IMPROVING RESILIENCE TO STORM SURGE HAZARDS
ASSESSING RISK THROUGH WAVE SIMULATIONS, SHORELINE MODELLING AND FIELD OBSERVATIONS

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Project Team

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Cooperation:

Throughout this project, all data requests and inquiries to external parties were promptly answered with an keen intent to help and assist.

Credit this to BNHCRC fulfilling their mission, broader community view these projects as preferred and trusted source of research and knowledge in bushfire and natural hazards.
Talk Outline

1) Rationale
2) Objectives
3) Methodology
4) Results
5) Conclusions and future work
rationale

1) Storm surge and waves are capable of causing severe damage to coastal property and infrastructure.
2) Accurate assessment of these erosion and inundation risks are required to inform mitigation strategies.
rationale

- Old Bar, NSW
- Erosion ‘hotspot’
- Infrastructure at risk
Objectives

1) Develop a methodology to assess coastal erosion hazards within a probabilistic framework.

2) Test this methodology at two erosion hotspots:
   a) Old Bar, NSW. (Completed)
   b) Adelaide Metropolitan Beaches, SA. (In progress)

3) Demonstrate utilization examples in regards to impact on infrastructure for the developed hazard line scenarios.
Methodology

1) Choose a suitable shoreline evolution model.

2) Development of wave and tide forcing.
   a) Statistical analysis of historical wave, and tide observations and hindcasts for both project sites.
   b) Generation of many realizations of synthetic time-series.

3) Analysis of field data for site characterization and model initialization.

4) Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

5) Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).
Methodology DETAILS

Choose a suitable shoreline evolution model.
Choose a suitable shoreline evolution model.

Linear Wave Theory

\[ Q = \frac{K \sqrt{\frac{g}{\gamma}} H_b^{2.5} \times 2 \sin(\alpha_b)}{16(s - 1)} \]
Methodology DETAILS

Choose a suitable shoreline evolution model.

Cross shore
Choose a suitable shoreline evolution model.

- Off the shelf Shoreline Evolution Model developed at WBM BMT engineering consultants.
- Agreed upon releasing as open source code.
- Accounts for curvilinear coasts, coastal structures,
- Efficient run-times suitable for probabilistic framework.
Methodology

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Methodology DETAILS

Development of wave and tide forcing.

a) Statistical analysis of historical wave, and tide observations and hindcasts for both project sites.

b) Generation of many realizations of synthetic time-series.

3 m Storm Event Threshold.
Methodology DETAILS

Development of wave and tide forcing.

Joint Distributions

Storm Event Timing

Seasonality

- Instantaneous storm rate
- Time
- Number of Storms
- Duration
- Holg
- Period
- Direction
- Tidal Residual
- Hs
- D
- R
- T
- 0.824**
- 0.537**
- 0.298**
- -0.049
- 0.54**
- 0.241**
- 0.122**
- 0.008
Development of wave and tide forcing.

a) Statistical analysis of historical wave, and tide observations and hindcasts for both project sites.

b) Generation of many realizations of synthetic time-series.

- **Open source code repository** "stormwavecluster"
  - [https://github.com/GeoscienceAustralia/stormwavecluster](https://github.com/GeoscienceAustralia/stormwavecluster)
Methodology

1) Choose a suitable shoreline evolution model.

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3) **Analysis of field data for site characterization and model initialization.**

4) Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

5) Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).
Methodology DETAILS

Analysis of field data for site characterization and model initialization.

**Old Bar, NSW**
- a) Ground penetrating radar
- b) LIDAR
- c) Photogrammetry
- d) Historical Aerial Surveillance
- e) Australian Hydrographic Service (AHS) Charts
- f) Hydrographic surveys
- g) Geoscience Australia Bathymetry

**Adelaide, SA**
- a) LIDAR
- b) **Beach profile surveys**
- c) Nearmap imagery
- d) Australian Hydrographic Service (AHS) Charts
- e) Geoscience Australia Bathymetry
- f) Historical sand carting and pumping
Methodology DETAILS

Analysis of field data for site characterization and model initialization.

**Old Bar, NSW**

a) **Ground penetrating radar**  
b) **LIDAR**  
c) **Photogrammetry**  
d) **Historical Aerial Surveillance**  
e) **Australian Hydrographic Service (AHS) Charts**  
f) **Hydrographic surveys**  
g) **Geoscience Australia Bathymetry**

Bedrock and Nearshore Reefs
Methodology DETAILS

Analysis of field data for site characterization and model initialization.

**Old Bar, NSW**

a) Ground penetrating radar  
**b) LIDAR**
c) Photogrammetry  
d) Historical Aerial Surveillance  
e) Australian Hydrographic Service (AHS) Charts  
f) Hydrographic surveys  
g) Geoscience Australia Bathymetry

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Methodology DETAILS

Analysis of field data for site characterization and model initialization.

Old Bar, NSW

a) Ground penetrating radar
b) LIDAR
c) Photogrammetry
d) Historical Aerial Surveillance (OEH aerial surveillance and Nearmap)
e) Australian Hydrographic Service (AHS) Charts
f) Hydrographic surveys
g) Geoscience Australia Bathymetry
Methodology DETAILS

Analysis of field data for site characterization and model initialization.

Old Bar, NSW
a) Ground penetrating radar
b) LIDAR
c) Photogrammetry
d) Historical Aerial Surveillance and Nearmap
e) Australian Hydrographic Service (AHS) Charts
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g) Geoscience Australia Bathymetry

AHS Chart: Complex Near shore Bathymetry
Methodology DETAILS

Analysis of field data for site characterization and model initialization.

Old Bar, NSW

- a) Ground penetrating radar
- b) LIDAR
- c) Photogrammetry
- d) Historical Aerial Surveillance and Nearmap
- e) Australian Hydrographic Service (AHS) Charts
- f) Hydrographic surveys
- g) Geoscience Australia Bathymetry

Good Agreement Between AHS charts and Hydrographic Survey
Analysis of field data for site characterization and model initialization.

**Methodology DETAILS**

- LIDAR
- Beach profile surveys
- Nearmap imagery
- Australian Hydrographic Service (AHS) Charts
- Geoscience Australia Bathymetry
- Historical sand carting and pumping

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**Adelaide, SA**

- a) LIDAR
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Beach Profile Survey Monitoring Campaign Since 1970
Survey Profile and EVO profile
Methodology

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Methodology DETAILS

Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

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Contour

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Methodology DETAILS

Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

- Linear Look-up Table
- Non-linear Look-up Table
Methodsology DETAILS

Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

**NSW nearshore wave toolbox**

a) Good agreement between our method and the NSW wave transformation toolbox.
b) Potential to apply NSW wave transforms for future shoreline modelling applications.
Methodology DETAILS

Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

Wave climate: Dominated by local wind seas.

Swell Transmission;
At 255 degrees
~ 28% for 08 s waves
~ 18% for 12 s waves
Methodology DETAILS

Simulating waves nearshore (SWAN) model coastal wave transformation simulations.

A Global Wave Hindcast focussed on the Central and South Pacific

Tom Durrant, Diana Greenslade, Mark Hemer and Claire Trenham
CAWCR Technical Report No. 070
April 2014
Methodology

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Methodology DETAILS

Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).

Biggest: 1/50 year event.

Second Biggest: 1/25 year event

Third Biggest: 1/16.6 year event.
Methodology DETAILS

Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).
Methodology DETAILS

Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).
RESULTS

Utilize GIS to map potential impact on infrastructure for various RP.
RESULTS

50 yr return period ‘storm series’ event

Assumes no shoreline management strategies in place (e.g. sand bagging)
RESULTS

50 yr return period ‘storm series’ event

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RESULTS

50 yr return period ‘storm series’ event

Assumes no shoreline management strategies in place (e.g. sand bagging)
CONCLUSIONS and FUTURE WORK

1) Have successfully developed a methodology to assess coastal erosion hazards within a probabilistic framework.

2) Tested this methodology at two erosion hotspots:
   a) Old Bar, NSW. (Completed)
   b) Adelaide Metropolitan Beaches, SA. (In progress)

3) Demonstrated utilization examples in regards to impact on infrastructure for the developed hazard line scenarios.
CONCLUSIONS and FUTURE WORK

1) Adelaide simulations now running.
2) Infrastructure analysis at unfortified northern beaches.
4) Final project reports.