HAZARD NOTE

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TOPICS IN THIS EDITION | ECONOMICS | ENGINEERING | FLOOD | MITIGATION

COSTS AND BENEFITS OF FLOOD MITIGATION IN LAUNCESTON

▲ **Above:** FLOODWATERS IN ROYAL PARK, LAUNCESTON, DURING THE JUNE 2016 FLOOD. PHOTO: UPSTICKSNGO_CREW CC BY 2.0.

ABOUT THIS PROJECT

This flood risk mitigation assessment for Launceston was conducted as part of the *Cost-effective mitigation strategy for flood-prone buildings* project. It was carried out in collaboration with the City of Launceston, the Launceston Flood Authority, the Tasmanian Department of Premier and Cabinet, Northern Midlands Council, Tasmania State Emergency Service and Geoscience Australia.

Download the full report at www.bnhcrc.com.au/hazardnotes/40

AUTHORS

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SUMMARY

With Launceston experiencing severe flooding in June 2016, this project reviewed the costs and benefits of mitigation work (upgraded levees) which began in 2010. Flood mitigation is an expensive exercise, and this research highlights the benefits through avoided impacts of the flood levee mitigation program, against the cost of construction.

Findings show that the upgrading of the levee system, completed in 2014, resulted in avoiding losses of about $216 million (had the pre-existing levees failed), which is approximately four times the total investment in the new levee system. This investment in building the new levee system was found to be a sound economic decision based on the estimated costs at the time of decision making, alongside improved estimates of benefits from this study. The actual benefits of these mitigation works to the community extend beyond the direct benefits as assessed in this project, to the intangible and indirect benefits that have not been included.

It was found that sea level rise scenarios would only have a limited impact on building losses. However, the combined impact of sea level rise and increased rainfall intensity due to climate change on the total losses may be significantly greater and could be further investigated.

CONTEXT

The nature of recent flood mitigation works and the specific nature of the June 2016 flood provide a sound opportunity to assess the cost benefits of the Launceston levee system. This assists in developing an evidence base for future investment in mitigation.

BACKGROUND

Located within the Tamar River floodplain at the confluence of the Tamar, North Esk and South Esk Rivers in Tasmania, Launceston is a flood-prone city. There have been 35 significant floods, with the 1929 flood considered the worst. In the 1960s, a ten kilometre flood levee system was constructed to mitigate the risk. The levee system was upgraded from 2010 to 2014, expanding to 12 kilometres of earth levee, 700 metres of concrete levee and 16 floodgates. Following significant flooding in June 2016, this project conducted a cost benefit analysis of this new levee system.

BUSHFIRE AND NATURAL HAZARDS CRC RESEARCH

This study assessed many factors related to the flood risk in Launceston:

- What was the avoided damage costs as a result of the 2010 to 2014 levee upgrade?

- How many people would be displaced because their home was flooded, ranging from a 20 year annual recurrence interval, up to the probable maximum flood height?
- What was the avoided building damage in the June 2016 floods as a result of the 2010 to 2014 levee upgrade?
- What would have been the long term cost to Launceston from floods prior to the mitigation works?
- What are the long term costs to Launceston from floods following the mitigation works?
- Undertake a cost benefit analysis of the investment in the 2010 to 2014 levee upgrade.

TABLE 1: ADOPTED CONDITIONAL PROBABLITY OF FAILURE FOR EXISTING AND NEW FLOOD LEVEES

AVERAGE RETURN INTERVAL (Years)	CONDITIONAL PROBABILITY OF FAILURE OF PRE-2010 LEVEES	CONDITIONAL PROBABILITY OF FAILURE/OVERTOPPED OF CURRENT LEVEES
100,000	100%	100%
1,000	100%	100%
500	100%	10%
200	75%	0%
100	40%	0%
50	5%	0%
20	0.05%	0%

RESEARCH FINDINGS

Avoided damage costs
The results indicate that during the 2016 flood (a 50 year annual return interval event for the North Esk River), the reconstruction of the levee system resulted in avoiding losses of about $216 million (had the pre-existing levees failed). The losses that would have been experienced should the old levee have failed would be approximately four times the investment in the new levee system.

Estimated affected population
Estimates of the number of people displaced by flooding are based on the assumption that the new levee system would provide protection up to flood heights expected to occur on average every 200 years (see Table 2, page 3).

Residential building damage
Residential building damage was estimated using 15 vulnerability models for residential buildings developed by Geoscience Australia. Each residential building (1,980 in total) was assigned an appropriate vulnerability model based on the building attributes, such as the type of foundation, wall material, age, number of stories, and presence of a garage. Losses to ancillary structures such as fences, swimming pools, garden sheds and detached garages were not considered.

The damage index (ratio of repair cost to replacement cost), was assessed for each residential building for different flood levels, ranging from the 20 year average return interval, up to the maximum probable flood height based on the inundation depth above ground floor level.

The total repair cost for each flood level was calculated as the summation of the product of the damage index, the updated unit replacement rate, the number of stories and the ground floor area of each affected residential building.

It is estimated that the investment in the new levee system reduced the total losses related to residential buildings by $1.28 million per year.

END-USER STATEMENT

By engaging and partnering with the Bushfire and Natural Hazards CRC, the City of Launceston reaffirmed its wise decision to invest in upgrading the flood levees in 2010, further backed by a robust ongoing maintenance program for the levees. The coordinated effort with the scientists gives confidence to the safety of the Launceston community from the impact of significant flood events, which also result in reduced levels of economic losses to the city.

By engaging with the Bushfire and Natural Hazards CRC we have managed to refine our data by acquiring better information and knowledge which should benefit future choices in effective flood management within the urban drainage catchments.

– Felix Chigama, Hydraulics Advisor, City of Launceston

Long term cost
The average annual loss from floods in the residential and non-residential sectors was calculated for a number of different scenarios:

- No levee system at all (potential loss in table four, page 3)
- The older, pre-2010, levee system, taking into account the likelihood that the levee would fail (conditional loss – before mitigation in table four, page 3)
- The new levee system, taking into account the likelihood that the levee would fail (conditional loss – after mitigation in table four, page 3)

Findings show that the average annual loss from flooding with the old levee system would be $3.95 million, but that the new levee system reduced this annual loss to $1.04 million per year. This reflects a saving of $2.91 million per year due to the investment in mitigation (see Table 4, page 3).

Cost benefit analysis
This aspect investigated the dollar benefits of the new levee system, compared to the old system. The project life was considered to be 80 years, and five annual discount rates (ranging from three to seven percent) were used to assess the sensitivity of the results to investment capital cost. Typically in Australia a seven percent discount rate has been used within government for investment decisions, as it represents the longer term opportunity cost of capital. However, for climate change studies, discount rates as a low as 3.5% have been used (e.g. in the UK) to assess long-term benefits of adaptation, as the future climate-related impacts and benefits tend to disappear in economic assessments when high discount rates are used.

The actual investment cost comprised an initial construction and land acquisition cost of $58 million in 2016 dollars. The ongoing maintenance cost consists of $181,000 annually, with an additional $250,000 every five years for the first twenty years. For the calculation of the benefit cost ratio, it was assumed that the maintenance cost would be

TABLE 2: ESTIMATED AFFECTED NUMBER OF PEOPLE IN RESIDENTIAL SECTOR

AVERAGE RETURN INTERVAL (Years)	ANNUAL PROBABILITY OF EXCEEDANCE	NUMBER OF AFFECTED RESIDENTIAL PROPERTIES	NUMBER OF AFFECTED PEOPLE	
			Before Mitigation	After Mitigation
100,000	0.00001	1,853	4,262	4,262
1,000	0.001	989	2,275	2,275
500	0.002	864	1,987	199
200	0.005	786	1,356	0
100	0.01	707	650	0
50	0.02	627	72	0
20	0.05	551	1	0

TABLE 3: ESTIMATED BUILDING REPAIR COST (RESIDENTIAL SECTOR)

AVERAGE RETURN INTERVAL (Years)	TOTAL POTENTIAL LOSS ($ M)	CONDITIONAL PROBABILITY OF FAILURE		CONDITIONAL LOSS ($ M)		AVERAGE ANNUAL LOSS ($ M)	
		Before Mitigation	After Mitigation	Before Mitigation	After Mitigation	Before Mitigation	After Mitigation
100,000	466.06	1	1	466.06	466.06	1.769	0.486
1,000	218.23	1	1	218.23	218.23		
500	192.27	1	0.1	192.27	19.23		
200	149.53	0.75	0	112.15	0		
100	127.35	0.4	0	50.94	0		
50	106.23	0.05	0	5.31	0		
20	75.39	0.0005	0	0.04	0		

TABLE 4: ESTIMATED TOTAL LOSS ($) BEFORE AND AFTER MITIGATION

AVERAGE RETURN INTERVAL (Years)	ANNUAL PROBABILITY OF EXCEEDANCE	POTENTIAL LOSS ($ M)	CONDITIONAL LOSS ($ M)		AVERAGE ANNUAL LOSS ($ M)	
			Before Mitigation	After Mitigation	Before Mitigation	After Mitigation
100,000	0.00001	972.2	972.2	972.2	3.95	1.04
1,000	0.001	476.5	476.5	476.5		
500	0.002	430.2	430.2	43		
200	0.005	324.8	256.4	0		
100	0.01	278.4	111.2	0		
50	0.02	232.4	11.9	0		
20	0.05	165.8	0.08	0		

the same for both the existing and new levee. Therefore, this cost was not included in the cost benefit analysis.

Results show that the benefit cost ratio remains less than one for the discounted rates of five to seven percent when the actual project costs are used (see table 5, page 4). However, the benefit cost ratio improves considerably if the original estimated cost of the project used for decision making is used. This was assessed to be $22 million in 2006 ($27.9 million in 2016 dollars), but was exacerbated later due to increases in the cost of construction and land acquisition. The original estimated cost yields a benefit cost ratio greater than one for all discount rates.

These findings show that under most discount rates for the estimated and actual cost, the benefit of the mitigation work is greater than the cost of the levee construction.

▲ **Above:** FLOODWATERS AT CATARACT GORGE NEAR LAUNCESTON. PHOTO: DANIEL SALLAI CC BY-NC-ND 2.0

TABLE 5: COST BENEFIT ANALYSIS FOR SELECTED DISCOUNT RATES

COST BASIS	TOTAL INVESTMENT (2016 $ M)	AVOIDED LOSSES (2016 $ M)					BENEFIT COST RATIO (BCR)				
		3%	4%	5%	6%	7%	3%	4%	5%	6%	7%
Actual cost	58.4	88	69.7	57.1	48.1	41.4	1.51	1.19	0.98	0.82	0.71
Estimated cost	27.9	88	69.7	57.1	48.1	41.4	3.15	2.49	2.04	1.72	1.48

HOW IS THIS RESEARCH BEING USED?

This research continues to add to the national and international evidence base for the benefits of investing in mitigation over response and recovery. It provides support for the further development of the Launceston flood mitigation program.

This project also revealed that despite the difficulties in quantifying intangible benefits to support flood mitigation, good evidence-based scientific research is progressing in Australia to narrow this knowledge gap. Quantification in monetary terms of the social and environmental impacts resulting from flooding may come as a relief for those communities who would otherwise be excluded from flood mitigation projects. Note, that for the purpose of economic analyses, avoidance or reduction in flood risk is defined as a ‘benefit’.

The City of Launceston hopes that any outcomes from further research in intangible benefits will assist it and its partners in future decision making.

FURTHER READING

Fullard A (2013), Launceston – a city on a floodplain, protecting Launceston from a 1 in 200 ARI flood. Floodplain Management Association National Conference; 19pp.

Maqsood T, Wehner M, Mohanty I, Corby N and Edwards M (2017), Launceston flood risk mitigation assessment, Bushfire and Natural Hazards CRC.

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.