Didn't you always want a water feature in your backyard? Impacts of climate change on estuaries

Cameron Noakes **University of Wollongong**
Philomena Gangaiya Wollongong City Council
Gabrielle Wiltshire Department of Environment and Climate Change

The project

- UoW, DECC and WCC collaborative project
- Develop and test a methodology for identifying the potential impact of climate change on estuaries
  - Low cost
  - Information available to Councils
  - Best available science
- Supervisors: Professor Colin Woodroffe, Professor Colin Murray-Wallace (UoW)

University of Wollongong | Department of Environment & Climate Change NSW | Wollongong City of Innovation

Presentation Outline

- Local Climate Change - sea level rise & storminess
- Estuaries and Climate Change
- A case study in Wollongong
- Methodology
- Findings and discussion
- Conclusions and Recommendations

Local Climate Change: SLR

Recorded:

- Mean relative sea-level rise around Australia was 1.2mm/yr from 1920-2000 (Church et al., 2004).
- Locally, the Port Kembla (Wollongong) tide gauge shows a short-term upward sea level trend of 3.4mm/yr over 16 years (BOM, 2008).

Projected:

- Local (NSW) SLR will be 4 to 12cm above global average (McInnes et al., 2007).
- Practical Considerations of Climate Change Guideline (DECC, 2007): 0.18 – 0.91m by 2090 – 2100.

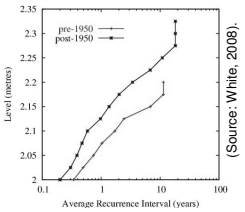
Local Climate Change: Increased Storminess

Recorded:

Since 1950 frequency of extreme sea level events in Sydney reaching:

- 2.1m has doubled
- 2.2m has tripled

(Church et al., 2004).



(Source: White, 2008).

Projected:

CSIRO models indicate an overall future increase in intensity and frequency of NSW coastal storm systems (Hennessy et al., 2004a).

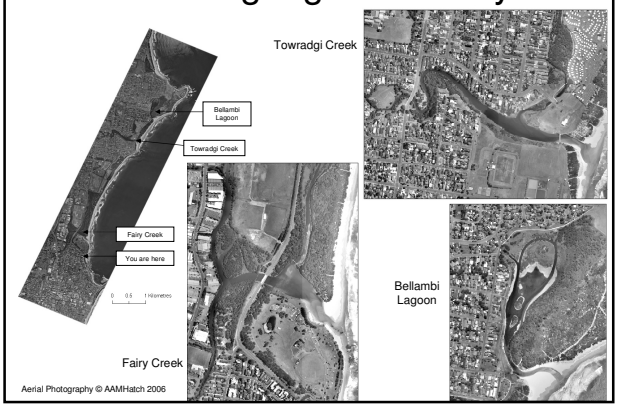
Estuaries and Climate Change

- The majority of Illawarra and NSW estuaries have an intermittent connection with the ocean (Intermittently Closed and Open Lakes and Lagoons, ICOLLs).
- There is limited research on the impact of climate change on ICOLLs, and what is available seems rather generalised, likely due to the high variability of NSW ICOLL systems.
- This study does not attempt to explore more broad conceptual impacts (see Haines and Thom, 2007), but test a methodology for performing site-specific assessments using some of the conceptual impacts.

Methods

- Topographic elevation as a proxy for potential risk to coastal inundation and flooding
- Other studies have used a similar approach in the mid-Atlantic Coast, entire NZ coastline, NSW Central and Hunter Coasts, entire Australian coastline
- This study applies the method at a local scale to perform site-specific assessments to identify and manage site-specific issues.

Wollongong case study



Scenarios

Scenario	Entrance Condition	Description
1	Open	SLR*1 (0.18m, 0.55m, 0.91m)
2	Open	SLR (0.18m, 0.55m, 0.91m) + HAT*2 (1.175m AHD)
3	Open	SLR (0.18m, 0.55m, 0.91m) + EE*3 (2.37m AHD)
4A,B	Closed	SLR (0.18m, 0.55m, 0.91m) + MBH*4 (1.76m, 3m AHD)

*1 SLR, Sea Level Rise — Practical Considerations of Climate Change (DECC, 2007)

*2 HAT, Highest Astronomical Tide — Manly Hydraulics Laboratory Sydney Tidal Gauge data

*3 EE, Extreme Event — Bewsher Consulting (2003). Addendum to Towradgi Creek Flood Study Following August 1998 Flood.

*4 MBH, Maximum Berm Height — Cardno Lawson Treloar (2007); Hanslow et al., (2000)

Assumptions of Scenario 4

1) the MBH of an estuary entrance can be used as a proxy for the potential maximum water level of the lagoon under closed entrance conditions prior to the overtopping and breaching of the entrance berm; and

2) the MBH will increase by an equal amount to the increase in sea level (Bruun, 1962; Hanslow et al., 2000; Davidson-Arnott, 2005).

Scenarios

Scenario	Entrance Condition	Description
1	Open	SLR*1 (0.18m, 0.55m, 0.91m)
2	Open	SLR (0.18m, 0.55m, 0.91m) + HAT*2 (1.175m AHD)
3	Open	SLR (0.18m, 0.55m, 0.91m) + EE*3 (2.37m AHD)
4A,B	Closed	SLR (0.18m, 0.55m, 0.91m) + MBH*4 (1.76m, 3m AHD)

*1 SLR, Sea Level Rise — Practical Considerations of Climate Change (DECC, 2007)

*2 HAT, Highest Astronomical Tide — Manly Hydraulics Laboratory Sydney Tidal Gauge data

*3 EE, Extreme Event — Bewsher Consulting (2003). Addendum to Towradgi Creek Flood Study Following August 1998 Flood.

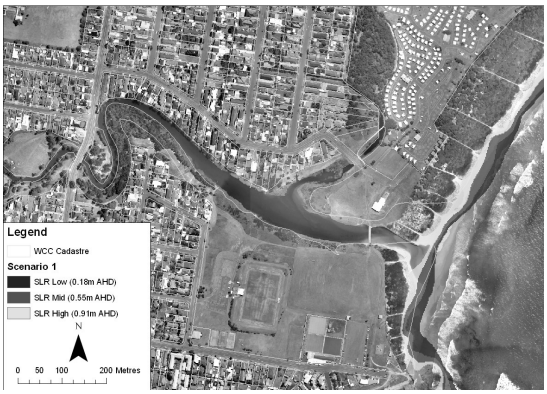
*4 MBH, Maximum Berm Height — Cardno Lawson Treloar (2007); Hanslow et al., (2000)

Analyses

With the maps generated for each scenario and lagoon, two analyses were performed using the highest sea level for each scenario:

- the number of zoned lots inundated were counted;
- low-lying assets at risk to inundation or flooding were identified (e.g. heritage items, endangered ecological communities & protected vegetation, infrastructure, recreation & tourist facilities).

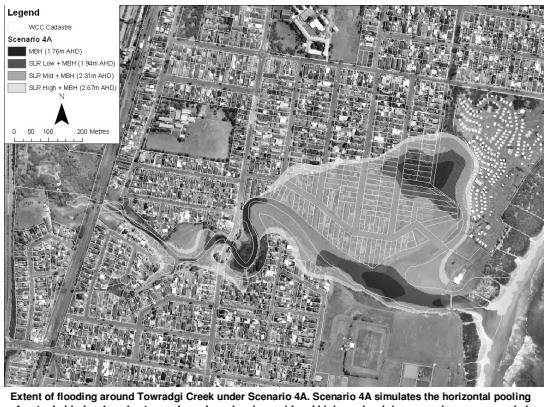
I will present selected results from Fairy and Towradgi Creeks to illustrate the findings.



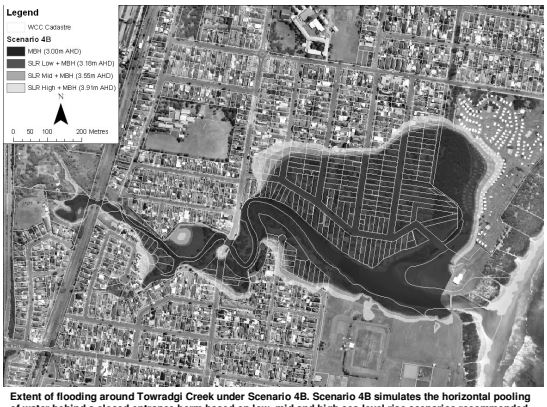
Extent of inundation around Towradgi Creek under Scenario 1. Scenario 1 simulates low, mid and high sea-level rise scenarios recommended by DECC (2007) for the NSW coast by 2100. (Aerial Photography © AAMHatch 2006).

Extent of inundation around Towradgi Creek under Scenario 2. Scenario 2 simulates low, mid and high sea-level rise scenarios recommended by DECC (2007) for the NSW coast by 2100 in combination with the highest astronomical tide (HAT) for the Wollongong coast. (Aerial Photography © AAMHatch 2006).

Extent of inundation around Towradgi Creek under Scenario 3. Scenario 3 simulates low, mid and high sea-level rise scenarios recommended by DECC (2007) for the NSW coast by 2100 in combination with 'Extreme Events' (EE), which refers to elevated sea-levels resulting from tidal and storm surge effects, plus wind and wave set-up, experienced under current climatic conditions. (Aerial Photography © AAMHatch 2006).

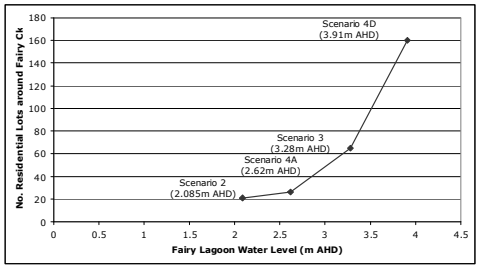


Extent of flooding around Towradgi Creek under Scenario 4A. Scenario 4A simulates the horizontal pooling of water behind a closed entrance berm based on low, mid and high sea-level rise scenarios recommended by DECC (2007) for the NSW coast by 2100 in combination with a maximum berm height (MBH) of 1.76 m AHD (Cardno Lawson Treloar, 2007). (Aerial Photography © AAMHatch 2006).



Extent of flooding around Towradgi Creek under Scenario 4B. Scenario 4B simulates the horizontal pooling of water behind a closed entrance berm based on low, mid and high sea-level rise scenarios recommended by DECC (2007) for the NSW coast by 2100 in combination with a maximum berm height (MBH) of 3.00 m AHD (Hanslow et al., 2000). (Aerial Photography © AAMHatch 2006).

Impacts - Residential



Impacts - other

- Heritage assets
- EECs & protected vegetation
- Recreation
- Infrastructure: stormwater, road & sewerage
- Tourist facilities: caravan parks

Limitations of the methodology

This study does not attempt to:

(1) model the hydrodynamics of coastal inundation and flooding

(2) allow for the attenuation of oceanic waters propagating through the narrow inlets into the lagoons

(3) consider the non-horizontal surface of floodwaters, or

(4) consider shoreline recession in response to sea level rise.

Limitations of the data

- Recency of DEM data – 1976
  - estuary and lower creek system likely to have undergone some modification since date of data capture.
- DEM pixel resolution

Conclusions

- This project has provided WCC and DECC with additional information on the potential increased exposure of estuarine systems to coastal inundation or flooding with SLR which may inform future management decisions.
- This has been achieved at a low cost, using data widely available to Councils, whilst still employing the best science available.

Conclusions

- The methodology is simple in design and practice and can be carried out someone relatively quickly even with a limited understanding of geographic information systems.
- While several limitations were identified, they do not detract from the potential of this methodology to provide preliminary assessments of vulnerability and prompt further comprehensive studies.

Recommendations

- This methodology to be adopted by DECC, WCC and other coastal councils as a means of providing a quick, low cost, preliminary assessment of the potential risk of SLR on estuaries along the NSW coast.
- Future use of high resolution DEMs (ideally derived from LiDAR technologies) to ensure accurate and precise modelling.
- More site-specific assessments are required to accurately predict the likely impact of climate change on estuaries, especially given the high-variability of NSW estuaries.