Guidelines for Local Flash Flood Warning System Proposals

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ABSTRACT

In response to enquiries from several NSW Councils for local flash flood warning services, a workshop was held in April 2007 to develop guidelines for the NSW Flood Warning Consultative Committee to coordinate funding proposals for such systems.

Three levels of local flash flood warning system were identified, ranging from a General System, that relies on existing warning services provided by the Bureau of Meteorology for severe weather and thunderstorms as well as Flood Watches; an Intermediate System, that includes additional field stations; through to a Total Warning System, that aims to deliver targeted warnings to people located on the high flood hazard sites where evacuation may be necessary.

This paper describes the guidelines that were developed to assist NSW councils and their consultants to prepare viable local flash flood warning system proposals that may arise from recommendations of the Floodplain Risk Management Process outlined in the NSW Floodplain Development Manual. A case study of the proposed flash flood warning system for Newcastle is also discussed as a possible example of a Total Warning System to highlight the various components involved.

INTRODUCTION

The 8 June 2007 storm and resultant severe flash flooding in Newcastle and other areas in the Hunter Valley and NSW central coast highlighted the need for more targeted flash flood warning services for several high hazard flood-prone areas where evacuation was necessary to minimise the risk to life. Although the Bureau of Meteorology (Bureau) issued Severe Weather Warnings and a Flood Watch for the area, anecdotal evidence suggests that these had little impact upon the public’s preparedness and response for this event, during which 9 lives were lost.

In recent years several NSW councils have submitted proposals to the Natural Disaster Mitigation Program, and the previous Regional Flood Mitigation Program, for local flash flood warning systems. Unfortunately, most of the proposals were rejected as they only had a narrow focus on field data networks to support predictions. The submissions did not recognise the other components of a total warning system necessary to achieve the stated objectives, or outcomes, in terms of a reduced risk to life and property from flooding. In April 2007, the NSW Flood Warning Consultative Committee held a workshop with representatives from local councils, NSW State Emergency Service (SES), NSW Department of Environment and Climate Change (DECC) and the Bureau, to develop guidelines to assist councils
and their consultants to develop appropriate local flash flood warning system proposals. This paper describes the guidelines and the proposed “Ready Set Go” flash flood warning system for Newcastle.

BACKGROUND

Flash flooding has been defined as flooding that occurs in less than 6 hours of heavy rain. Flash flooding can be caused by severe thunderstorms alone or by the larger scale major flood producing weather systems, such as the deep low pressure cell which caused the June 2007 major floods at Newcastle and in several neighbouring catchments. The large scale flood producing weather systems can also have embedded thunderstorms that produce extremely high local rainfalls. This also occurred at Newcastle during 8 June 2007 when, for example, 350 mm fell in 24 hours at Merewether.

This 6 hour flash flood definition has been used by the Bureau to differentiate between the types of flood warning service provided. To date, with the exception of South Australia, the Bureau's national hydrologically-based, and more targeted, flood warning service has been provided to the larger than 6 hour catchments. The smaller, or flash flood, catchments are provided with more general meteorologically based warning services, such as Severe Weather Warnings and Severe Thunderstorm Warnings, for events that may lead to flash flooding.

The main reason behind this differentiation was to prioritise the use of limited real-time operational resources to develop site specific flood forecasts for locations where there was considered to be sufficient time for reliable flood predictions and Flood Warnings to be developed and for an effective dissemination and response to the Warnings. For warning times significantly less than 6 hours, a more rapid user response is required. This may necessitate a specialised warning communication system and a high degree of public flood awareness to achieve a successful outcome. This is particularly so for the very small catchments, with response times less than 1 to 1½ hours, where traditional warning dissemination techniques, such as through the local media and doorknocking by the SES, combined with a low level of flood awareness, are unlikely to result in an effective response to a warning.

Another major limitation to the effectiveness of flash flood warning systems is that flash floods are less predictable than larger scale flooding. Rainfall over small catchments is usually not well predicted by the numerical weather prediction models (McKay 2005).

Therefore, flash flood warnings rely heavily on triggers based on exceeding rainfall and or river level thresholds. Rainfall triggers need be set conservatively to accommodate various degrees of catchment wetness, so “false alarms” will occur. There is also the possibility that the rainfall values based upon rain gauges may underestimate the true rainfall over the catchment, particularly during thunderstorms, when rainfall rates are highly variable.

On the other hand, when relying on river levels to exceed threshold values as a trigger for action, although there is more certainty of flooding, there is also less warning time than is the case when using rainfall values.
APRIL 2007 FLASH FLOOD WORKSHOP FINDINGS - SUMMARY

The workshop participants are listed in the Acknowledgements at the end of the paper.

Three levels of local flash flood warning system were identified:

- **General System** – relies on existing warning services provided by the Bureau for severe weather and thunderstorms as well as Flood Watches, which is an early warning product based on forecast rainfall. These services are typically issued for a much larger region, or groups of catchments, that includes the local flash flood site. These warnings can be augmented by real-time information from local weather radars, automatic weather stations and existing rainfall and river gauges. Combined with a public education/awareness program, the likely outcome is some reduced risk to life and property from flash flooding through precautionary action triggered by these general warnings.

  Indicative costs – Initial $0 (do nothing) to $20,000, and a further annual cost of $1,000 to $7,000 for a public education/awareness program.

- **Intermediate System** – General system plus additional rain and river gauges within the targeted flash flood catchment to help local emergency personnel to assist the community through improved evaluation and management of the flash flood threat. The likely outcomes are those of the General System plus improved reduction of risk through better local emergency response and management due to improved identification of flood thresholds from local rain and river gauges.

  Indicative costs – Initial $60,000, Annual $10,000 to 15,000 for a public education/awareness program and rainfall and river gauge maintenance.

- **Total Warning System** – Intermediate system plus a targeted warning dissemination system aimed at people located on the high flood hazard zone where evacuation may be necessary. The proposed system for Newcastle is an example of such a system and is described in the next section. The likely outcomes are improved reduction in risk to life and property from flash flooding through warnings being better communicated to a flood aware community.

  Indicative costs – Initial $100,000 to $200,000, Annual $10,000 to $30,000 for all components.

The annual cost of maintaining flash flood warning systems needs to be largely borne by the local council or direct users, typically businesses, as usually there is no other agency with responsibility to fund this. This issue is further discussed in the third point on the next page.

While all systems need to be underpinned by an appropriate public flood awareness program, the Total Warning System will require a more comprehensive and sustained public flood awareness campaign. Full details of the outcomes, components (and their likely costs), of these systems and the associated draft DECC Guidelines for SES Information Requirements from the Floodplain Risk Management Process are available on the FMA internet site or can be obtained from the Bureau’s NSW Regional Office.
Other key workshop findings included:

- To qualify for funding to install a local flash flood warning system, the council will need to have completed and adopted a Floodplain Risk Management Plan (FRM) for the whole catchment. This process will typically identify and contain enough detail for all flood risks. However, should the need for a flash flood warning system for a specific part of the catchment be identified at a later stage then the council can review the Management Plan to quantify the extent of the flash flood problem and to outline and justify the management options being put forward, including the warning system. Some cases may require further detailed study to determine the community’s needs and expectations from a local flash flood warning system to enable its proper design and specification. Advice on the information that needs to be provided at each step of the FRM process is provided in the detail on the FMA internet site.

- The roles and responsibilities of the SES, Bureau of Meteorology, Councils and other agencies are often confused. They are defined in Part 4 of the NSW State Flood Plan April 2001, see link on http://www.ses.nsw.gov.au/topics/2271.html. The priority for a flash flood warning system within the affected council’s own area depends on its relative importance in the council’s overall risk management plan.

- Funding to establish local flash flood warning systems has been available through the Natural Disaster Mitigation Program on a 1:1:0 basis, i.e. council’s initial contribution is nil. However, councils need to be aware that they are responsible for the costs of maintaining local flash flood warning system components including such items as rain and river gauges, warning communication systems and ongoing public awareness/education programs. The maintenance obligations need to be planned for and identified in the initial funding application. Upon installation of a local flash flood warning system, the SES Flood sub-plan for the area can be used to document the operation and maintenance specifications of the system, including any public education/awareness components.

- Following the appointment of a dedicated Senior Hydrologist specifically for flash flood in the Bureau’s NSW Flood Warning Centre, it is proposed to provide targeted Flash Flood Warnings to 12 sites in NSW for which local forecasting procedures have been developed and Total Warning Systems have been installed. Given the limited resources available to address the flash flood problem, targeted Flash Flood Warnings will only be issued for additional sites where “Total Warning Systems” have been installed on for which sufficient information from past floods and flood modelling from studies is available to develop reasonably reliable flood prediction tools. This approach is consistent with the provision of quantitative flood warnings for the larger catchments in NSW for which the SES have developed flood plans to ensure that cost-effective outcomes are achieved from flood predictions.
PROPOSED NEWCASTLE FLASH FLOOD WARNING SYSTEM

Up to 25,000 properties in Newcastle are prone to flash flooding. In some areas flooding up to 5 metres deep can occur in less than one hour. In 1988, 1990 and 2007 several thousand properties were affected by flash flooding.

The flash flood warning system suggested for Newcastle is a 3 phased approach comprising:

- **Ready.** See Figure 1. Weather warnings provide an outlook of possible flooding in the Newcastle area. **Monitor for changing weather conditions.**

  Outlooks range from an approximate 3 hour time frame, from Regional Severe Thunderstorm Warnings for storms which are predicted to occur within the Hunter Region, to 24 hours, from Severe Weather Warnings and Flood Watches which alert the community of possible widespread flooding from large scale weather systems, such as deep low pressure cells.

- **Set.** See Figure 2. Approximately 1 to 2 hours alert of likely flooding in more closely defined areas. **Prepare to act.**

  Alerts will be issued when rainfall or river levels exceed initial threshold values. This information will be supplemented by coverage from the Newcastle weather radar and the Graphical Severe Thunderstorm Warning Service, introduced in February 2006, which provides a map of the area likely to be affected and the predicted direction of severe storms.

- **Go.** Up to 1 hour warning of flooding at major trouble spots. **Action!**

  Warnings issued when rainfall totals and river levels reach, or are predicted to exceed, flood threshold values.

The proposed system will be underpinned by the following local system components:

- **Data** from a local network of 12 radio telemetered rain and 2 river gauges will be used to trigger the Set and Go phases at key risk sites when thresholds have been exceeded. This data will be transmitted to local based stations at Newcastle City Council and Hunter Region SES as well as the Bureau. The information will also be available on the Bureau’s internet site.

- A **warning communication system** utilising a mass dial out phone services, mobile phones, SMS, pagers, email and the internet. Set and Go triggers will be automatically transmitted to key sites by SMS, text and/or email from the 2 local base stations.

- **Public education** material produced by the SES, with council input, to help the community understand the flash flood warning system and know what to do in the event of a flood.
Figure 1 – Ready Phase of the proposed Newcastle Flash Flood Warning System
“Set” alarm automatically generated when initial rain or river thresholds are exceeded. High flood hazard sites where evacuation may become necessary. Rain and river data collection base stations at Newcastle City Council and SES Hunter Region HQ. Newcastle Community. Data and warnings on www.bom.gov.au. Newcastle Radar. Local Media. Internet. Figure 2 – Set Phase of the proposed Newcastle Flash Flood Warning System.
Severe Weather Warnings or Thunderstorm Warnings updated to reflect deteriorating conditions

"Go" alarm automatically generated when rain or river thresholds are exceeded

High flood hazard sites where evacuation is now necessary

Newcastle Community

Local Media

Internet

Data and warnings on www.bom.gov.au

Newcastle Radar

Australian Government Bureau of Meteorology

Severe Weather Warnings or Thunderstorm Warnings updated to reflect deteriorating conditions

Newcastle Community

Data collection base stations at Newcastle City Council and SES Hunter Region HQ

Rain and river data

Rain and river level field stations with radio telemetry

Newcastle Radar

Figure 3 – Go Phase of the proposed Newcastle Flash Flood Warning System
CONCLUSION

The guidelines developed by the workshop are designed to help councils develop flash flood warning system proposals that are consistent with their overall risk management strategy outlined in the Floodplain Risk Management Plan and making effective use of available financial and other resources. Further details are available on the FMA internet site or from the Bureau's NSW Regional office. Bureau staff are also available to discuss and provide technical input to help councils and their consultants develop flash flood warning system proposals.

TAKE HOME MESSAGE

An ongoing public education/awareness program is a key element in all three levels of flash flood warning systems that were identified by the workshop. Due to the relatively short warning lead times for flash floods, people need to know in advance how they are affected by flooding and how to respond to the flood warning. Without this basic knowledge, flash flood warning systems are unlikely to help people achieve a significant reduction in risk to life and property.

ACKNOWLEDGEMENTS

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REFERENCES