

KNOWING WHEN TO GET THEM OUT - IMPROVING FLOOD EVACUATION PLANNING THROUGH FLOOD MODELLING AND STAKEHOLDER INVOLVEMENT

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Abstract

Floods are not new to Grafton, nor to the Clarence River. But the approach to planning and responding to floods has changed significantly in recent years. This paper discusses these changes, particularly how these changes have already and will continue to result in improved flood management and security for the City of Grafton. Specific reference will be made to the different approach taken in the 2013 flood compared to other recent flood events like in 2001 and 2009.

In 2012 Council's consultants completed a levee overtopping assessment for Grafton. The objectives of the assessment were to identify the locations where the levee is likely to initially overtop, evaluate the flood risk within Grafton following overtopping, provide detailed emergency response information for levee overtopping events, and assess potential measures which may reduce the flood risks within Grafton.

On the 29th of January 2013, the Bureau of Meteorology (BOM) forecast flood levels at the Prince St gauge in Grafton would reach 8.1m, the highest recording since installation of the river gauge. The recently completed flood modelling suggested that a flood of that level would result in minor overtopping of parts of the Grafton levee, and levels over this reach had the potential to inundate up to 1/3 of Grafton, being over 900 properties.

This BOM prediction proved quite accurate, with the flood level in the Clarence River reaching 8.08m. But in a rare good news story coming out of the January 2013 floods, the planning foresight by Clarence Valley Council, accurate flood prediction by the Bureau of Meteorology, accurate flood modelling by consultants, and careful flood evacuation planning by the NSW SES all combined so that no unnecessary evacuations occurred. This event demonstrated the benefits of flood modelling and stakeholder involvement in flood planning and response.

Key Words:

Floods, evacuation, Clarence River, Flood Modelling, Stakeholder Consultation, Grafton.

Introduction

The Clarence River is called the 'big river' and this is for good reason. The Clarence's catchment is a huge 22,716 km² and stretches from the Queensland border to the Doughboy Range in the south – some 250 km. The river itself is greater than 430km in length with 10 rivers flowing into it.

Flooding is something that is a common occurrence in Grafton and something that the city somewhat takes in its stride as the rains fall. Generally Grafton is not affected by mainstream flooding from local rainfall; rather its flooding is triggered from weather events that occur a considerable distance away. Since flood records commenced in 1839, Grafton has been subject to over 120 floods - the highest being in January 2013 at 8.08m. In Grafton the most important gauge for recording river height is the Prince Street gauge. See Figure 1.

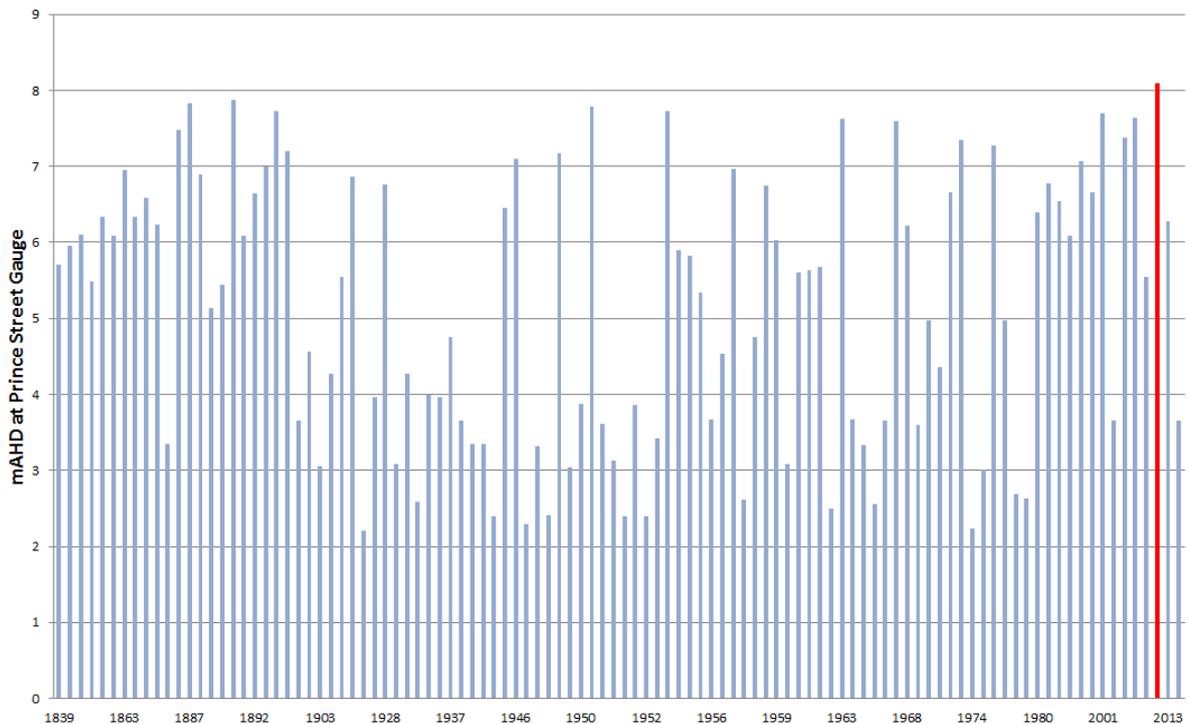


Figure 1. Historic Flood Peak Heights at Grafton since 1839 (2013 event highlighted in red)

Grafton and South Grafton are currently protected by a series of levees that, in addition to naturally high ground and an elevated railway line, surround the town (Huxley and Beaman, 2014). The levee system has evolved progressively over time from 1890 in response to previous floods in the region (Huxley and Beaman, 2014). These constant augmentations have meant that there is no overall master design of the levee system.

With significant improvements in technology and with major studies and modelling undertaken across the catchment, the forecast accuracy of an event is now able to be rather precise and hence allows for detailed evacuation planning. Current event forecasting and subsequent evacuation is much different to that which is described by the Clarence River Historical Society (2011) of days gone by where the forecast depended upon telegrams being received from the Copmanhurst Post Office. It is stated that when the water level had reached the dispatching desk at Copmanhurst, communications stopped and business people in Grafton starting packing up goods beyond flood level.

Evacuation routines and flood procedures of Grafton have been refined as its flood plans have been reviewed, however up until the development of the Grafton Annexure of the Clarence Valley Local Flood Plan (2012), hereafter referred to as 'the 2012 Plan' the evacuation priorities and procedures did not have any 'buy in' from the community. It was after the 2001 and 2009 flood events that it was realised that 'participation' in the evacuation of the city was low. Despite the significant height of the 2001 event, Pfister (2001) acknowledges that the evacuation did not proceed optimally and less than 10%

of the 12,000 residents of the flood prone areas left the city during the 9 hour evacuation period.

It was following the 2001 flood event that the NSW SES started to seriously analyse what had occurred so that improvements could be made for the future. Community view was sought, Grafton participated in a large study regarding flood perception, risk and warning across 4 Australian towns. Past research and papers have focussed on the problems of getting people to follow the SES evacuation warnings (see Pfister 2001, Becker et al 2007, Molino et al 2011). But these past papers have not critically examined the SES's flood plan arrangements for the Grafton area. Important inputs into flood plans are essential for the plans to be effective.

Whilst having data regarding the thoughts and movement of the town's people, it took a few more years for good flood modelling to become available, which combined led to the development of the integrated and improved 2012 Plan.

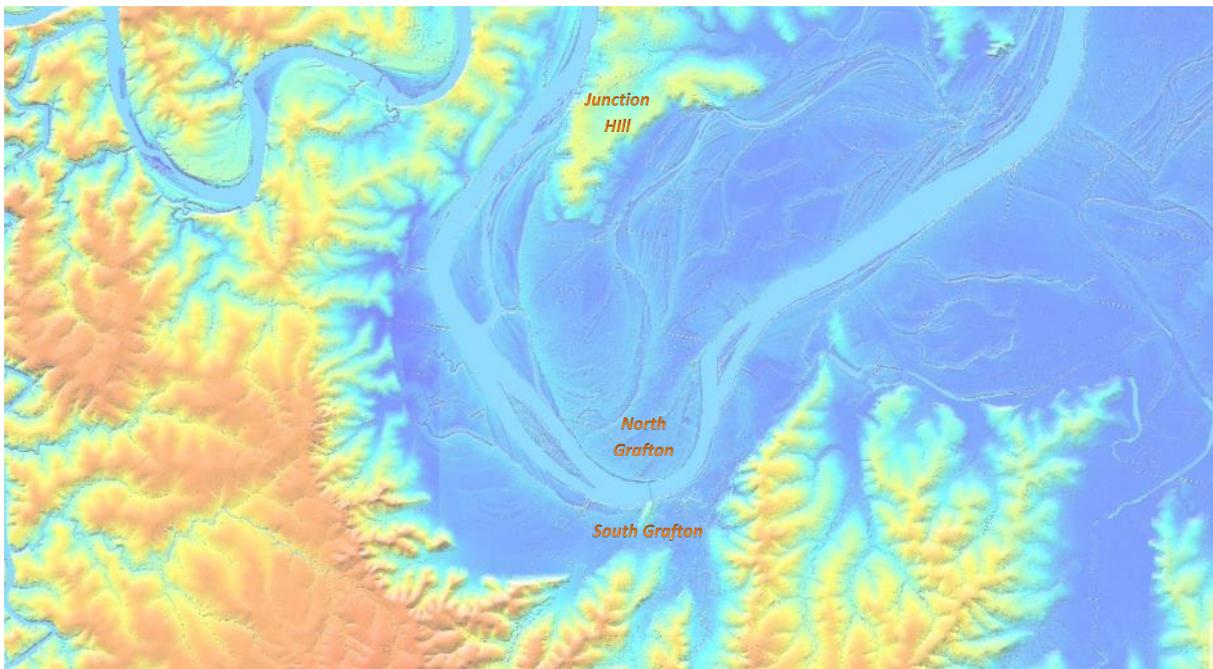


Figure 2. Locality Map - Grafton and Surrounding areas Digital Terrain Model

Before the 2012 Plan

Flood Plans are traditionally written with the best information available at the time. As better information has become available, the 2012 Plan is significantly different from SES evacuation plans in the past.

Previous flood plans (e.g. Grafton City Local Flood Plan, 2001) for Grafton have had the below general evacuation strategies:

- Evacuation Direction – The evacuation strategy in 1996 was to direct people north of Grafton to a higher ground locality called 'Junction Hill'. This strategy changed in 2001 and 2009, where evacuees were transported to Coffs Harbour, a city approximately 80kms to the south of Grafton.
- Trigger Heights – up until the 2012 Plan there was one single trigger height for the evacuation of Grafton. This trigger height was 7.5m (7.8m less 0.3m freeboard).
- Sectorisation of Evacuation Warnings – there was no sectorisation of Grafton, meaning that all properties were evacuated at once rather than in stages.

- Local Mass Evacuation Centres – there were no large scale evacuation centres locally based.
- Level of Flood Protection – former plans were based on the commonly held belief in Grafton that the levee provided a 1% AEP level of protection.
- Flood Impacts on Critical Infrastructure – these impacts were unknown and undocumented. There was no information about the Grafton Hospital, electricity, water, or sewer infrastructure.

The 2012 Plan

The 2012 Plan was produced in line with the 5 yearly review structure, required by the NSW SES, as part of the legislative requirements of the State Emergency Service Act (1989). This plan was produced following significant changes in the philosophy and methodology in local emergency management practices. The inputs to inform the 2012 Plan included data obtained from flood modelling, stakeholder consultation and observations from previous observations.

Flood Modelling Inputs

It is difficult to have an effective flood plan without good technical engineering or modelling information and improvements in technology were a corner-stone to the current arrangements prescribed in the 2012 Plan. The previous flood plans in Grafton have not had this and as such been difficult to implement.

Over the years there has been much confusion regarding the overtopping height and impacts of the Grafton and South Grafton levees. In response to the uncertainty, Council engaged a hydraulic modelling consultant (BMT WBM, 2011) to prepare several reports under a collective project title of “*Grafton and Maclean Flood Levee Overtopping: Hydraulic Assessment (2011)*”, hereafter referred to as ‘the Study’.

The model used in the Study was built based on the best information currently available (e.g. LiDAR data, recent levee height survey data and historical river flow rating curves). The modelling in the Study was intended to be used by a variety of stakeholders for a range of purposes (e.g. planning purposes, capital works purposes and evacuation purposes). As evacuation is the focus of this paper only this area will be discussed. The Study was required to provide Council and SES with information specifically for emergency management purposes, including information about evacuation route closures (depths and timings) and significant community resources such as the Grafton Base Hospital.

The production of the Study contributed significantly to the production of the revised 2012 Plan. In brief, the new modelling provided significant benefits for evacuation planning, including:

- Clarifying Grafton’s flood interval level of protection – a 5% AEP levee, not a 1% AEP levee as had been previously believed by much of the Grafton community.
- Informing appropriate trigger heights for evacuation. This is essential for a leveed city like Grafton. Until this information was obtained there had been great uncertainty in the community about when the levees will actually overtop. Some believed it was 8.00m, others thought 8.23m. There had been no real test, and as there was no overall levee design this was an unknown. Grafton residents have in the past viewed the SES’s triggers heights as low, causing “unnecessary” evacuations and have chosen to delay action until the last moment.

- Detailing which areas of Grafton flooded earlier by levee overtopping, allowing for staged evacuations. This meant that depending on the predicted flood peak, the SES now had the opportunity to limit the evacuation warnings to areas impacted by a 5% AEP flood (e.g. as per Figure 3) and perhaps only door-knock small number of properties. In the event of a 100 year flood, the SES could now sequence evacuations meaning some areas of Ryan Street (South Grafton) would require evacuation prior to some areas of North Grafton.
- Listing the theoretical times inundation would reach certain areas, which allowed the SES to get a good idea of times need to undertake evacuations. The report provided an assessment of critical evacuation routes (e.g. Fitzroy Street, Summerland Way, Bent/Ryan intersection, North Coast Railway), and provided detail on how long after levee overtopping the floodwater will reach a depth of 100mm over roads.
- Provided flood information for the Grafton Base Hospital, Grafton's most vulnerable facility, explaining how certain floods impact the Hospital. For example, the over floor inundation timings, with references to the Prince Street gauge and the final depths of water expected in the hospital in certain design floods. This allow for the SES and NSW Health to undertake an informed risk assessment before attempting patient relocation prior to or during flood events.

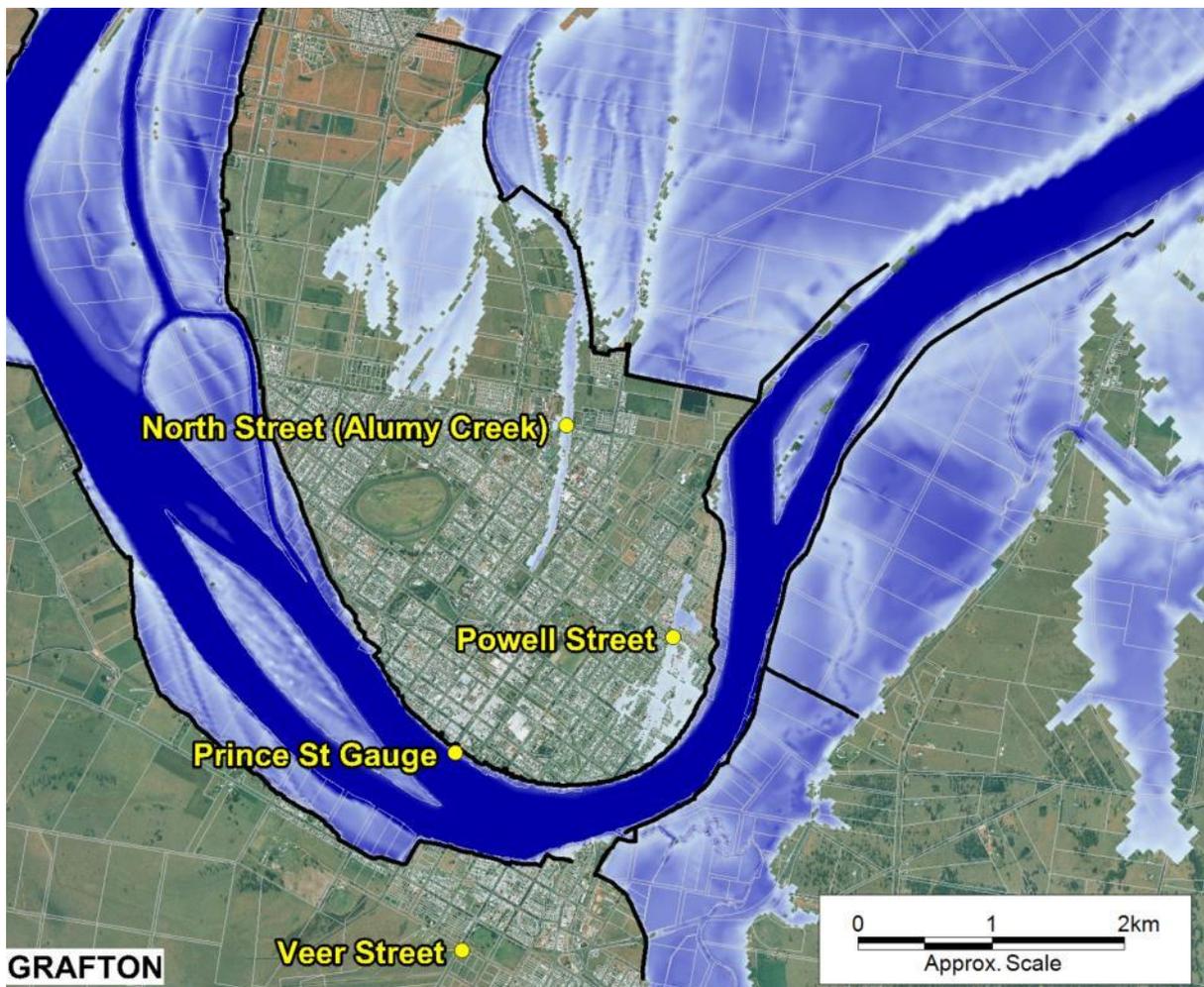


Figure 3. 5% AEP Flood Depth Grafton, note, minor overtopping of levees in South East Corner of Grafton (BMT WBM, 2011)

Stakeholder Consultation and Observations from Previous Floods

Grafton's levee and flooding situation is complex – and it must be emphasised the importance of stakeholder collaboration in solving complex situations. The 2012 Plan is a result of numerous stakeholder inputs.

Significant flood events were experienced in the Clarence Valley in 2009 and 2011. As the community is the largest stakeholder in floods, community focus groups were conducted following the floods which offered some very important analysis of what happened in the event at the coal face and views on where improvements could be made. Example of some focus group comments (SES Focus Group, 2009):

- The SES door knock was very determined, and there appeared to be no delineation of 'low-lying' areas i.e. most vulnerable areas.
- For evacuations Grafton should be divided into low, moderate and high risk levels and commence with the highest risk.
- There should be ongoing dialogue between community, the NSW SES, Bureau of Meteorology, NSW Police and the local Clarence Valley Council to better prepare the district and improve warnings and response.

In the formation of the 2012 Plan, a Working Group was established consisting of Clarence Valley Council members, Emergency Service Agencies (LEMC), Flood Engineers, NSW SES State HQ planners, Local SES Controller, and Flood Consultants. This group met in April 2011 setting agreed triggers informed by modelling that had previously been the cause of considerable confusion for emergency management personnel and contention for the community. This provided more realistic heights for commencement of evacuations.

The 2009 and 2011 floods allowed for the collection of enhanced flood intelligence. The lessons learnt from previous events provided opportunities so past mistakes are not continued into the future. The opportunity to enact parts of the earlier plan and the revision of procedures was invaluable. The general evacuation strategies discussed earlier were able to be critiqued:

- Evacuation Direction: The problem with the Junction Hill strategy is that it is likely to be isolated during a major flood event and also there is no potential evacuation centre located in Junction Hill of sufficient capacity to house the evacuated residents. Additionally, the problem with the Coffs Harbour strategy is that the SES obtained feedback that evacuees were more likely to move to an evacuation centre if it was locally based. People were not happy moving to locations 80km away from their homes. The 2012 Plan states the priorities of self-evacuation to friends/family outside of the impact area or to an appropriate facility located on high ground in South Grafton.
- Trigger Heights – clearly the existing single trigger height was too low, as floods had reached that level without any inundation of Grafton. It was realized that multiple triggers would be beneficial. The 2012 Plan states that prediction of floods to reach or exceed 7.8m would result in targeted evacuation warnings of Sector A, 7.9-8.0m floods evacuation order for Sector A and warning for other areas, and predictions of 8.2m evacuation orders for the remaining low-lying areas of Grafton.
- Sectorisation of Evacuation Warnings – this was considered essential, was desired by the community and made possible by flood modelling. The 2012 Plan schedules evacuations using the order of Sector A, Sector B, Sector C, and finally Sector D.
- Local Mass Evacuation Centres – it was deemed essential to have a locally based large scale evacuation centres. The 2012 Plan nominated assembly area is the South Grafton High School Auditorium. This large facility can be used as an assembly point in the short term, but could also double as an evacuation centre should the need arise.

- Flood Impacts on Critical Infrastructure – knowing these impacts was deemed essential to inform evacuation decision. As such these impacts were revealed through stakeholder consultation and flood modelling. The 2012 Plan provided information on sewer, drinking water, electricity and communications. The modelling stated that the Grafton hospital will only be inundated in floods that exceed 9.0m (a rarer than the 0.1% AEP flood).
- Notification of Warnings – January 2011 was the first occasion where emergency alert telecommunications technology was utilised. Community feedback enabled determination of better messaging for the future.

The 2013 Flood Event

The flood event in January 2013 provided an occasion to test the changes implemented in the plan and the benefits they provided to emergency response and community.

On the 29th of January 2013, the BOM forecast flood levels at the Prince St gauge would reach 8.1m. At this flood level the modelling predicted minor overtopping of parts of the levee and under the 2012 Plan, the targeted evacuation of Section A was undertaken. The BOM prediction proved quite accurate, with the flood level reaching 8.08m. The flood modelling proved accurate in terms of defining the area which would be inundated from the minor overtopping.

This new refined 2012 Plan allowed the community to access specific data from either the NSW SES or Clarence Valley Council website, on their local area, detailing all trigger alert mechanisms which will be used and the evacuation routes to the established Assembly Areas. The Clarence Valley Flood Plan was also supported by Flood Safe Guides which are provided to community members prior to operational times, and mirrors the information held by the Incident Controller but in a simple, easily understandable format.

The operational sectoring of the high risk areas into fourteen response components allowed the operational planners quick access to important information needed for enacting the evacuation of residents through various alert systems and relocation to pre-established assembly areas, through a road network system that should not be affected by closures or inundation. Timeframes allowed for the issuing of warnings via, radio, television, social media and emergency alert mechanisms nominated in the sectors.

The success of the 2013 flood in Grafton and the good management practices that were followed and put into action resulted from all of the above stakeholder contributors. During this event warning orders were issued to high risk areas rather than all residents and a new evacuation centre, outside of the flood zone, was implemented. Other key indicators of the success of the 2013 event was the fact that After Action Reviews revealed very little need to change any aspect of the 2012 Plan, there was only positive media coverage of the SES's performance in the event, and the Grafton community seemed to have good 'buy-in' of the 2012 Plan.

Lessons from the Experience

The lessons from this project are similar to the lessons noted in Keys (1995/96):

- Develop networks to support the planning activity. Emergency planning cannot be carried out in isolation, either in terms of inputs to it or outputs from it.
- The SES has found it useful to maintain effective liaison with councils by, for example, keeping council engineers briefed on the planning work and presenting papers at conferences on flood themes.
- Keep the plans alive. A failing of much emergency management planning is that too many plans are allowed to gather dust after they have been written.
- Response organisations must be encouraged to keep their plans under review so as to recognise changes in the flood environment (which will alter the nature of the flood problem) or changes in the community (which may alter the required management arrangements outlined in the document).

Conclusion

This paper described recent changes to the Grafton Annexure of the Clarence Valley Local Flood Plan and how these changes came about. This paper does not claim that the 2012 Plan is perfect and that it will not be updated again in the future. There is no such thing as a perfect plan, and with changes such as a new Grafton Bridge, a major highway bypass, and technology developments, the 2012 Plan will certainly need to be updated again in the near future.

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