pressure system. In addition, a surface trough deepened off the east coast resulting in strengthening north-easterly winds and flooding rainfall in the far north-east of NSW. Numerous rainfall stations recorded their highest ever daily rainfall for June including: Tweed Heads, Mullumbimby, Woodburn, Alstonville, Byron Bay and Murwillumbah. (MHL & Department of Commerce, 2005). Record flooding was recorded at Billinudgel on Marshalls Creek.

The most serious consequences of flooding occurred in the communities of Lismore, Ocean Shores, New Brighton, South Golden Beach, Pottsville, Tweed Heads and Billinudgel, where several hundred homes and businesses were flooded and infrastructure was damaged. One person died in Byron Bay and two in South East Queensland.

In response to the flood situation the Australian Government Bureau of Meteorology (BoM) issued Flood Watches, Flood Warnings and Severe Weather Warnings for Flash Flooding. In response to the magnitude of flooding forecast the State

Emergency Service (SES) conducted evacuation operations, the largest of which were focused in Lismore, Ocean Shores, South Golden Beach, New Brighton, Billinudgel and Pottsville.

Warning and Evacuation Operations

In Lismore the SES warned approximately 5000 people to evacuate including North, South and Central Lismore residents, in response to a flood height prediction at the Lismore Rowing Club gauge of 10.4m AHD. Central Lismore, is located behind the newly constructed CBD levee, which at the actual flood peak of 10.3m AHD (not the initially predicted 10.4m AHD) came within 0.3 metres of overtopping at one of its three spillways.

After the initial prediction and evacuation decision based upon that prediction there was a downward revision to 10.0m AHD. As a result the evacuation of South and Central Lismore was cancelled, leaving only approximately 650 people to evacuate from North Lismore. However, only approximately 50 people were accommodated at the established evacuation centre.

The evacuation decision for Lismore was made at a time when the SES had to deal with considerable uncertainty relating to:

- A new levee not tested in any flood and for which the relationship between the various spillways and the key warning gauge, including the issue of flood gradient, were still being determined; and

- The peak flood level given that predictions were being made under conditions where further heavy rain was still possible.

In Byron Shire, approximately 150 people were evacuated from the communities of Billinudgel, New Brighton, Ocean Shores, South Golden Beach and Mullumbimby. Some additional residents were evacuated from Pottsville and Tweed Heads.

Evacuation warnings were delivered in these communities via radio stations, doorknocking, mobile public address announcements and telephone calls to selected residents.

Effective warning time was far greater for Lismore than Byron Shire, since Byron Shire is comprised of communities situated in flash flood catchments. Typical warning time available for Lismore is 12 to 15 hours compared with less than six hours for Byron Shire communities.

The SES also operates an emergency assistance telephone number 132 500, which received 524 requests for flood and storm assistance in the North Coast area.

The State Emergency Service and a Philosophy of Continuous Improvement

The SES is the combat agency (lead agency) for flooding in NSW, with its role being comprehensive, incorporating floodplain risk management, community education, flood emergency planning and flood response. The SES seeks to continually improve the service it offers to the community by capturing the lessons of past events and conducting innovative research and development. The Service was therefore eager to evaluate its warning and evacuation performance as well as study community attitudes and behaviour in response to flood and evacuation warnings.

To achieve these goals the SES leads internal and external debriefs, community meetings and community surveys after flooding.

Following the North Coast floods all of these activities were undertaken. The most comprehensive of which were a community survey undertaken by Molino Stewart Pty Ltd on behalf of the SES and a community meeting facilitated by Lismore City Council. The results of these activities and key outcomes are discussed in this paper.

The Service in recent years has undertaken similar community surveys following flooding in Jingellic, 2003 and Grafton, 2001 (Pfister, 2002); and contributed to a survey following the Kempsey, 2001 flood (Gissing, 2002). The Service has also learnt valuable lessons

from related inquiries regarding recent bushfires, rail accidents and overseas events.

In addition, the Service is also undertaking work to improve its plans, intelligence systems, operational information management and its understanding of the dynamics of large scale evacuations.

Evaluation Methodology

Community Survey

The community survey had two goals. Firstly, to evaluate the effectiveness or otherwise of communication methods used for warnings; and secondly, to assess peoples actions in response to warnings (including their awareness and preparedness for the flood risk).

The thirty six question survey dealt with: awareness and preparedness of respondents for the flood risk; sources of information for flood and evacuation warnings; responses to these warnings; understanding of the warnings and satisfaction with the warning service.

Surveys were conducted face to face by Molino Stewart Pty Ltd representatives in the three to four weeks following the flood. In total, 192 surveys were completed. Of these, 40% were businesses and 60% residences.

Due to the majority of evacuations taking place in Lismore City and Byron Shire communities, the community survey focused on these areas. Byron Shire communities involved in the survey included Billinudgel, Ocean Shores, South Golden Beach and New Brighton, whilst Lismore City communities were North, South and Central Lismore. The majority of surveys (78%) were completed by respondents in Lismore City.

Community Meeting

On the 27th of July 2005 a community meeting was held in Lismore and was facilitated by Lismore City Council. The meeting was attended by over one hundred residents, predominately from North Lismore. Speakers represented Lismore City Council, SES, BoM and Richmond River County Council. The minutes of this meeting are available on the Lismore City Council website (www.liscity.nsw.gov.au).

Results

Awareness of the Flood Risk

Most respondents were aware that there was some risk of flooding to their properties before the June, 2005 floods as shown in Figure 1. However, this awareness was much higher in Lismore than in Byron Shire. In Lismore, the SES and Council for several years have undertaken a flood education program, including community specific FloodSafe brochures, media supplements, shopfront displays and public meetings. In Byron Shire, an A4 laminated sheet showing evacuation routes and centres, with contact information and advice on the reverse side had been distributed not long before the June, 2005 flood. Lismore has some recent flood experience being last flooded in 2001. However, the last major flood to affect areas of Byron Shire was 1987; the exception being Billinudgel which last suffered major flooding in 2003.

Very few respondents (6%), however, thought flooding posed a threat to their personal safety at any point during the floods, even when their properties were being flooded. This is important because it emphasises both a lack of appreciation for the serious risks flooding does pose and suggests that appeals to prepare for floods based upon personal risk are less likely to be as effective as they might be for other natural hazards such as fire. This is despite statistics that show floods have claimed an estimated 1090 lives in NSW between 1788 and 1996 (Coates, 1999), a number which is far greater than deaths caused by bushfires. This is supported by other research which found that businesses at high risk of flooding perceived the risk of fire to be greater than flood (Molino and Gissing, 2005).

By contrast, most respondents (74%) did believe that flooding was a threat to their property or possessions when they first thought their property might flood. There were no major differences between Lismore and Byron Shire. There was a slight difference between businesses and

residences with businesses being slightly more cautious.

Despite the extensive community education program conducted in Lismore, only 32% of Lismore respondents indicated that information provided over the past few years influenced their decisions during the June, 2005 flood.

It was evident at the community meeting that there was a high level of confusion about the interpretation of flood levels. In recent years residents have been provided with property specific diagrams representing the relationship between individual property spot heights (eg. floor and ground) and flood levels based on the Australian Height Datum. Residents were clearly unable to interpret these diagrams, thinking that AHD property levels referred to flood gauge heights. This resulted in an inability to interpret flood warnings.

Effectiveness of Warning and Notification Systems

The extent of warning coverage varied between location and type of warning product. Warning coverage was more effective in Lismore than Byron Shire. In Byron Shire 56% of respondents heard Severe Weather Warnings, in contrast to 71% of Lismore respondents. Only 30% of respondents in Byron Shire heard Flood Warning, in contrast to 84% in Lismore. Only two percent of respondents in Byron Shire heard evacuation warnings, in contrast to 61% of Lismore residents.

Not all respondents that received warnings believed that they applied to them. Lismore respondents were much more likely to think warnings applied to them. Reasons given by respondents for why they thought warnings didn't apply to them included: didn't believe they could flood (36%); and didn't hear their specific locality mentioned (28%).

Respondents were questioned regarding their understanding of what key warning terms meant. These terms were 'Severe Weather Warning', 'Flood Watch' and 'Flood Warning'. Respondents were asked unprompted what these terms meant to them.

The large majority of respondents used words such as rain (43%), wind (34%) or storm (19%) to describe what they thought a 'Severe Weather Warning' meant, indicating a good understanding of the warning product.

Respondents understanding of Flood Watches were largely poor, with only 20% giving responses which corresponded to the correct meaning of a Flood Watch. Thirteen percent of respondents said they didn't know what 'Flood Watch' meant. Further discussion of Flood Watches is presented in Opper and Gissing (2005).

Flood warnings were largely understood to mean that flooding was imminent or highly likely (50%), or that there was a chance of flooding (20%).

Numerous methods are used by the SES to warn the public, including radio, television and doorknocking. In addition, people are regularly informed about warnings through informal sources such as neighbours, family and friends; and by environmental signals such as heavy rain or river rises.

Respondents were asked what sources first made them think that they may be flooded. Environmental signals of heavy rain (40%) and the observation of flood waters (19%) were the most common responses. Radio was the most effective source for disseminating official warnings (21%). Informal notification through friends, neighbours or relatives was stated by 10% of respondents.

In Byron Shire, 85% percent of respondents indicated environmental signals in contrast to 51% of Lismore respondents. This may be explained by the fact that Byron Shire is a flash flood environment where flooding can occur with little warning.

Sixty eight percent of respondents in Lismore and 44% in Byron Shire indicated they had attempted to validate flood warnings. The most common sources used to validate warning information were the radio (40%) and the SES (36%). In Lismore, 42% of respondents said they checked the internet, but only 18% of respondents in Byron Shire did likewise.

Respondents were asked what source first made respondents think they may have to evacuate. In Lismore, the majority of respondents indicated radio (30%) and doorknocking (32%) as the sources, while again the majority of Byron Shire respondents (47%) indicated environmental signals, perhaps due to the better coverage of evacuation warnings in Lismore. Informal notification was significant in both locations accounting for 12% of responses overall.

Action in Response to Warnings

Respondents generally took actions to reduce or prevent loss of or damage to property and possessions. Most lifted possessions to higher levels and many in Lismore moved their car to a location which was not flood prone before roads were closed.

The majority of total respondents did not evacuate with only 40% of Lismore (72% were businesses) and 19% of Byron Shire respondents evacuating. Businesses were more likely to evacuate than residences with 62% of businesses compared with 21% of residents evacuating. The low proportion of residents evacuating is consistent with previous research of the Lismore community which indicated that only 36% of residents would be likely to evacuate their homes during a flood if asked to do so (Scott & Vitartas, 2003).

Of those that did evacuate their reasons varied upon locality. The primary reasons given for evacuation included that it was 'better to be safe than sorry'; and that a firm belief was held that the building would flood. The average time taken by both residences and businesses to prepare to evacuate was four hours. The minimum preparation time was 10 minutes and the maximum 48 hours for an electrical business.

The majority of those that evacuated from residences relocated to a friend's, relative's or neighbour's residence. Only a small percentage relocated to an official evacuation centre. Many evacuated to friends or relatives because it was convenient, they felt comfortable there or they knew the sleeping arrangements. Ninety five percent of evacuees from businesses reported that they relocated to their home, the remaining 5% relocated to a friends house.

Seventy seven percent of respondents evacuated using their own vehicle. The remainder walked, used a friend's or neighbour's vehicle, or were transported by emergency services supplied transport.

Businesses were more likely to evacuate than residences with 62% of businesses evacuating, whilst only 21% of residents evacuated.

When respondents indicated they did not evacuate, they were asked why. In Lismore, answers were influenced by flooding not occurring in Central and South Lismore after it was predicted to do so. Thirty two percent did not evacuate because they did not think the building would flood, of which 74% were in South Lismore. Twenty five percent stayed to protect their property or possessions from flood water, of which 67% were in North Lismore. Eighteen percent said they knew how to manage and a similar percentage cited that there was not a great enough threat to personal safety. Twenty one percent said there was no need to evacuate in the end and 11% cited the need to protect property or possessions from looters.

Of those in Byron Shire that did not evacuate, 52% said it was because they did not believe their building would flood. Seventeen percent said they did not evacuate because the flood was not a great enough threat to their personal safety and 17% stayed to protect property or possessions from flood water. Ten percent said they simply did not know where to go.

An issue raised at the Lismore community meeting related to the extent of the SES's legal power to evacuate people from their homes and businesses. The SES does have the legislated power to call for an evacuation of any scale (SES Act 1989 - Section 22). It is not clear (no precedent) whether or not if a person chooses to ignore an evacuation warning, if a legal penalty applies. However, the SES can request a person to leave a property and may do all such things as are reasonably necessary to ensure compliance.

Satisfaction with Flood Warning Service

The majority of respondents were happy with the flood warning service they received from the SES, particularly in Lismore. In Byron Shire, a number were unhappy with the service. This was perhaps to be expected considering the lower levels of community flood experience in Byron Shire, the limited coverage of warnings and the shorter length of possible effective warning time. By contrast, respondents in Lismore were much more aware of the flood risk and received considerable warning of impending flooding before the event. In addition, flooding in Lismore was less severe than warnings had suggested, and respondents were generally happy that the SES was being cautious in its warnings.

Those who heard the warnings in both communities generally found them easy to understand. One thing that did cause confusion in Lismore was the recent change in gauge measurements to Australian Height Datum (AHD).

Recommendations for Improvement

Respondents were asked to nominate ideas of how flood warning services could be improved. Suggestions included:

- more local information provided in warnings;
- more extensive use of doorknocking;
- provision of community education material regarding AHD, flood evacuation and the new Lismore flood levee;
- provision of guidelines to media outlets to ensure consistent reporting of the flood situation;
- more face to face information regarding the flood situation;
- restriction of access to flood affected areas to prevent sightseers;
- clarification about what flood levels mean, including advice about what streets may be affected; and
- provision of graded evacuation notification where the first warning would be ‘ prepare to evacuate’ and the second to ‘evacuate now’.

How Councils and the SES can work closer together to improve warning and evacuation performance

Councils and the SES already have strong relationships, but these can be strengthened to further ensure the effective emergency management of flooding.

Flood Studies and Floodplain Risk Management Studies are a valuable source of flood information to the SES when conducting planning for warning and evacuation operations. To ensure that the information requirements of the SES are met in relevant studies, SES and DNR are developing a Floodplain Risk Management Guideline titled, ‘Information for SES from the Floodplain Risk Management Process’. This guideline details the recommended information requirements of the SES.

In addition, useful information regarding flood consequences can be collected following floods. The Floodplain Development Manual (2005) encourages councils to assist SES following floods to collect information regarding flood consequences. This information can then be used in emergency planning, community education and future flood operations.

The SES needs to have an understanding of the operation and design of levees. It is essential that councils and floodplain management authorities involve the SES in the design, construction and audit of levees to ensure that an adequate understanding of levees from an emergency risk management perspective is developed and incorporated into flood emergency plans.

Some of the specific information requirements which the SES must be provided include:

- Description of a levee, detailing: location; construction type; and the communities protected.
- The following heights relative to the relevant flood warning gauge; and the

Annual Exceedance Probability of the respective heights:
    - Levee Design Height
    - Overtopping heights of levee low points
- Likely locations of levee overtopping and the sequence of overtopping and flooding.
- Size of the population; the number of residential and commercial properties; and critical infrastructure affected by levee over-topping or failure.
- The height relative to the relevant flood warning gauge that any backwater flooding commences impacting upon urban areas behind a levee and the pattern of inundation.
- Once over-topped the length of time taken to fill the basin area behind a levee and the pattern and behaviour of inundation.
- Location of any parts of each levee which need to be closed other than drains (eg. gates for roadways and railways) and the height relative to gauge that action must be completed by.
- Knowledge of any critical issues including structural integrity affecting a levee.

It is likely that in many cases outputs relating to overtopping and backwater flooding will vary between different floods. In these cases a description of each flood scenario, details of associated required outputs and an indication of confidence will be required.

Flood aware and prepared residents are able to effectively respond to flood warnings. Most communities in NSW lack recent flood experience and are unlikely to be prepared for flooding, as discovered by Molino and Gissing (2005). To enhance the awareness and preparedness of NSW communities the SES has developed a comprehensive education strategy branded FloodSafe. The strategy has now been delivered in many NSW flood prone communities and the demand on it continues to grow. The program has many components including brochures, newspaper supplements, media interviews, public meetings, displays and school visits. Brochures are tailored to local flood prone areas, and contain information on the local flood risk and how to prepare for and respond to floods when they occur.

More recently the SES has developed a Business FloodSafe toolkit, designed to increase the preparedness of businesses in flood prone areas, by encouraging them to produce a business flood plan. The program has recently won awards in the Australian Safer Community Awards and is available on the SES website www.ses.nsw.gov.au. The program was piloted in Wagga Wagga and Kempsey and is discussed in Gissing et al. (2005).

Floodplain Risk Management Studies regularly recommend the delivery of community education programs. The SES Public Communications Branch can provide councils with advice regarding how to deliver effective community education programs and resources in the production and delivery of them.

Conclusions

The evaluation results present clear evidence of the need to continue with efforts to enhance warning and evacuation performance. The results will also form the basis of recommendations for further improvement programs.

The SES will continue current programs to enhance warning effectiveness. These programs include: pre-writing of warning messages; research and development of GIS flood information tools to improve flood warning client identification; development of closer relationships with media outlets; the relaunching of the standard emergency warning signal; improvements in the availability of flood information on the internet; and community education programs focused upon improving the understanding of warning products and appropriate responses to warnings.

The results provide valuable information regarding the perceptions and behaviour of residents. Similar perceptions and behaviours can be expected to occur in future floods. The SES attempts to ensure that its warning and evacuation planning is consistent with the likely behaviour of residents.

Incorporation of these results into planning assumptions will ensure that this occurs.

The comparison between the two study areas, Lismore and Byron Shire, suggests some influence by factors such as effective warning time, property type and flood experience and awareness in determining community responses to warnings. Further research is required to confirm the influence of these factors.

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Appendix A

Figure 1: What respondents thought the chance of their property being flooding was prior to June 2005