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An interdisciplinary approach to identify adaptation strategies that enhance flood resilience and urban liveability

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Abstract: This paper provides guidance on how to identify and design the most suitable climate adaptation strategies for enhancing the liveability and flood resilience of urban catchments. It presents findings from a case study of Elwood, a coastal Melbourne suburb regularly affected by flooding. The research integrates social science, architecture and environmental engineering to co-develop technical, design and policy solutions that respond to the local community's vision for the future and are robust under a range of future climate, population and urban development scenarios. The paper shows that ensuring a city's flood resilience involves a range of measures to retreat from, adapt to and defend against flooding; this necessarily requires an integrated approach and interdisciplinary expertise to develop adaptation pathways that are grounded in community aspirations and priorities, inspired by novel design solutions and informed by modelling of performance, robustness and economic viability.

Keywords: climate change adaptation, envisioning, flood risk, modelling scenarios, strategy testing, urban densification

Introduction

Within the context of rapid urbanisation and population growth, an emerging agenda for governments is to both enhance urban liveability and increase the resilience of cities to climate change impacts. Rethinking water management is central to this (Wong and Brown, 2009). For example, addressing flood risk due to sea level rise, storm events of greater intensity and increased imperviousness.

A three-tier flood resilience framework outlines three complementary approaches for managing this risk. "Retreat" aims to use areas frequently affected by flooding for other purposes. "Adapt" aims to change the built form to cope with moderate flood event levels. "Defend" aims to build defence structures to stop water breaking out in extreme events. For these types of adaptation measures to increase both resilience and liveability, explicit consideration of the local geomorphological, ecological, infrastructural, institutional and cultural context is needed, along with a recognition that the long-term future conditions are highly uncertain.

Development of flood risk strategies is therefore complex, and guidance is required on how water practitioners can identify and design the most suitable adaptation solutions. This paper aims to provide such guidance, presenting the findings from a case study of climate adaptation in a Melbourne suburb. The research integrates social science, architecture and environmental engineering to co-develop technical, design and policy solutions that respond to the local community's vision for the future and are robust under a range of future climate, population and urban development scenarios.

Methods

This project focused on the case study area of Elwood, a coastal suburb of Melbourne regularly affected by flood events. The research involved a number of different methodological approaches to develop adaptation strategies, outlined below.

A vision for the future of Elwood in 2065 was developed with local community members over a series of three participatory workshops led by the social science team that were based on visioning and backcasting techniques (Robinson et al., 2011). These workshops revealed the community's broad water-related aspirations, generated ideas for adaptations of their suburb and provided insight into their receptivity to different types of flood mitigation solutions.

The community vision and ideas provided a brief for the architectural team, who used a design-led methodology to develop novel adaptation solutions for urban densification and flood management. A range of future scenarios provided the context for visualising and analysing the proposed design solutions, which ranged in scale from catchment-wide to key local Elwood sites identified for immediate action.

The performance of these urban designs, as well as infrastructure and policy strategies, was then tested by the engineering team using new scenario-based modelling tools (specifically, DAnCE4Water's urban development algorithms coupled with MIKEFLOOD). This enabled flood risk in space and time to be assessed, as well as other liveability benefits such as water security, urban heat mitigation and waterway health.

Insights from across these three areas were integrated to inform overall cost-benefit analysis of different climate adaptation pathways, involving the sequencing of possible adaptation strategies in response to changes in climate, land use, demography and socio-economics.

Results

Space limitations in this outline prevents the results from each of the research areas to be shown: Table 1 presents the community's vision for Elwood in 2065 and Table 2 presents example adaptation solutions that were identified for testing with the models.

Discussion and Conclusion

Successful adaptation to ensure a city's liveability and flood resilience will involve a range of technical, urban design, policy and social measures to retreat from, adapt to and defend against rising waters. This paper has provided guidance on how suitable flood risk strategies can be developed and implemented using an interdisciplinary approach to: (1) engage effectively with communities about their concerns, aspirations and priorities, (2) design solutions that make room for water while densifying and activating urban forms, and (3) test the performance, robustness and economic viability of adaptation solutions using novel modelling techniques.

References

- Robinson, J., Burch, S., Talwar, S., O'Shea, M., & Walsh, M. (2011). Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. *Technological Forecasting and Social Change*, *78*(5), 756–768.
- Wong, T. H. F., & Brown, R. R. (2009). The water sensitive city: Principles for practice. *Water Science and Technology*, *60*(3), 673–682.

Tables

Table 1

A vibrant, connected and self-sufficient community that celebrates its healthy and beautiful environment, uses water and other resources efficiently, and is resilient to natural hazards.

1. *Celebration of Water in the Landscape:* Elwood is a beautiful, playful and sharing place to live.
2. *Adapted to Rising Waters:* Elwood is prepared for rising sea levels and flooding from rainfall.
3. *Rich Habitats and Thriving Biodiversity:* Elwood hosts abundant and resilient biodiversity.
4. *An Innovative Green Economy:* Elwood has a culture of innovation in technology and policy that drives a 'green' economy.
5. *The United People of Elster Creek:* Elwood thrives with new-found institutions and collaborative decision-making.

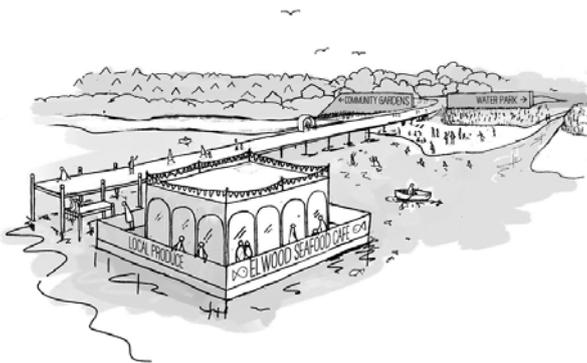
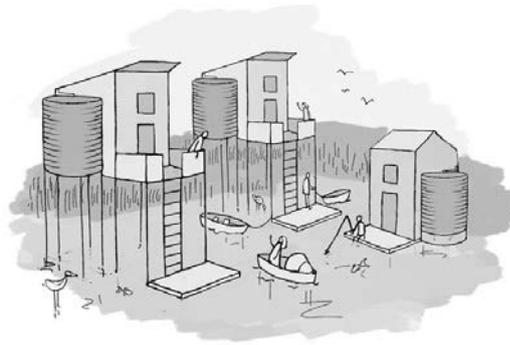


Table 2

Tier	Possible Adaptation Solutions
Retreat	<p>Making room for river flow and sea level rises, e.g.:</p> <ul style="list-style-type: none">• Creating ecological landscapes• Detaining floods in parkland and sportsfields• Designating flood ways• Claiming existing streets and land for green space and floodways• Purchasing properties in high flood risk zones and converting to land uses other than residential
Adapt	<p>Design houses and urban spaces, as well as temporary measures, to protect homes from stormwater, e.g.:</p> <ul style="list-style-type: none">• Setting floor levels higher• Making appropriate use of ground floor spaces• Increasing permeability of surfaces• Encouraging installation of rainwater tanks on private property• Building social capital for planning and preparedness• Developing emergency responses• Preparing for recovery after flood events
Defend	<p>Install major infrastructure to defend against flood events, e.g.:</p> <ul style="list-style-type: none">• Building an artificial reef to protect the canal from storm surges• Flood gates• Levees around key assets• Pumps