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The Lismore levee system and the lessons learnt - 2002 to 2013

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ABSTRACT

With the floods experienced in Queensland, mitigation measures like levees are increasingly seen as the future of risk reduction for communities. If this is the case then authorities who will be planning, designing and constructing levees will need to ask these fundamental questions: Is it achievable?; What design height is logical for the area? Will it be affordable?; and what happens when the levee is overtopped as it inevitably will.

The Lismore Floodplain Risk Management Plan (FRMP) was adopted by Lismore City Council (LCC) in October 2002. Since then some measures in the plan have been successfully implemented, notably the CBD levee.

From the outset there were many challenges including achieving consensus on how high the levee should be, whether it be a 1:20 ARI or a 1:10 ARI, and what the alignment should be, which was the subject of intense lobbying by various individuals and groups; this alone meant that to reach agreement required compromise. .

The 1:10 year CBD levee was completed in 2005 and recognising the importance of the levee's role in mitigating flooding for Lismore, a detailed Operations and Maintenance Manual was developed with clearly defined roles. Following the 2009 floods a routine levee audit identified a failure in a section of levee, which led to three years of planning and restoration works costing $2.1 million.

Local authorities are more than aware that the levee will be overtopped at some time in the future and evacuation planning and education are seen as critical to averting disaster for residents and businesses in the CBD and nearby areas due to complacency about the flood risk and the level of levee protection.

Background

The 1:10 year Lismore CBD levee was completed in 2005 and recognising the importance of the levee's role in mitigating flooding for Lismore, a detailed Operations and Maintenance Manual was developed with clearly defined roles. Richmond River County Council in partnership with Lismore City Council conducts regular audits and maintenance works to ensure that the levee performs as designed. Following the 2009 floods a routine levee audit identified a failure in a section of levee, which led to three years of planning and restoration works costing $2.1 million.

Local authorities are more than aware that the levee will be overtopped at some time in the future and evacuation planning and education are seen as critical to averting disaster for residents and businesses in the CBD and nearby areas due to complacency about the flood risk and the level of levee protection.

This paper provides an overview of the lessons learnt on levee design, construction, maintenance, audits and risk reduction for the Lismore levee system. Without the levee, flooding would have inundated the Lismore CBD in 2009 and possibly in 2005. At a cost of $21 million the levee has proved its worth considering a similar flood damage bill has been averted.

Levees are just one component of flood mitigation and not the complete answer for flood risk management. This paper also discusses the importance of an integrated approach to flood risk management by State and local governments in achieving a viable multi-faceted flood protection scheme for Lismore.

In 2006 a paper by the key note speaker suggested that there are two types of levees those that have failed and those that are waiting to fail. The reliance solely on structural answers like levees needs to be closely scrutinised. In the Lismore experience the levee had provided a design protection of a 1:10 ARI and has kept the city dry from three flood events 2005, 2008 and 2009. These lower magnitudes of floods represent the nuisance flooding that impacted Lismore on a regular basis (Figure 1) and the cost associated were not insignificant. It is estimated that the Lismore levee has paid for its construction cost over twice through reduced flood damages.

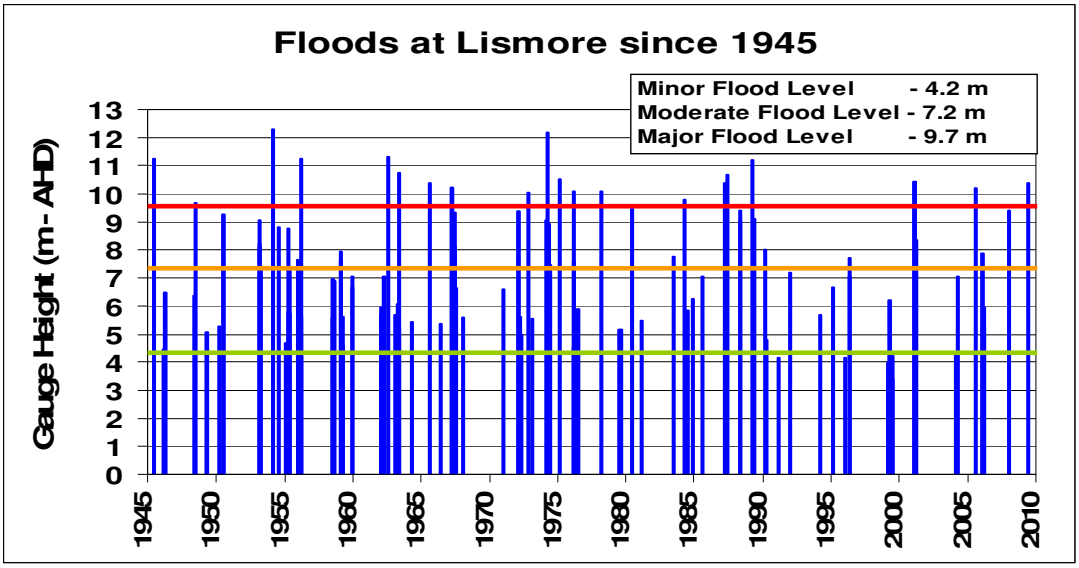

Figure 1: History of floods in Lismore 1945-2010

The completed 1 in 10 Year Lismore Levee Scheme was conceived in 1999 and approved the following year, after the 1 in 20 Year Lismore Levee Scheme was rejected in 1995 as being too costly. The scheme's objective was to provide a minimum 1 in 10 year ARI flood protection to Lismore as well as equity in flood protection between the three sectors of Lismore (refer to Figure 2).

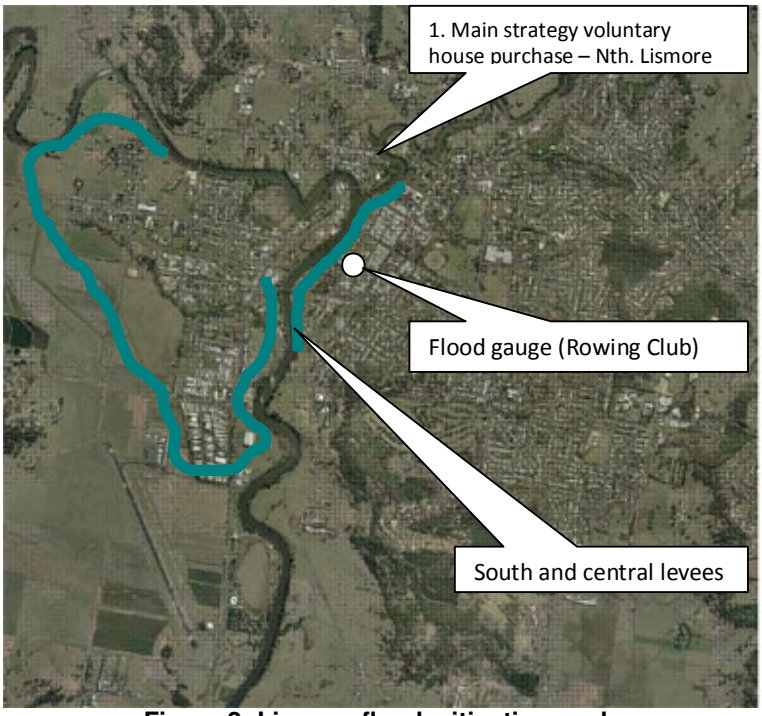

Figure 2: Lismore flood mitigation works

The main components of the scheme are:

- Relocation of a 1.7km section of the existing 1 in 10 year ARI South Lismore levee to increase the flow capacity of the airport floodway.
- Construction of a 1.7km CBD levee to protect flooding of the CBD up to the 1 in 10 year ARI flood.
- Raising of 15 houses in North Lismore with floor levels lower than the 1 in 10 year ARI flood to 300mm above the 1 in 100 year flood level.

Importantly the CBD levee also provides an additional two hours in flood evacuation time for residents to evacuate.

The extreme risk to life associated with severe floods was not recognised until LCC prepared its Floodplain Risk Management Plan (FRMP) in 2002. In an extreme flood the hazard would be so great that large tracts of South Lismore, North Lismore and to a lesser extent the CBD would suffer great damage. Anyone trapped on the floodplain would probably perish.

Understanding the benefits and issues with levees

Prior to any authority embarking on structural mitigation measures it is important to ask the questions of:

1. Is it achievable?
2. What design height is logical for the area?
3. Will it be affordable? and

4. What happens when the levee is overtopped as it inevitably will?

Is it achievable?

In the Lismore experience the answer is of course yes but not without a number of construction and alignment issues. Supporting the lower bank through rocking or piles allowed the construction to be close to the River bank edge but in hind sight was this the best option?

Original Levee concepts proposed the levee be constructed approximately 100m from the river's edge. Well away from possible failure zones adjacent the high bank.

While this was achieved in a number of areas local politicians and business people joined forces to have the levee constructed around important buildings. Most notable were the Lismore RSL and Lismore Club.

The RSL required continuous piling and Rocking of the river bank.
The Lismore Cub levee suffered a major failure in 2009 and had to be reconstructed highlighting the importance choosing the right alignment and resisting lobbying from interest groups..

What design height is logical for the area?

This is a critical question and in the context of the Lismore levee why a 1:10 tear ARI design height? The Grafton levee is a 1:100 ARI design height and although it has not over topped yet in 2001 and 2013 the City escaped major flooding by centimetres.

As noted above this magnitude of flood represented the majority of floods that entered the Lismore City. A 1:20 year ARI was mooted but for financial and political reasons was not adopted.

The original proposal was to construct a levee around all sections of Lismore

- South Lismore
- Central Lismore CBD and
- North Lismore

After numerous reports the adopted Levee system included the following:

- The existing 1 in 10 levee for South Lismore was extensively modified and raised.
- The protected areas was reduced allowing for an enlarged floodway around the levee and
- A 1 :10 levee around Central Lismore CBD

There was no levee planned for North Lismore but assistance with house raising and business flood storage was provided.

Additional pump stations in South and Central Lismore to handle internal flooding

Will it be affordable?

At a final cost of $21 million Dollars for the Lismore levee this represented a major investment of public funds. The source of the funding was on a 1:1:1 basis with Federal, State and Local Government cost sharing to realise the full construction costs.

Lismore City Loan funded their share of the works and a special rates levy was placed on everyone within the CBD protected areas to assistance with the costs.
The CBD business operators were happy to pay the extra rates and have realised meaningful savings from flood damage and clean up. The residents on land only mildly impacted by flood were less happy to pay the extra dollars.

What will happen when the levee overtops?

When the Lismore Levee does overtop that is when the real recrimination will begin. For example why did council not build a larger levee? There are a number of answers to this – cost; a larger levee when over topped would result in catastrophic damage to the City and the displacement of flood water would impact Nth and South Lismore to a greater degree.

A quick look at the flood frequency chart will show that Lismore CBD was regularly flooded. The Business people in the CBD wanted some relief from the regular flooding, loss of business and cost of packing up and unpacking after the flood.

While the Business people are very happy that they have been protected from two major floods most have little understanding of what will happen when a historically large flood such as the 1954 or 1974 flood arrives.

The one major advantage of having this levee is that it does give people more time to pack up and get out of town before the big flood arrives. It also gives the BoM and SES more time to provide sound flood predictions and SES to evacuate the town.

Currently SES evacuate:

- North Lismore through the CBD
- Then South Lismore through the CBD
- Finally evacuate the CBD and close the roads to all trying to enter the CBD.

The city remains closed to vehicular traffic until major routes are clear of water.
Police SES and Bushfire man the checkpoints to keep sight seers out of the CBD until the city can be cleaned and made habitable.

The Importance of maintenance; Operation and Audits for levees

(***Extract from the Development of Methodology and Visual audit for Urban Levees Office of Environment and Heritage 2013)***

Effective monitoring, maintenance and reporting of levee condition are important so their condition is understood and where warranted it also enables:

- Specific defects to be monitored and rectified so the levee remains fit for purpose for its design life.
- The reliability of the levee and key issues affecting this reliability to be understood and monitored as condition deteriorates or rectification works are undertaken.

- Rectification works to be completed as early as practicable to limit further deterioration, repair costs and additional risk exposure of the community.
- The levee owner RRCC to develop contingency plans to deal with defects where repairs may not be completed before the next flood.
- Relevant government agencies including flood risk managers (the Office or
- Environment and Heritage, OEH) and emergency services (NSW State Emergency Service, NSW SES) to be kept up to date on the levee condition and the owner's contingency plans to deal with defects so that effective response and recovery plans can consider the likely ramifications of a flood event.

The 2009 flood damage to the Lismore levee

Under the operations and maintenance manual regular audits are carried out following a flood to assess any damage and or at least twice a year to ensure maintenance is carried out.

On an audit of the levee following the 2009 flood some damage was detected in section of wall behind the Lismore Club. This seemingly innocuous and small opening of a joint was the first sign of a major failure of a 100m section of the wall compromising the flood protection to the city. The SES had to take the precautionary approach of treating and future flood response as if the wall was not there at all.

The restoration of the damages section took three years. Following is a potted history of that process.

The section of levee around the Lismore club was one of the first sections constructed and placed very near the river in order to maximise development potential of the site. This was clearly a mistake and there were always concerns about the long term durability of this section of the levee wall.

The levee condition is carefully inspected every 6 months and after flood events.

Following the 2009 flood the levee was inspected and found to be showing signs of failure. Experts from Snowy Mountains Engineering were called in which resulting in a test drilling program and the pronouncement that the whole area was unstable and likely to end up in the river as the next flood recedes.

The recommended remediation was to construct a new levee 30 m back form the existing levee. Unfortunately this required the purchase of two properties and the demolition of the rear of the historic Lismore Club.

Engineering work was relatively simple with a new 1.5 m concrete levee constructed on sound ground well away from the river. Removal of the old levee, removal and reshaping of the river bank and the instillation of 80 m of deep piles along the edge of the river were the last stages.

By far the most difficult part of the whole exercise was getting everyone involved to agree to the recommended option.

Land purchased end up costing $600 000, with the Engineering and construction costs of $1.7M.

Conclusion
The Lismore Levee system has delivered real flood risk reduction and savings to the local community, State and Local governments. On refection the process for the Lismore levee was convoluted and clearly there were some mistakes made in choosing the best alignment in some sections. The on-going education of residents is critical as belief in the levee allows complacency and at some time the levee will overtop. As with most projects the moral of the story is to do the job properly the first time and don't have any comebacks.

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