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INTEGRATED ECONOMIC ASSESSMENT OF FLOOD MANAGEMENT OPTIONS FOR ADELAIDE

Atakelty Hailu
Centre for Environmental Economics & Policy,
The University of Western Australia, WA

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme
THE UNIVERSITY OF WESTERN AUSTRALIA

FLOOD DAMAGES

- Flood related damages can be high and diverse
- In 2002, for example, floods in Germany, Australia and the Czech Republic caused about 15 billion euros in damages
- In Australia, floods are the most frequent natural disasters and account for 80% of the overall costs of disasters, and cost about AU$600 million per annum (Gentle et al. 2001; Productivity Commission 2015)

QUEENSLAND FLOOD OF 2010/11

- The average figures do not reflect the severity of flood impacts

- The 2011 Queensland floods, for example, caused extensive and devastating impacts (in the billions)

DISASTER SPENDING IMBALANCE

- There is a growing recognition that funding arrangements are not efficient and do not create the right incentives for managing risks (Productivity Commission 2015)
- Under-investment in mitigation and over-investment in post-disaster interventions
- Structural solutions (levees, dams, diversion channels, detention basins, etc.) are typically capital intensive and costly
- On the other hand, assessment of mitigation benefits tends to be partial and focused on direct and tangible benefits

IMPROVEMENTS IN FLOOD MANAGEMENT

- Intangible values can be large, and even the dominant cost in some cases

- Key areas for improvement in flood management include (Meyer et al. 2015):

  - Increased focus on **non-structural measures** (early warning and evacuation systems, and community education programs)

  - Evaluating **indirect and intangible costs** or values

INTANGIBLE OR NON-MARKET VALUES

- Intangible or non-market costs and benefits are values that are **not captured in market transactions**
- Broadly speaking, these can be **Use** or **Non-use** values
- Require special **techniques** for estimation
  - **Revealed preference** (based on observed behaviour)
  - **Stated preference** (based on surveys that elicit people's willingness to pay (WTP) directly or indirectly)
    - Contingent valuation
    - Choice experiments

NON-MARKET VALUE TYPES

Health	Environment	Social
Mortality, morbidity, injury, stress/anxiety, pain, trauma, grief, increased vulnerability among flood survivors	Wildlife loss, ecosystem degradation, water quality problems, invasive species	Recreation values, amenity values, safety, social disruption, cultural heritage, animal welfare, loss of memorabilia

DAMAGE COSTS

	Tangible costs	Intangible costs
direct	**(Inside flood)** Damage to buildings, infrastructure and other property, evacuation and rescue expenses, cleanup costs	Loss of life, injuries, psychological distress & other health effects, loss of memorabilia, water quality problems and loss of environmental goods
business interuption	**(Inside flood)** losses because of damaged production assets or accessibility problems	Nonmarket losses (e.g. ecosystem services) due to interruption
indirect	**(Outside flood)** losses imposed on consumers and producers, upstream and downstream of directly affected companies; (market) cost of traffic disruption	Nonmarket aspects of traffic and other disruption suffered, inconvenience of post-flood recovery, trauma, loss of trust and increased sense of vulnerability

RISK MITIGATION COSTS

	Tangible costs	Intangible costs
direct	Direct setup or capital costs of infrastructure and running and maintenance costs	Cultural heritage and environmental damage resulting from flood infrastructure (e.g. dams) and other changes
indirect	Costs imposed on other economic sectors	Loss of recreational values because of mitigative investment or structure

BROWN HILL AND KESWICK CATCHMENTS STUDY

BROWN HILL AND KESWICK CATCHMENTS (ADELAIDE)

- Storm Management Plan (SEM 2016) as a result of collaboration among councils (Adelaide, Burnside, Mitcham, Unley and West Torrens)

- Objective of reducing major flooding from four water courses in the catchment, up to a 100-year average recurrence interval (ARI) flood

- Mitigation works fall under two categories
  - **Part A**: already agreed to and aim to mitigate flooding from mainly urban sub-catchments of lower Brown Hill Creek, Keswick Creek, Glen Osmond Creek and Parklands Creek
  - **Part B**: Still under consideration, aim to mitigate flooding from upper Brown Hill Creek

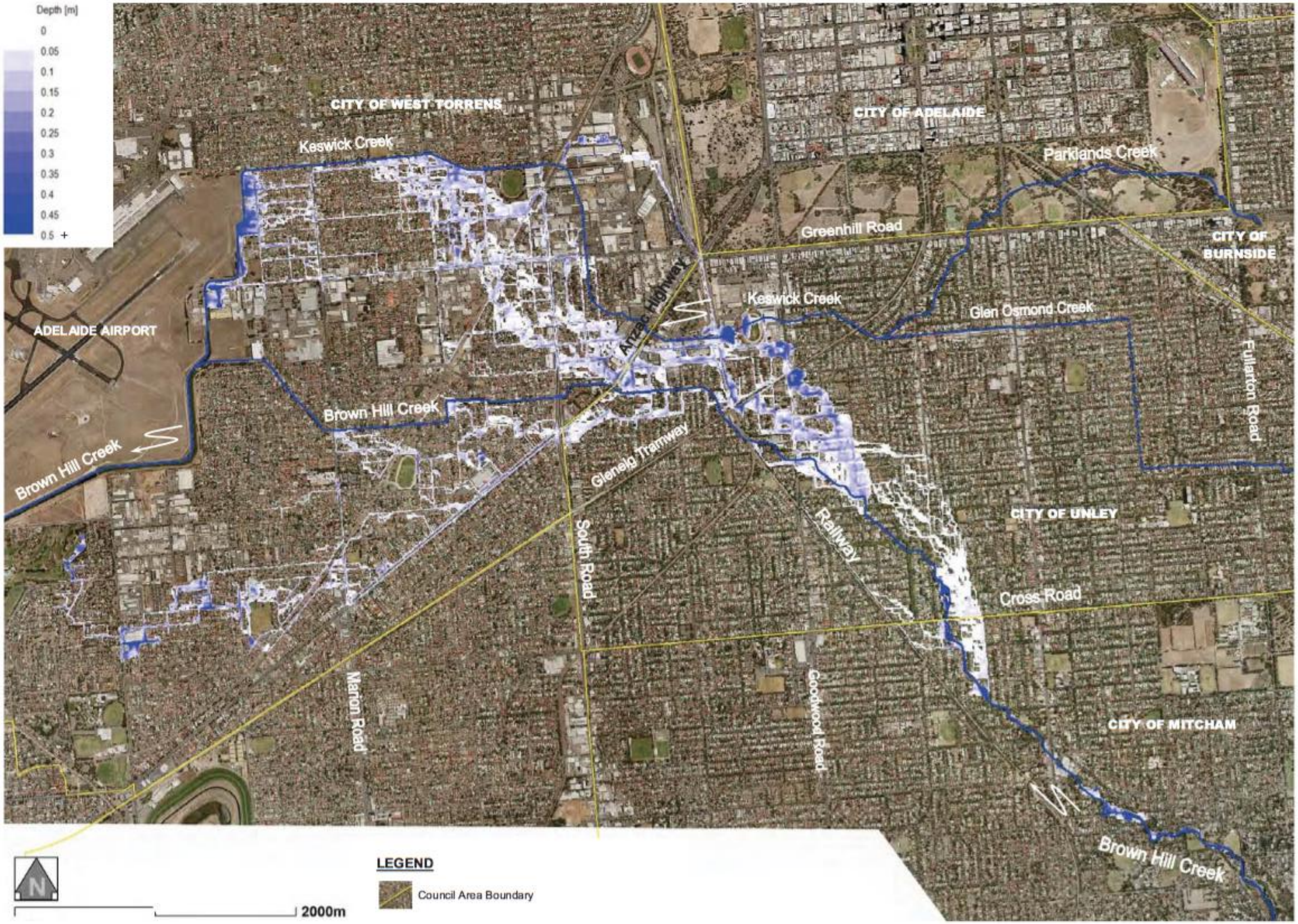
PART B WORKS INCLUDE OPTIONS THAT COMBINE

- Detention dams to temporarily store and reduce floodwater flows into the Creek from the rural parts of the catchment

- High flow bypass culverts to avoid creek overflows in low capacity sections

- Creek capacity upgrade (including bridge upgrades)

- All options (see next table) provide the same level of flood protection (up to 100-year ARI)



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Rp301015-02356 – Brown Hill Keswick Creek SMP
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SIMULATION No. 7
100 YEAR ARI BASE CASE FLOOD MAPPING
[36HR UPPER BROWN HILL CREEK INFLOWS ONLY]

Component Options	B1	B2	D
Detention dam location	Brown Hill Creek Recreation Park	Ellisons Gully	Not required
Estimated number of properties requiring creek capacity upgrade works; requiring an agreement or easement	29	22	66
Number of properties where land acquisition is required	0	2	0
Number of properties requiring an easement for Dam Site 2	0	3	0
Number of public bridge upgrades	4	4	10
Creek rehabilitation works	Full length of creek	Full length of creek	Full length of creek

TANGIBLE VALUE DAMAGE ESTIMATES (SOURCE: SEM 2016)

Years of ARI	Annual probability	Flood damages (AU$000)			
		Base Case	Option D	Option B1	Option B2
10	0.1	-	-	-	-
20	0.05	1,339	-	-	-
50	0.02	22,273	-	-	-
100	0.01	40,141	137	91	80
500	0.002	168,316	145,744	123,963	64,655
PMF		500,000	500,000	500,000	500,000

INTANGIBLE VALUES CONSIDERED

1) Mortality
2) Morbidity
3) Recreation
4) Cultural heritage
5) Social disruption
6) Electricity outage
7) Road traffic annoyance and delays
8) Displacement costs

MORTALITY

NMV literature has mainly focused on estimating the value of a statistical life (VSL)

VSL measures the rate of substitution between wealth (or income) and reductions in the risk of dying

Department of Prime Minister and Cabinet (2014) VSL estimate of $4.2 million used

The number of deaths with and without mitigation is estimated at 0.003498 and 0.0000519

Expected mortality cost of a 100-year ARI flood reduced from about 14,700 to almost zero ($218)

MORBIDITY

Floods can have physical and psychological health impacts

Health impacts (short-term and long-term) can result from: flood event, problems while recovering from flood event, or anxiety about the risk of a flood recurring

Most studies examining willingness to pay (WTP) to reduce morbidity risks relate to acute diseases rather than flood-related health risks

Some studies specifically focusing on flood related health risks – for people that have experienced flooding and those who have not

MORBIDITY…

Estimates for WTP for avoiding or reducing flood-generated health impacts range between $473 and $545 per household per year for flooded respondents, and about $408 for those that are not flooded

Residents in the Brown Hill and Keswick catchments have not been exposed to widespread flooding since the 1930

So, we take conservative estimates ($408 per household per year). Reduction in morbidity costs from $852,312 to only $12,648 (i.e. exposure of 2089 versus 31 households)

SOCIAL DISRUPTION …

Social disruption from floods may include: electricity outage; road traffic annoyance; road traffic delays and reliability problems; and displacement from home

Electricity outage estimates for Canberra (similar to results for Midwest US) of $3 per hour are used

Converted into flood damage estimates based on number of houses that would suffer from over-floor flooding – Mitigation options would reduce damages from 100-year ARI flood, from $9,396 to only $216

TRAFFIC ANNOYANCE

Traffic annoyance: Cost estimate based on estimate of hours of water rise, number of people affected (10,920) and WTP to avoid nuisance from studies

Benefits of mitigation: cost reduction from $16,926 to $651

OTHER INTANGIBLE COSTS

Those were a few examples to provide a sense of what is involved in developing the cost estimates

Similar approaches are used to generate estimates for:

- Traffic delay costs (high cost effect)
- Displacement costs
- Recreational value losses (Options B1 and B2)
- Heritage value losses

TANGIBLE AND INTANGIBLE COST ESTIMATES

Years of ARI	Prob.	Values	Cost (AU$000)			
			Base Case	Option D	Option B1	Option B2
100	0.01	Total	46,159	151	105	94
		Intangible	6,018	14	14	14
500	0.002	Total	193,552	167,596	142,549	74,349
		Intangible	25,236	21,852	18,586	9,694

BENEFIT COST ANALYSIS

Use benefit-cost analysis to compare the options

Discount rate of 5% used

Benefit and cost streams converted to present values

Benefit cost ratios used to rank options

BENEFIT COST RATIOS: WITH AND WITHOUT INTANGIBLES

Option	Capital costs	Intangible costs of dams	Benefit-Cost Ratio	
			Tangibles only	Intangibles and tangibles
D	35.5 M		0.38	0.66
B1	40.5 M	25.5 M	0.36	0.37
B2	44.1 M	2 M	0.43	0.72

BENEFIT COST ANALYSIS

The inclusion of intangible values changes the benefit-cost ratio of two of the three options significantly

But all options still have Benefit-Cost ratios below 1.

Given the conservative nature of our intangible estimates and the uncertain nature of these values, it is useful to evaluate how big intangible numbers would have to be for the options to become attractive (with ratios above 1).

Do calculation for 2089 households that are at risk from 100-year ARI flood

BENEFIT COST ANALYSIS

Annual intangible benefits (AU$)		
Option D	Option B1	Option B2
1,010,157	1,135,574	1,476,620
Number of households at risk of a 100-year ARI flood (without mitigation)		
2,089		
Average annual intangible benefits of mitigation per household at risk (AU$)		
Option D	Option B1	Option B2
484	544	707

REQUIRED AVERAGE WTP (AU$ PER HOUSEHOLD AT RISK)

Option D		Option B1		Option B2	
WTP	BCR	WTP	BCR	WTP	BCR
970	1.00	3,650	1.00	1,240	1.00
1,120	1.10	4,080	1.10	1,420	1.10
1,260	1.25	4,700	1.25	1,710	1.25
1,700	1.50	5,750	1.50	2,190	1.50
2,415	2.00	7,850	2.00	3,140	2.00

CONCLUSION

Intangibles are real values and need to be accounted for in the analysis of mitigation options

Getting estimates for intangibles is not an easy task but it is useful to use available resources (and maybe original studies as well) to generate reasonable estimates

Doing so can help with stakeholder dialogue and rationalise decisions

CONCLUSION

This research has identified many of the intangible values that need to be considered (both benefits and costs) for further Stormwater Management options in the Brown Hill and Keswick Catchments of Adelaide

Recreational values affect assessment of project values

The 'No Dam' option identified as preferred through community consultation (Option D) becomes more attractive with intangibles recognised

Results are sensitive to value estimates and it is useful to think in terms of what local communities would be willing to pay to avoid damages or conduct survey based studies when the decisions are really important

NEXT STEPS

This is the first stage in the analysis

We have received feedback from the end user (Michael Salkeld, Councils) with useful suggestions, including incorporating Part A works into the analysis

Further analysis will incorporate the feedback and some further sensitivity analysis

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Atakelty Hailu

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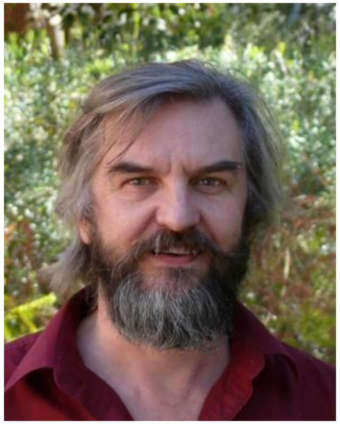
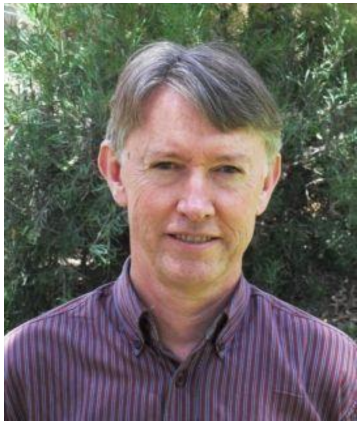
Fiona Gibson

Morteza Chalak

Abbie Rogers



Michael Burton



David Pannell

Marit Kragt

Questions? Please contact: atakelty.hailu@uwa.edu.au