LOCAL FLOOD PLAN FOR SMALL COASTAL CATCHMENTS

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Presenter's Profile

Habib Rehman is the manager in the Water Resources section of Cardno Lawson Treloar. Habib graduated with honours in Civil Engineering from University of Engineering and Technology Lahore, Pakistan in 1989 and completed a Master of Science in Civil/Environmental Engineering from Iowa State University, USA in 1993. During the fourteen years in water resources engineering, Habib has developed expertise in hydraulic investigation, hydrologic assessment, flood estimation and floodplain management, which have involved urban, riverine and estuarine environments.

Urban modelling projects have included a variety of flood studies, which have required detailed investigation and design of culverts, bridges and other hydraulic structures for flood management. Habib has worked on a number of RTA projects in preparing concept designs of cross drainage infrastructure and evaluating its flood impacts on the neighbouring properties. His expertise also includes groundwater modelling and total catchment management studies.

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Abstract

A Local Flood Plan is generally a sub-plan of the Local Disaster Plan (DISPLAN) which is prepared by the Local Emergency Management Committee in coordination with the State Emergency Services (SES). The plan covers the preparedness measures, the conduct of response operations and coordination of recovery measures in the event of flood emergency in a Local Government Area (LGA).

The operational procedures set out in the flood plan are often biased towards the large creek or river flooding in the LGA and ignore the specific requirements of small catchments where the nature of flooding is substantially different to that in a major creek. In addition, the coastal catchments are likely to experience sea level rise as a consequence of climate change and as such require special provisions for flood emergency management in the Local Flood Plan.

This paper presents the issues related to flood emergency management in small coastal catchments and how Local Flood Plans can ensure special provisions for such catchments. A case study is presented for the Turo Creek, Pretty Beach catchment in the Gosford LGA.

Key Words: Flood Emergency, Flood Plan, Flash Floods, Coastal Catchments, DISPLAN.

Introduction

Managing flood hazard in catchments is challenging and can be resource intensive for a particular LGA. A part of the hazard management strategy is to plan for managing flood emergencies when they happen. The NSW State Flood Plan provides guidelines for preparing a Local Flood Plan with responsibility for the plan placed with the State Emergency Service (SES).

Often Local Flood Plans are biased towards major creek or river systems in the LGA and fail to provide planning measures for the small catchments. The failure to address creek flood hazard in these catchments can be more perilous for small coastal catchments, which are subjected to additional flood threat from the ocean.

This paper discusses various aspects of the Local Flood Plan that need to include special provisions for small coastal catchments. A case study is provided for the Turo Creek catchment in Gosford LGA.

Flooding Characteristics of Small Coastal Catchments

A large number of coastal catchments in NSW are subjected to flash flooding. The nature of the catchment in terms of its flood generation capacity is determined based on the time it takes from the rainfall event to complete inundation of the floodplain. The catchment is generally considered ‘flashy’ in nature if the time taken for the flooding process is less than 6 hours. The flood hazard associated with this type of flooding is generally high and can result in significant loss of life and property. In United States, most flood related deaths are reported to be from flash flooding (NOAA, 1992).

Flash floods occur as a result of high precipitation rates over a relatively long period of the order of few hours. Majority of flash flood producing rainfall is convective in nature (Doswell, 1997), since such a rainfall system...
generally results in high precipitation rates. The other important factor is the duration of convection, as only high intensity rainfall sustained over a substantial period would result in flash flooding. In addition, hydrological conditions of the catchment such as antecedent wetness play an important role in generating flash flooding.

Catchments prone to flash flooding give little or no warning of the impending flood. Rapid urbanisation of the coastal areas has also magnified the flashy nature of these catchments as times to flood have been reduced with increased impervious areas in the catchment.

Additionally, the coastal catchments are subjected to met-oceanic processes that can add significantly to the flood hazard.

**Local Flood Plan**

These plans are based on standard emergency principals of Preparedness, Response and Recovery. Given the short timeframes for flooding in small catchments, preparedness is vital in managing the flood hazard. Adequate response measures are generally not feasible for very small catchments whereas the recovery phase of the flood event can generally be coordinated with other measures undertaken LGA wide. This paper concentrates on various aspects of preparedness required for small coastal catchments.

Preparedness for a flood event involves developing flood intelligence, development of an effective flood warning system, public education and clear definition of the roles to be played by various agencies. All these aspects of preparation for flood events are discussed in reference to a small coastal catchment in Gosford LGA. Description of the catchment and discussion on flood preparedness for this catchment is provided below.

**Turo Creek Catchment**

The Turo Creek catchment is a small catchment of Brisbane Water that discharges at Pretty Beach (Figure 1). The catchment has an area of 44 hectares and consists of forested and urban residential areas. The headwaters of this creek lie in the Bouddi National Park. The creek traverses through a number of private properties before discharging into Brisbane Water.

The Turo Creek catchment is very steep with an escarpment to the south in Bouddi National Park. Flash flooding occurs as a result of intense rainfall on steep upper portions of the catchment. During rainfall events, waterfalls can be observed over the escarpment.

**Existing Flood Behaviour**

Each property traversed by Turo Creek has a pedestrian bridge in the backyard. These bridges on the creek act as hydraulic controls during significant flood events and have a tendency to block during the flood events. The rate of rise of floodwaters in the creek is high due to the steep catchment. For a 100 year ARI event, the peak discharge is 20 m$^3$/s and the time to flood peak is less than an hour. The existing creek has an approximate capacity to carry a 5 year ARI event.

Fourteen properties in the catchment are flood prone with above floor flooding ranging from 0.2m to 0.77m. The Annual Average Damage for the catchment is $62,342.

The main access road to the catchment, Pretty Beach Road, is flooded in a range of design flood events. The depth of flooding ranges from 0.1m for the 5 year ARI event to 0.5m for the PMF.

**Flood Intelligence**

The core requirement for combating floods is to have an in-depth knowledge of the local flood behaviour. Such knowledge is generally
based on historic data gathered over a period as the catchment is subjected to flooding and flood records are preserved. Generally, historic river gauge data is available which can be related to actual flooding in the catchment for any future events. However, such data is almost non-existent for small catchments where resident surveys need to be carried out along with the use of catchment modelling tools to analyse the flood behaviour.

Hence a detailed flood analysis for the small catchments is required before any meaningful Local Flood Plan could be prepared.

For the Turo Creek catchment, the flood behaviour was established using hydrologic and hydraulic modelling. This process was assisted by the valuable historic flooding information provided by the residents.

Flood Warning

A national workshop held in November 2002 by Emergency Management of Australia highlighted the need for a separate approach for effective flood warning for flash flooding (Elliott et al, 2003). The workshop noted that the current flood policy generally recognises flash flooding as separate to other forms of flooding such as in NSW (SEMC, 2001), the application of this policy has not been consistent at the implementation stage. Elliott et al. note that

“The current flood warning policy treats warning for flash flooding in a different manner to other forms of flooding ....... There has been an uneven adoption of this policy and the institutional arrangements for flash flooding are not as formalised as for other forms of flooding ....... The workshop felt that the review was needed into the limitations and deficiencies of the current policy in each state with the aim of developing an improved approach”.

NSW State Flood Plan notes that flash flooding warning systems have been installed in only two Councils in the State (Byron and Hastings) and recommends the provision of such systems for the larger Sydney basin.

The flash flood warning systems are generally based on telemetry systems where rainfall or gauge height is read remotely through an automatic system in the upper parts of the catchment. This data is relayed to the SES where it is used in conjunction with look up tables to forecast the extent of flooding at the areas of interest.

Such systems are not feasible for small catchments like Turo Creek. An innovative methodology is required to provide effective flood warning for these catchments. Based on the existing technology and institutional set-up this can be a daunting task.

Flash Flood Warning System

The first and the foremost requirement for an effective warning system is the development of flood intelligence for the catchment. Such intelligence in most cases would need to be developed from flood analysis carried out using modelling techniques. The crucial piece of information with regard to flood warning that comes out of this flood analysis is the capacity of the creeks in the floodplain ie magnitude of the flood that results in overbank flooding of the creeks. For the Turo Creek catchment, overbank flooding would occur for an event greater than 5 year ARI. This equates to an approximate rainfall measurement of 30mm in an hour.

Thus if the timely rainfall information could be made available to the community, they can be better prepared for the oncoming flood. A methodology to communicate this information is described below.

Rainfall Data Acquisition

Provision of rainfall information would require a reliable rain gauge near the catchment, located in a strategic position in terms of the prevailing weather pattern in the area. The available rain gauge network in the area may not be suitable for this purpose. It is also likely that the owner of the gauge is not able to provide the required information in time. As such a separate gauge would be required for a particular catchment.

Since, a rain gauge for a single catchment may not be economically justifiable, clustering of adjoining catchments for this purpose would be more feasible. Thus based on BOM advice, the gauge can be located strategically to provide the rainfall information for a number of catchments in the area. The purpose of such a flash flood warning system would be well served if the ownership of the gauge rests with the local Council. The gauge needs to be of telemetric type with the relay of information in real time.
Communication of Rainfall Data
Before the flood warning could be relayed to the community, the rainfall data would need to be interpreted. Ideally, SES should carry out this interpretation and issue the appropriate flood warning. However, given the short time frame of flooding, it may not be possible for SES to warn the community in time. In order to expedite this process, the rainfall information would need to be relayed to other relevant agencies/groups. The Local Emergency Management Officer can play a role by receiving this information and taking appropriate actions. However, for the prompt delivery of the warning, the information would need to be relayed to a local community group directly. This would require that a few community members be trained to interpret the rainfall information.

Communication of Flood Warning
Once the flood warning has been issued, it can be communicated in various means such as radio, TV, telephone, e-mail/internet etc. However these media of communication are not likely to be effective for catchments with very short lead time to flooding. In such a case, like Turo Creek catchment, the local community group would need to play an important role in communicating the flood warning. This could be through telephone or simply door knocking.

Automated Warning Systems
Another automated system that can be deployed is to sound an emergency siren located at an appropriate location, say on a telephone pole, in the catchment that is directly triggered by the telemetric rain gauge once the critical rainfall has been recorded. The authors are not aware of such a system in place anywhere and would recommend testing it in a pilot project for a small catchment or any catchment with telemetric rain gauges.

Such a warning system is likely to minimise the communication delays, however, may need extensive maintenance to ensure its proper functioning.

Use can also be made of installing flood sensing devices that can alarm residents in a small catchment. Although such devices have been tested for road overtopping (NRC, 2001), they can probably be used at critical creek locations in the catchment. In the case of Turo Creek, such a sensor can be located upstream of the urban area. The sensor can then remotely trigger a siren in the area or may possibly trigger alarms in individual properties.

Community Education
The need to educate the community about the existing flood hazard can not be over emphasised. For catchments subjected to flash flooding it is important that the community is able to play an active role in the flood management since lead times for flash flood warning are generally small and effective dissemination of flood warning may not be feasible for the state or local agencies. However, the community would need to be thoroughly educated about the flood hazard and the community groups trained to help manage the flood threat to their catchment.

Key elements of the community education in a small catchment are

- Providing a clear understanding of the flood hazard that exists in the catchment
- Community is prepared to contribute to the flood warning process
- Community is able to manage the aftermath of the floods with assistance from state and local agencies

Impact of Climate Change
Current studies on climate variability indicate significant changes over the last century. Most authorities on climate change agree that the recent changes, by and large, have been brought about by human activity, which has increased atmospheric emissions thereby creating the greenhouse effect. A comprehensive report prepared by the Australian Greenhouse Office (DEH, 2003) indicates that the following changes are likely to occur with regard to flooding of the coastal catchments:

- Increase in the rainfall intensity
- Increase in the number of extreme events
- Increase in storm surge flooding due to meteorological activity
- Rise in sea levels
The above changes are predicted to occur over the next 50-100 years. As such all development along the coast with expected life of similar duration would need to address the increased flood hazard. A comprehensive impact assessment of climate change on flooding of coastal catchments is therefore required as part of the floodplain management process in order to develop the necessary flood intelligence for the Local Flood Plan.

Conclusion and Recommendations

A large number of small coastal catchments are subjected to flash flooding. However, Local Flood Plans generally do not address the issues related to managing flash flooding in an LGA. The current flash flood warning systems are not suitable for small catchments and hence some innovative approach is required to manage the flash flooding hazard.

This paper presents an approach that focuses on quick transmission of flood warning to the community in case of impending flood hazard. In summary, this approach has the following key elements

- Flood Intelligence needs to be established through the floodplain management process whereby a detailed flood analysis of the floodplain is required.

- Innovative flood warning systems are required for small catchments subjected to flash flooding. Some ideas have been presented in this paper in developing such a system.

- Involvement of community is of paramount importance. The community not only needs to be thoroughly educated about the flood hazard but also trained to help manage the flood hazard in the catchment.

- A comprehensive impact assessment of climate change on flooding of coastal catchments should be undertaken as part of the floodplain management process in order to develop the necessary flood intelligence for the Local Flood Plan.

This paper provides a discussion on flash flooding in the hope that industry wide dialogue may start into the importance of flood warning for small catchments. Needless to say, further research is required to establish key elements of an effective flash flood warning system.

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