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Shaping the Future

LAKE ILLAWARRA ENTRANCE STUDIES – FLOODING AND POTENTIAL CLIMATE CHANGE ISSUES

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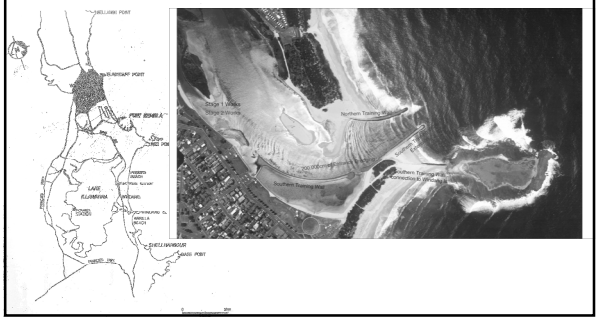
Presentation Outline

- Introduction
- Acknowledgements
- Study area
- Floodplain policy
- Application of numerical models in the management of Lake Illawarra
- Climate change scenarios
- Study approach and model system
- Outcomes
- Conclusions

Acknowledgements

- Lake Illawarra Authority
- Wollongong City Council
- Shellharbour Council
- DECC

Study Area



Floodplain Management

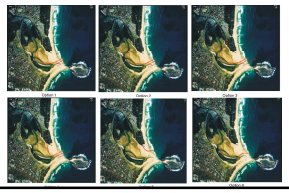
- Flood study – commissioned in 2000
- Floodplain management study and plan – 2005
  - 2100 planning level included 0.7m freeboard which included increased MSL and run-off due to climate change
- Stage 1 Climate Change Impact Study
  - Using established flood model system
  - Identified a 0.27m increase in 100-year ARI flood level due to climate change
- Stage 2 Climate Change Impact Study (2008)
  - Utilised a full-process model system to investigate climate change impacts on flood levels

Application of Numerical Models in the Management of Lake Illawarra

- Numerical modelling has been a tool utilised by the LIA and Councils to assist in managing Lake Illawarra
- Numerical modelling doesn't provide THE ANSWER
  - Valuable tool to quantify and assess
- Initial entrance studies
  - Early 1990's
  - 2D hydrodynamic modelling to investigate tidal flows and entrance behaviour
- Flood studies
  - Late 1990's to early 2000's
  - Utilised established 1D modelling techniques
  - Entrance behaviour characterised by empirical opening model
- Stage 2 training works
  - 2003/2004
  - A full process Delft3D hydrodynamic, wave, sediment transport and morphological model developed to investigate flood and tidal sediment transport and morphological change
- Stage 2 climate change study
  - 2008
  - Delft3D model upgraded and re-validated
  - Full process flood model including dynamic entrance opening

Stage 2 Entrance Works Studies

- Numerical modelling used to assess a range of preliminary options
- Optimise the preferred option
  - Tidal flow efficiency
  - Flood flow conveyance
- Model system include tides, catchment flows, waves, sediment transport and morphological processes simultaneously



Lake Illawarra Numerical Modelling

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Stage 2 Climate Change Investigations

- Scenarios based on DECC guidelines – "Floodplain Risk Management Guideline – Practical Consideration of Climate Change" (2007)
  - Scenario 1: Current 100-years ARI catchment flow + 20-years ARI ocean storm with Low-Level climate change scenario (SLR=+0.18m)
  - Scenario 2: Current 100-years ARI catchment flow + 20-years ARI ocean storm with Mid-Level climate change scenario (SLR=+0.55m)
  - Scenario 3: Current 100-years ARI catchment flow + 20-years ARI ocean storm with High-Level climate change scenario (SLR=+0.91m)
  - Scenario 4: Current 100-years ARI catchment flow + 20% increase in rainfall + 20-years ARI ocean storm with Mid-Level climate change scenario (SLR=+0.55m)

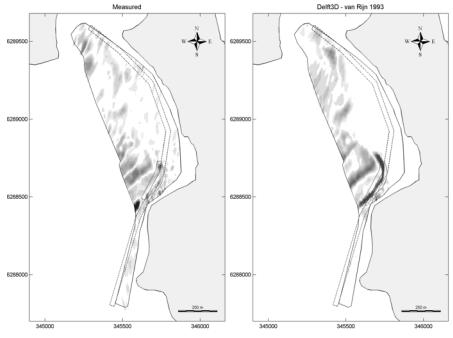
Study Approach

- Develop climate change scenarios in in consultation with DECC, LIA and Councils
- Upgrade numerical model systems
  - Since 2003 there has been significant advances in sediment transport modelling
  - Implement completed Stage 2 works
- Revalidate model system
  - Tidal flow conditions
  - Flood with entrance opening conditions
- Investigate climate change scenarios and report outcomes

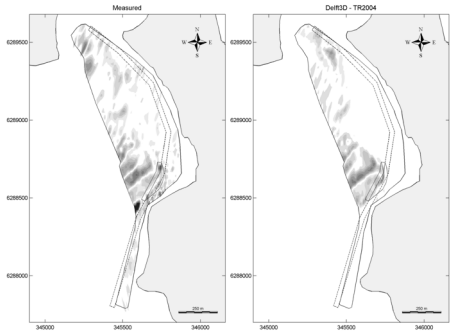
Model Systems

- Delft3D is a full process model system
- Sediment transport and morphological change is an inherently complex process to simulate
  - Turbulent flow conditions
  - Scale effects in laboratory
  - Interactions between waves and currents
- Since 2003, the latest range of sediment transport model have been documented
  - Latest models have advanced in a number of areas
    - Bed roughness
    - Bed forms
    - Wave-induced transport
    - Reference concentration

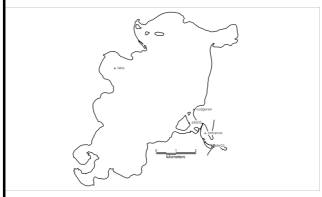
TRANMOR2004 Model

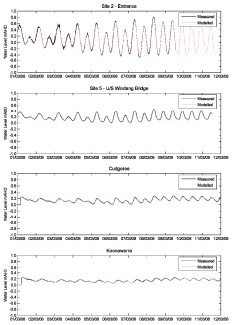


TRANMOR2004 Model



Model Calibration – Tidal Flow





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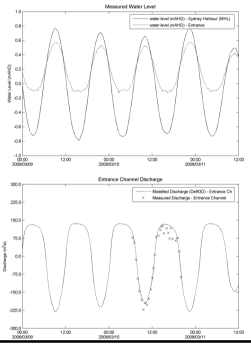
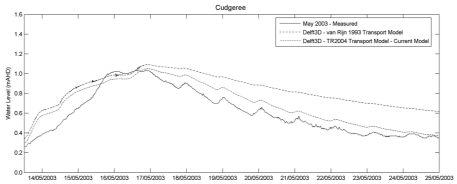


Flood Flow Validation

- Flow conditions in the entrance channel are very different under flood flow conditions
- Qualitative and quantitative calibration data available for entrance opening event in 2003
- Previous modelling could reproduce the morphology of the entrance during and post-opening, but not the rate of opening
- Measured lake water level is the most reliable dataset
- Consideration of bed roughness near the breakout very important



Climate Change Scenarios – Simulation Conditions

- Bathymetry
  - DECC 2007 survey of Lake
  - Council elevation data of foreshore including LIDAR
- Hydrology
  - 100-year ARI, 36hr duration
- Initial lake condition
  - Water levels
    - Model used to simulate mean lake level under all SLR scenarios
  - Entrance assumed to then close and establish a berm
- Ocean boundary conditions
  - 20-year ARI
- Overall precautionary approach

Climate Change Scenarios – SLR Results

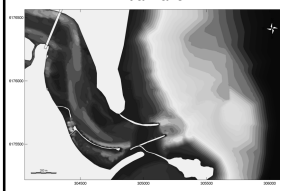
	100-years ARI Flood Levels (m AHD)			
	Existing Case Delft3D Model	Scenario 1	Scenario 2	Scenario 3
Hydrology	36-hour, 100-year ARI	36-hour, 100-year ARI	36-hour, 100-year ARI	36-hour, 100-year ARI
Climate Change	Existing	Low-level - SLR +0.18m	Mid-level - SLR +0.55m	High-level - SLR +0.91m
Griffins Bay	2.24	2.41	2.63	3.04
Tallawarra Power Station	2.24	2.41	2.63	3.04
Horsley Inlet	2.24	2.41	2.63	3.04
Cudgeree	2.24	2.41	2.64	3.04
Windang Bridge	2.15	2.35	2.55	3.01
Entrance Channel	1.71	1.89	2.25	2.32

Climate Change Scenarios – SLR + Runoff Increase

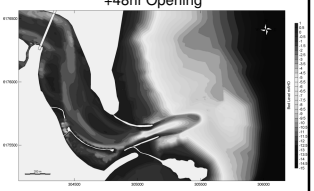
	100-years ARI Flood Levels (m AHD)		
	Existing Case Delft3D Model	Scenario 2	Scenario 4
Hydrology	36-hour, 100-year ARI	36-hour, 100-year ARI	36-hour, 100-year ARI +20%
Climate Change	Existing	Mid-level - SLR +0.55m	Mid-level - SLR +0.55m
Griffins Bay	2.24	2.63	2.88
Tallawarra Power Station	2.24	2.63	2.88
Horsley Inlet	2.24	2.63	2.88
Cudgeree	2.24	2.64	2.88
Windang Bridge	2.15	2.55	2.77
Entrance Channel	1.71	2.25	-

Climate Change Scenarios – Modelled Entrance Opening

Initial Lake



+48hr Opening



Climate Change Scenarios – Outcomes

- Latest models can realistically simulate entrance opening
- Entrance opening rate is likely to be much more rapid than previously adopted
  - Modelled dynamic entrance opening rate 70m^2/hr
- SLR impacts on flood levels are somewhat less than SLR
  - Low lying floodplain
  - Additional floodplain area as the Lake level increases
- Potential increases in flood levels are consistent with early preliminary estimates
- 0.7m freeboard has been a wise inclusion in the floodplain policy

Conclusions

- Entrance characteristics influence flooding upstream
- Latest model systems can reliably simulation flood flows and entrance changes simultaneously
- Modelling indicates that the initial opening of the entrance can be more rapid than previously thought
- Model systems cannot be just used 'off the shelf'
- Lake Illawarra studies provide a reference for the dynamic investigation of flooding and entrance behaviour at other NSW coastal lakes and lagoons

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