bushfire&natural HAZARDSCRC

IMPROVING RESILIENCE TO STORM SURGE HAZARDS

ASSESSING RISK THROUGH WAVE SIMULATIONS, SHORELINE MODELLING AND FIELD OBSERVATIONS

Uriah Gravois

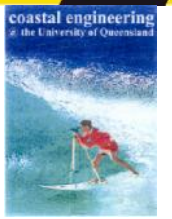
School of Civil Engineering,

University of Queensland, Brisbane, QLD

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme

Australian Government
Geoscience Australia

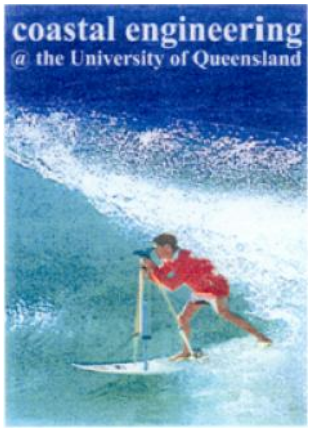
THE UNIVERSITY OF QUEENSLAND
AUSTRALIA



Project Team

1) University of Queensland
   a) David Callaghan
   b) Tom Baldock
2) Geoscience Australia
   a) Gareth Davies
   b) Wenping Jiang
   c) Duncan Moore
   d) Scott Nichol

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA



Australian Government
Geoscience Australia

ACKNOWLEDGEMENTS

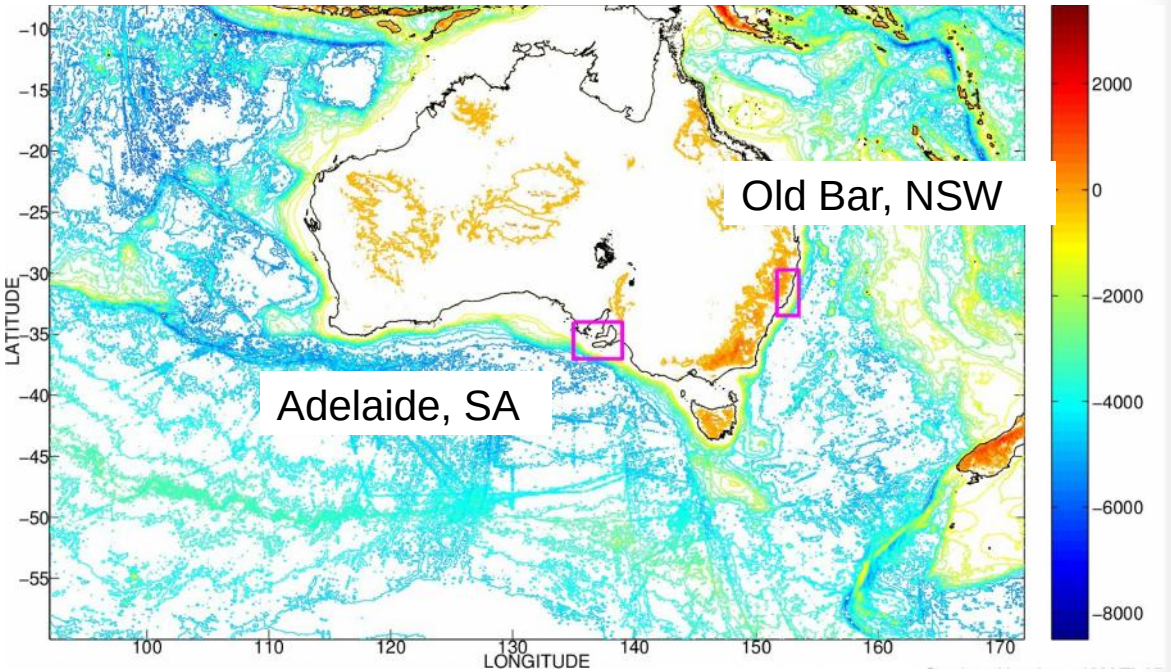
Cooperation:

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

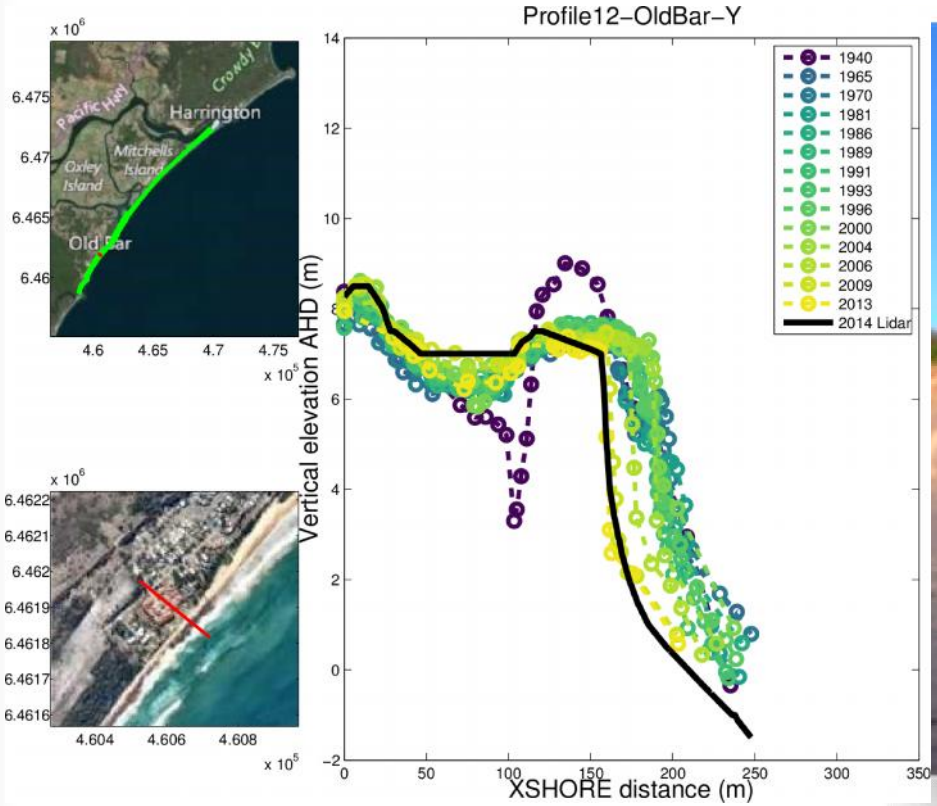
1) Rationale
2) Objectives
3) Methodology
4) Results
5) Conclusions and future work



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

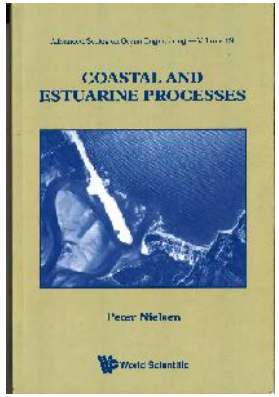
1) Develop a methodology to assess coastal erosion hazards within a probabilistic framework.
2) Test this methodology at two erosion hotspots:
   a) Old Bar, NSW. (Completed)
   b) Adelaide Metropolitan Beaches, SA. (In progress)
3) Demonstrate utilization examples in regards to impact on infrastructure for the developed hazard line scenarios.

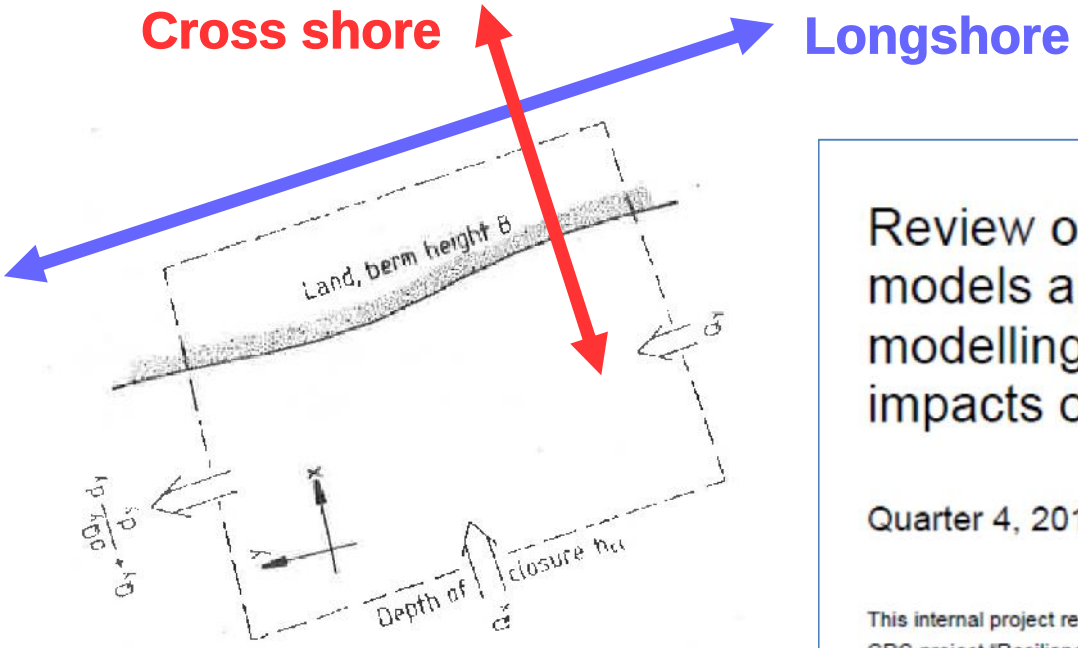
Methodology

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.





Review of beach profile and shoreline models applicable to the statistical modelling of beach erosion and the impacts of storm clustering

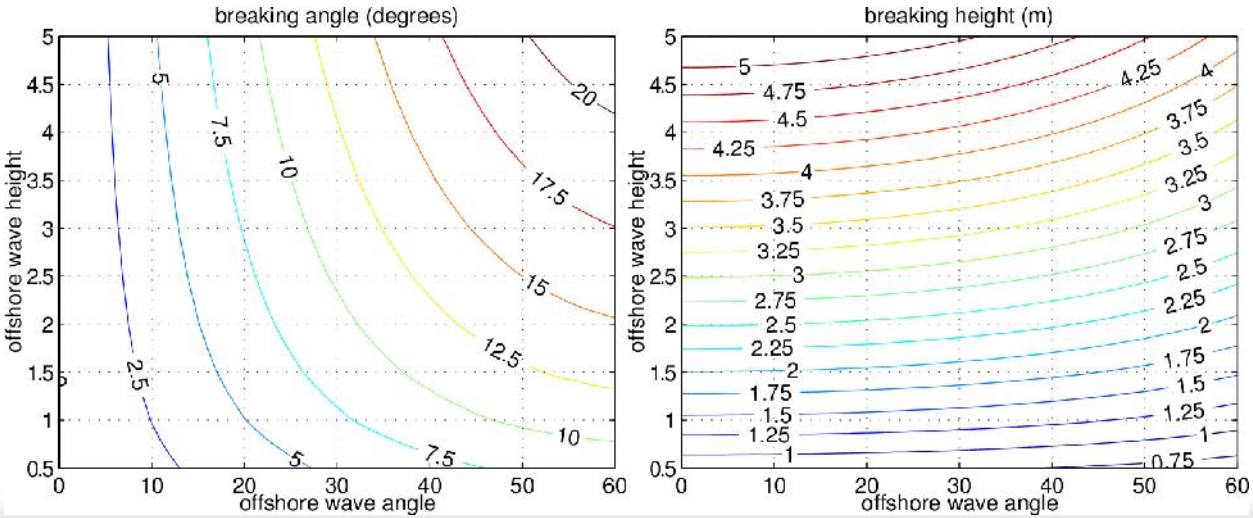
Quarter 4, 2014-15 Milestone

This internal project report has been completed as a component of the Bushfire and Natural Hazards CRC project "Resilience to clustered disaster events on the coast – storm surge"

Methodology DETAILS

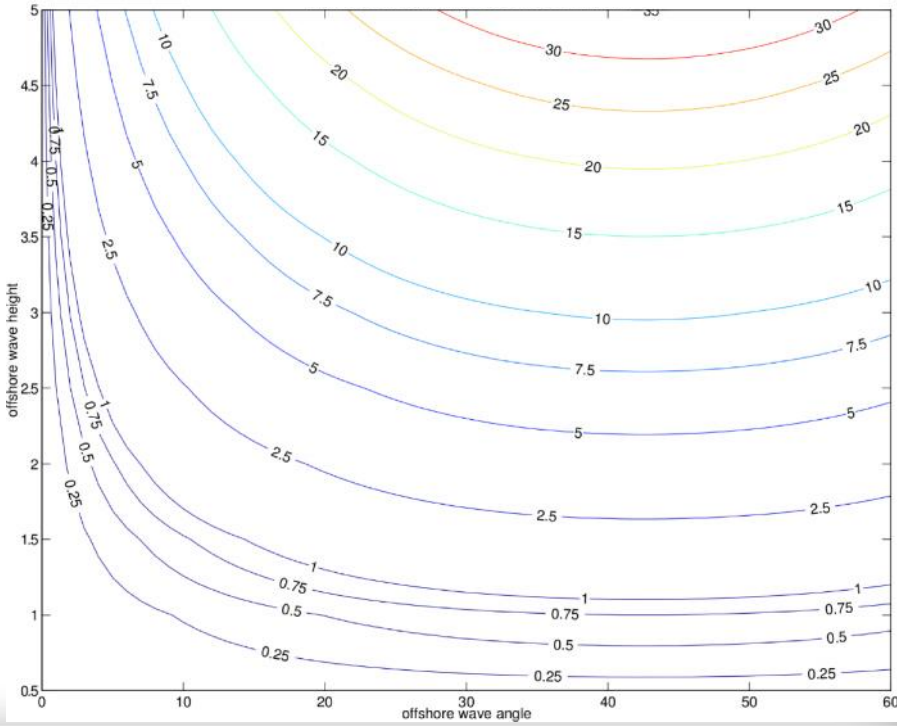
Choose a suitable shoreline evolution model.

Linear Wave Theory



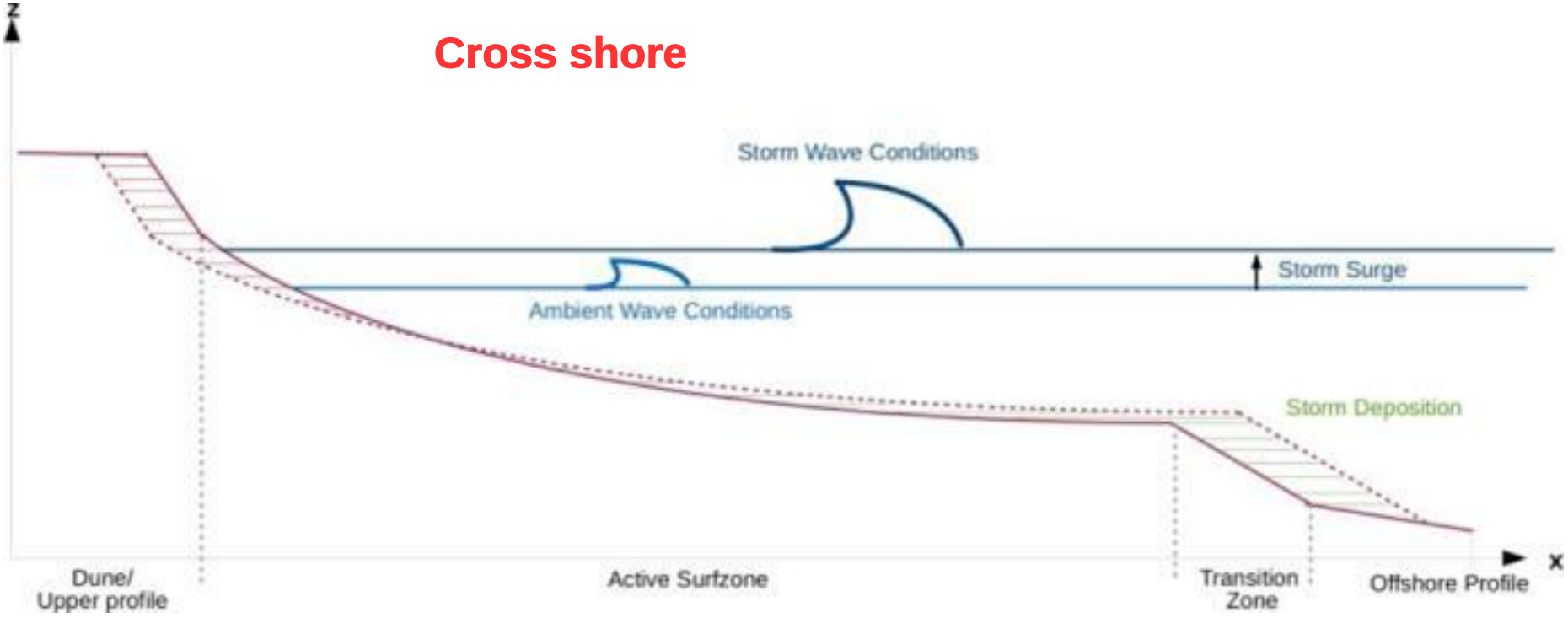
Longshore

$$Q = \frac{K\sqrt{\frac{g}{\gamma}}{H_b}^{2.5} \times 2\sin(\propto_b)}{16(s-1)}$$



Methodology DETAILS

Choose a suitable shoreline evolution model.



Methodology DETAILS

Choose a suitable shoreline evolution model.

- Off the shelf Shoreline **Evo**lution 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

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

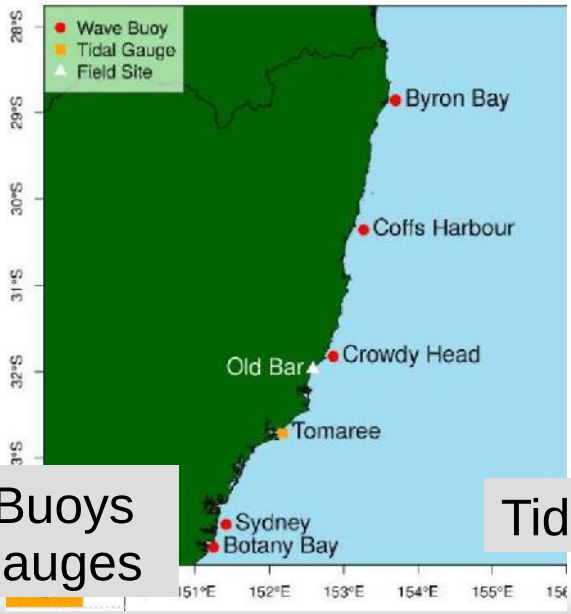
Methodology DETAILS

3 m Storm Event Threshold.

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.



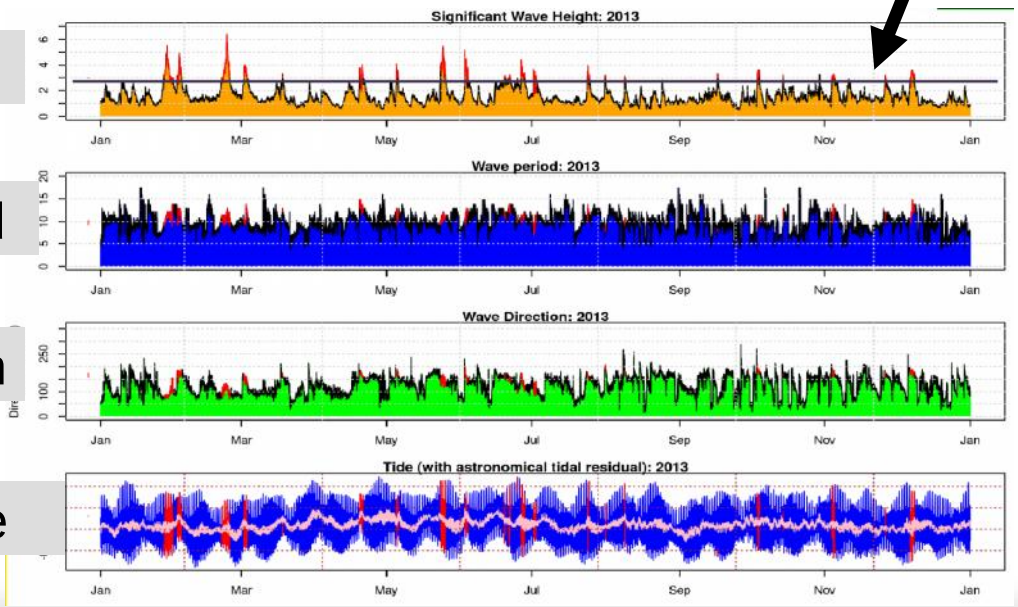
Waverider Buoys And Tide Gauges

Height

Period

Direction

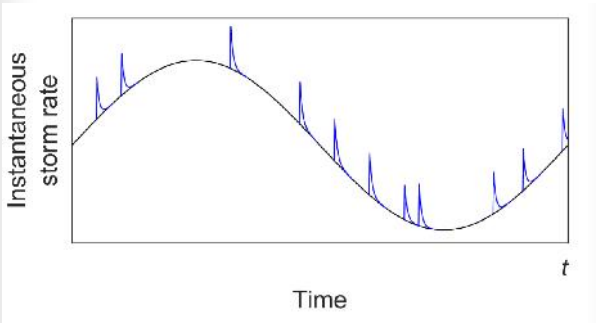
Tides & Surge

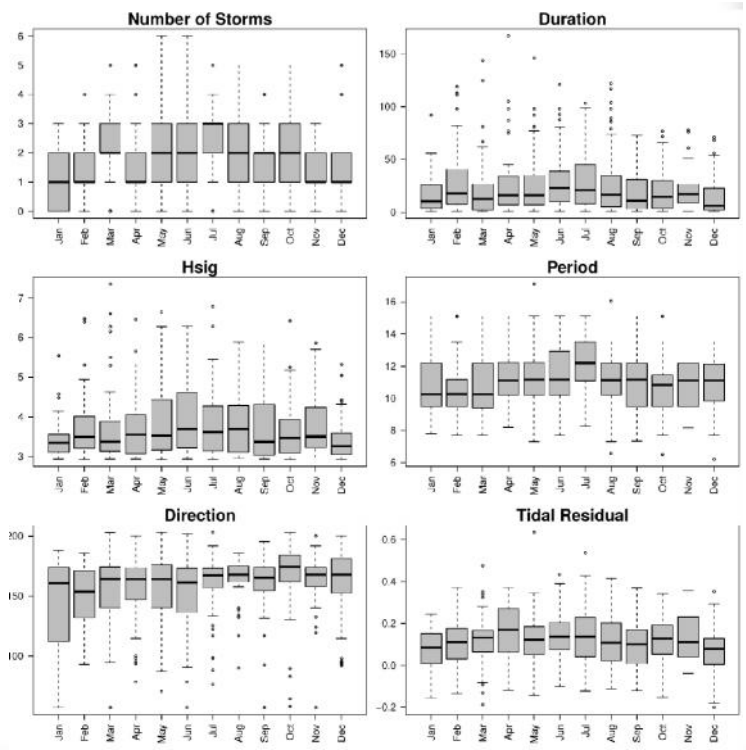


Methodology DETAILS

Development of wave and tide forcing.

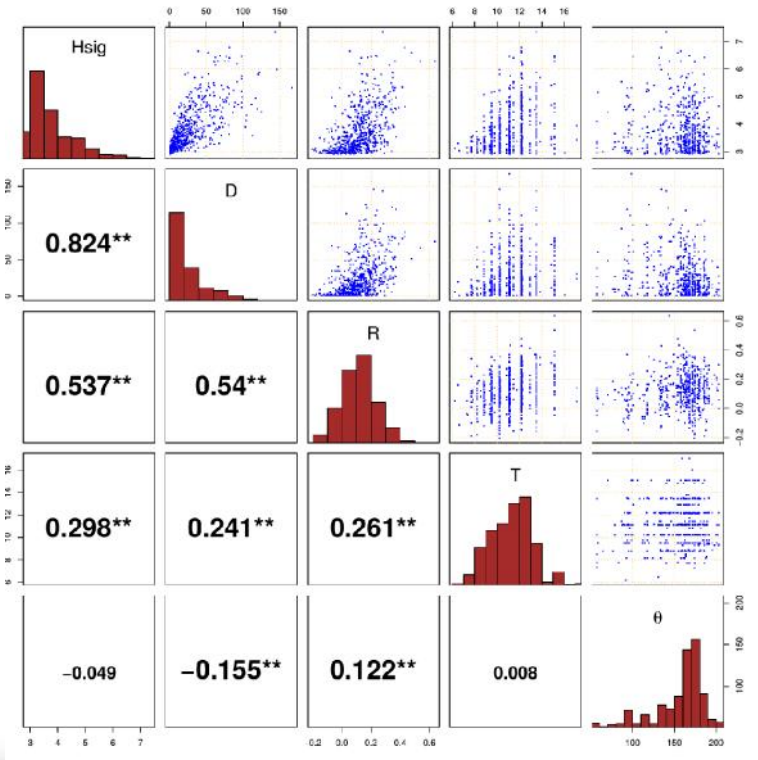
Storm Event Timing





Seasonality

Joint Distributions



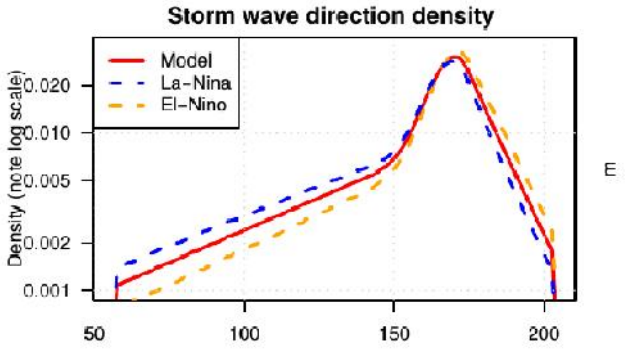
Methodology DETAILS

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.

- ***Open source code repository "stormwavecluster"***
  - https://github.com/GeoscienceAustralia/stormwavecluster

Teleconnections



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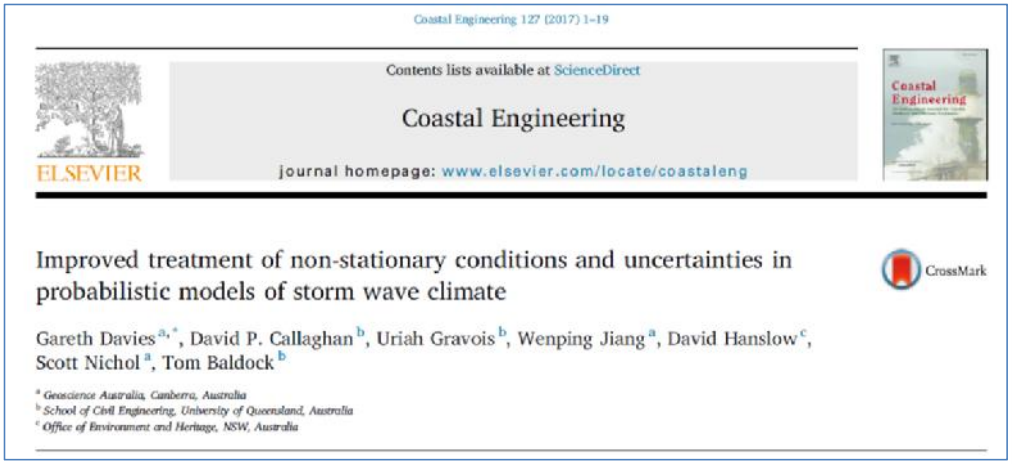

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journal homepage: www.elsevier.com/locate/coastaleng

ELSEVIER

Improved treatment of non-stationary conditions and uncertainties in probabilistic models of storm wave climate

Gareth Davies[a,*], David P. Callaghan[b], Uriah Gravois[b], Wenping Jiang[a], David Hanslow[c], Scott Nichol[a], Tom Baldock[b]

[a] Geoscience Australia, Canberra, Australia
[b] School of Civil Engineering, University of Queensland, Australia
[c] Office of Environment and Heritage, NSW, Australia

Methodology

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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
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

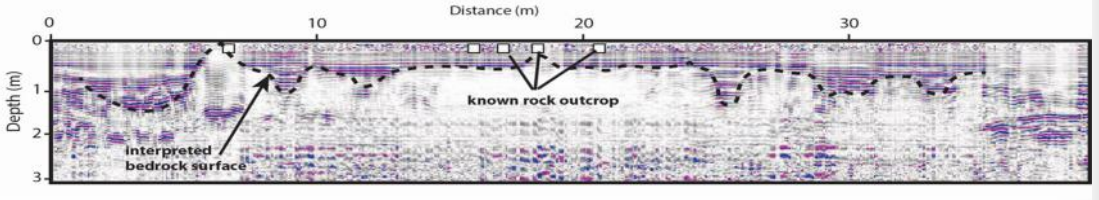
Methodology DETAILS

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

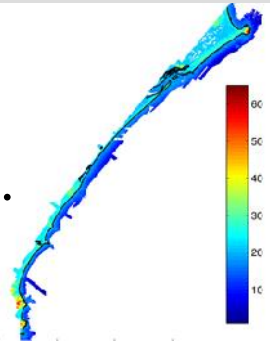
Bedrock and Nearshore Reefs



Methodology DETAILS

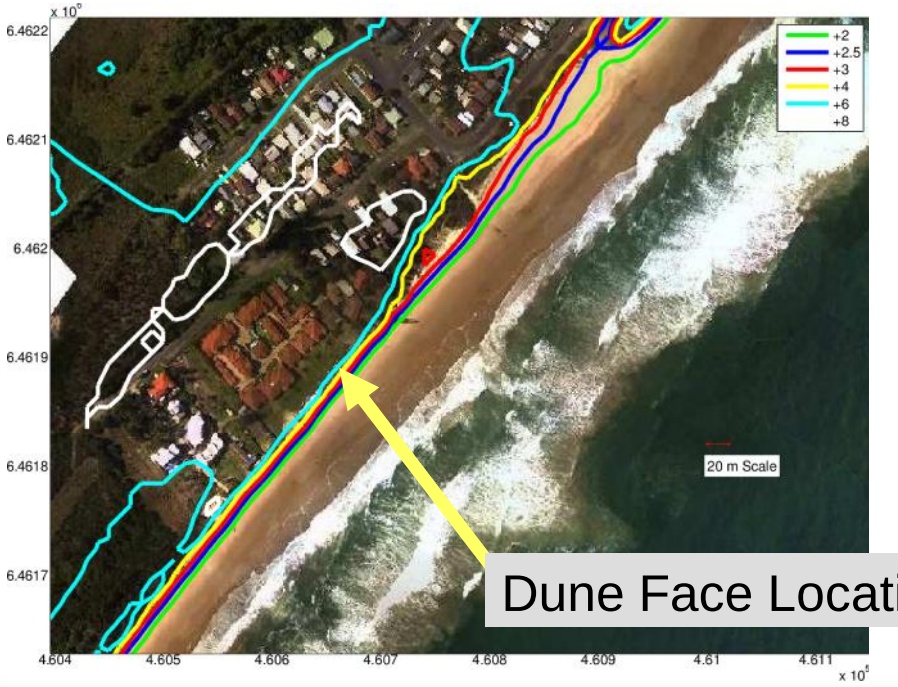
Analysis of field data for site characterization and model initialization.

LIDAR coverage



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



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 N**earmap**)
e) Australian Hydrographic Service (AHS) Charts
f) Hydrographic surveys
g) Geoscience Australia Bathymetry

Recent Nearmap Imagery

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
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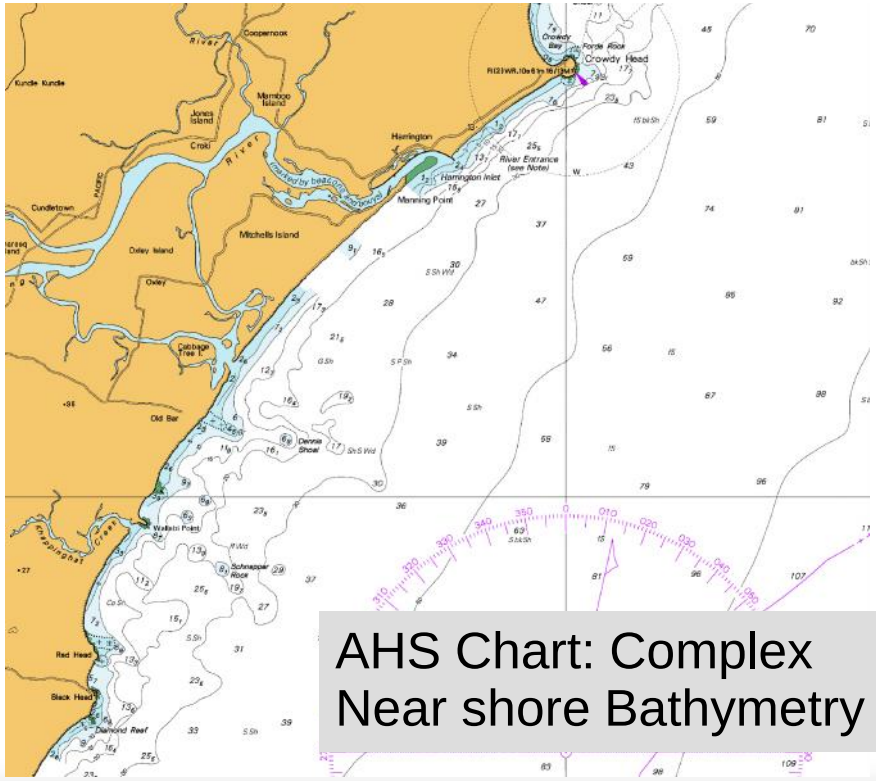

AHS Chart: Complex Near shore Bathymetry

Methodology DETAILS

Analysis of field data for site characterization and model initialization.

Old Bar, NSW

a) Ground penetrating radar
b) LIDAR
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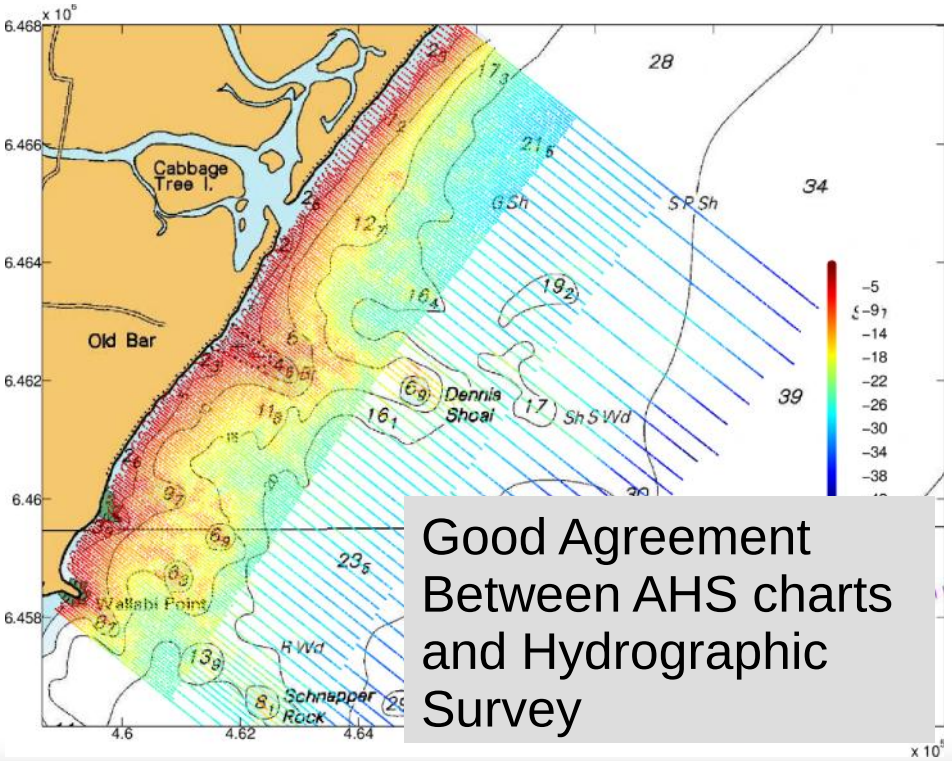
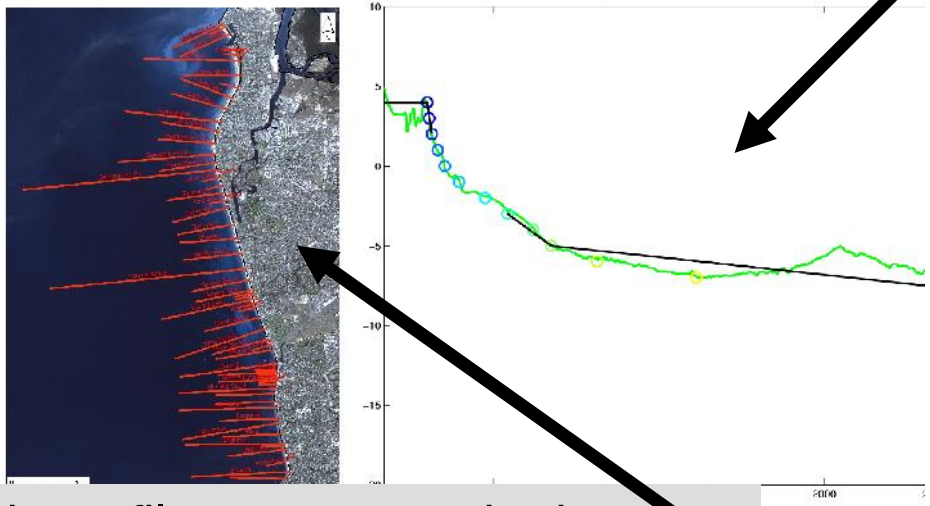


Good Agreement Between AHS charts and Hydrographic Survey

Methodology DETAILS

Analysis of field data for site characterization and model initialization.

Survey Profile and EVO profile



Beach Profile Survey Monitoring Campaign Since 1970

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

1) Choose a suitable shoreline evolution model.
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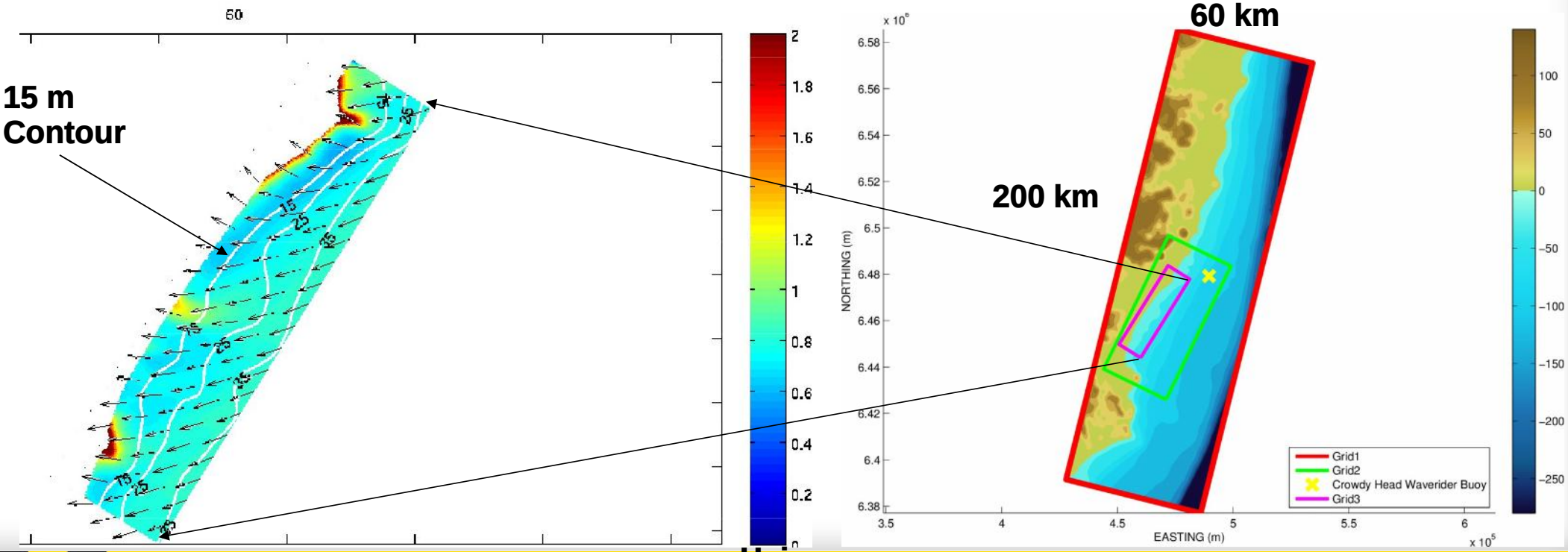
Simulating waves nearshore (SWAN) model coastal wave transformation simulations.



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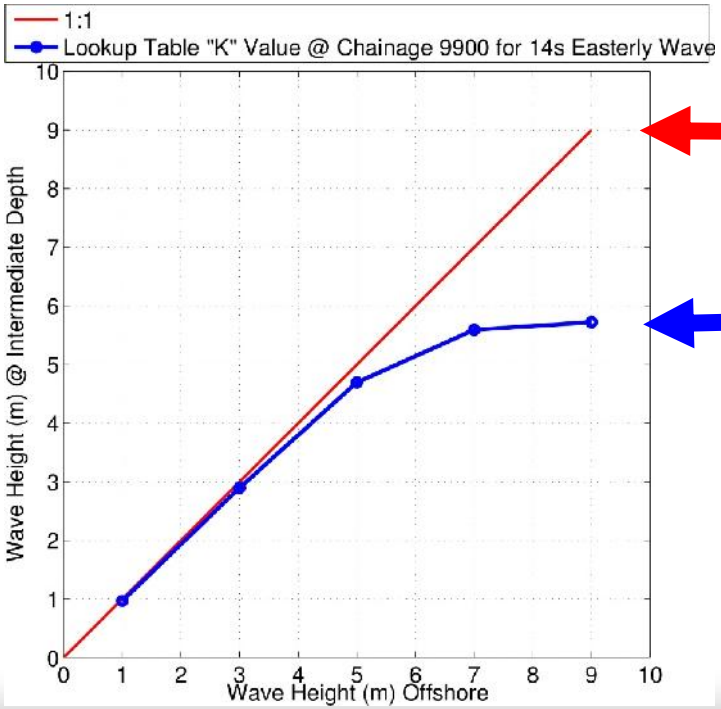


Linear Look-up Table

Non-linear Look-up Table

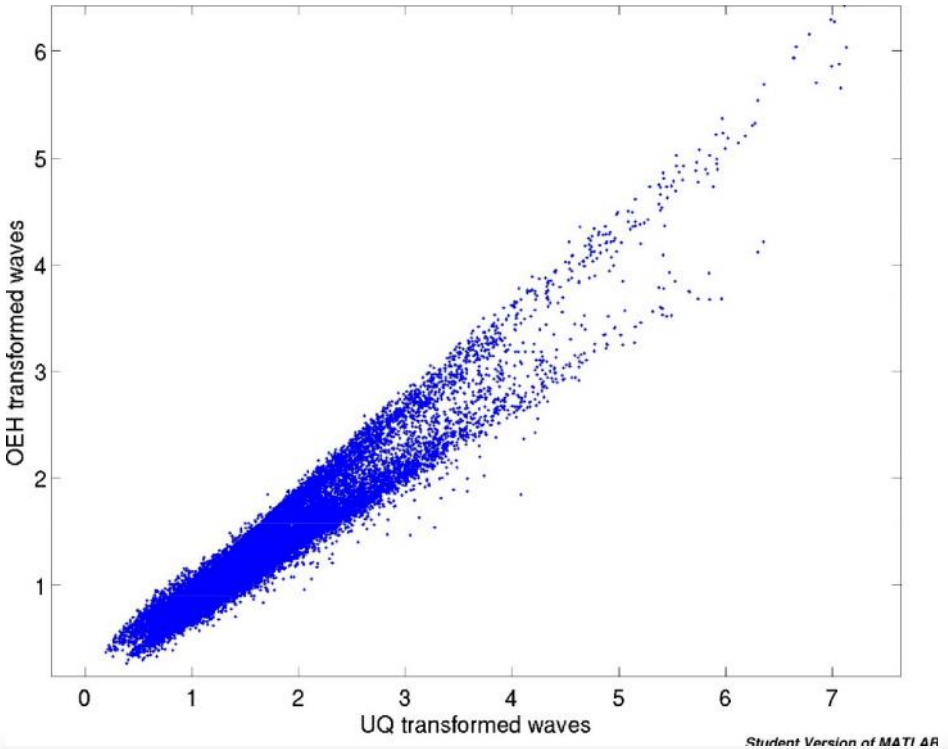
Methodology DETAILS

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

NSW nearshore wave toolbox

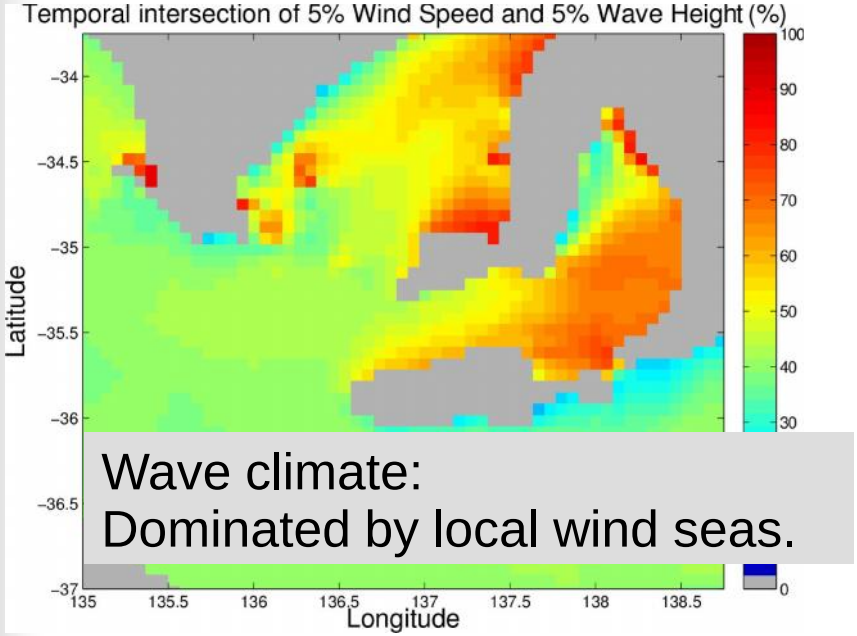
a) Good agreement between our method and the NSW wave transformation toolbox.

b) Potential to apply NSW wave transforms for future shoreline modelling applications.

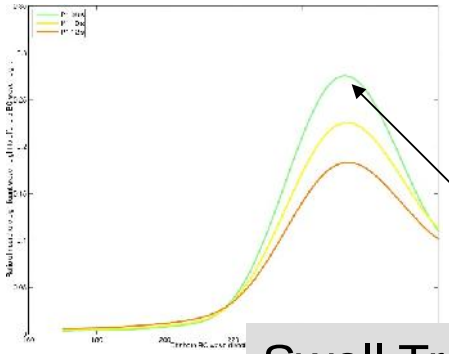


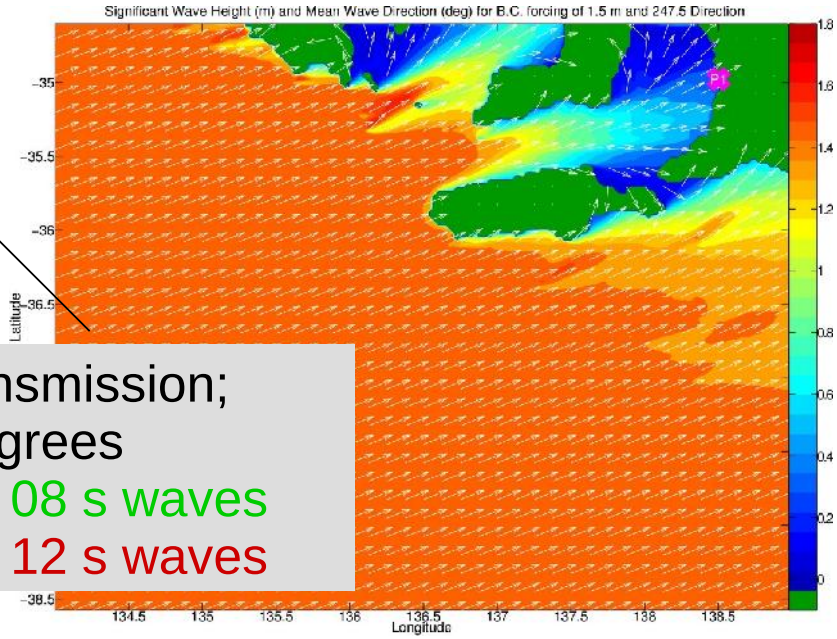
Methodology DETAILS

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.

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

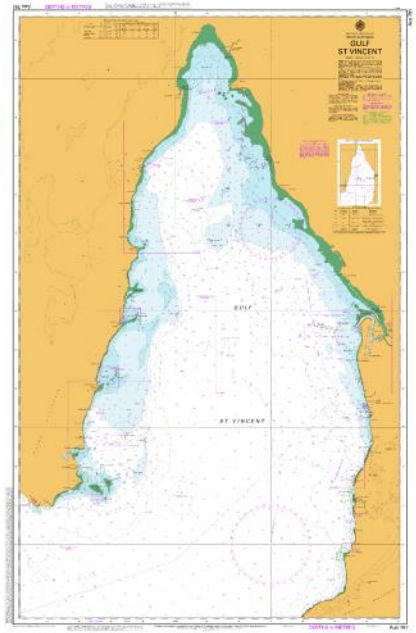
CSIRO

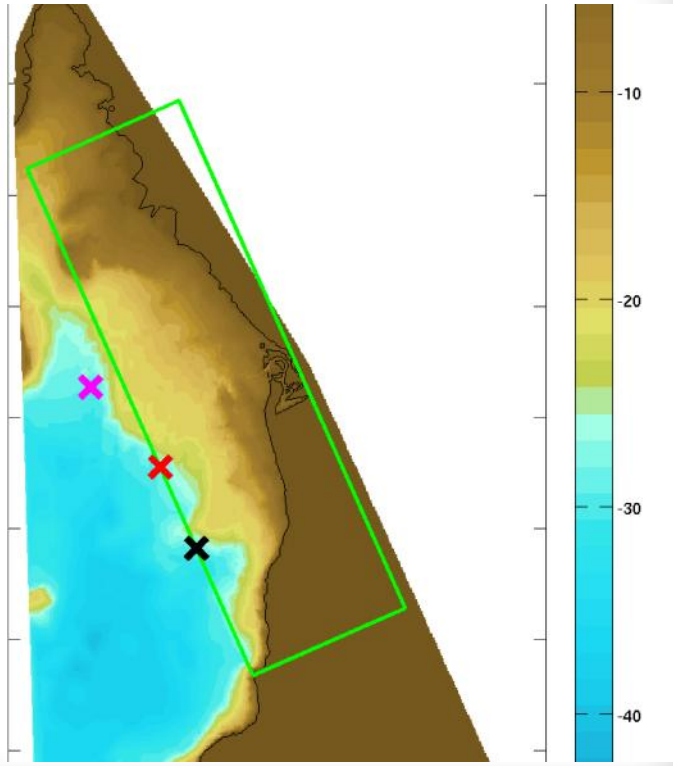
A Global Wave Hindcast focussed on the Central and South Pacific

Tom Durrant, Diana Greenslade, Mark Hemer and Claire Trenham

CAWCR Technical Report No. 070

April 2014





Methodology

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

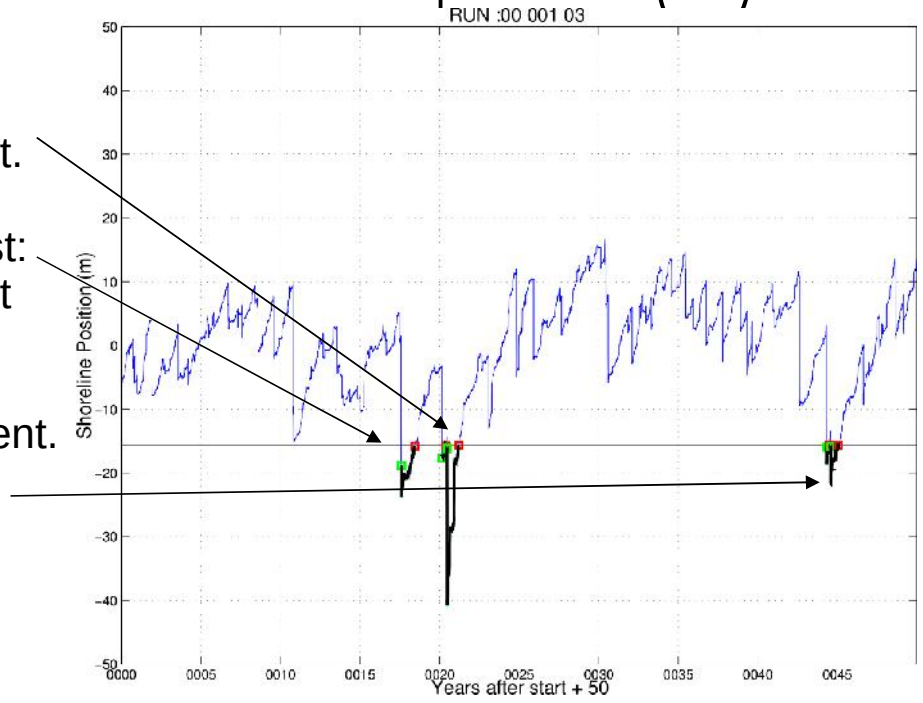
Methodology DETAILS

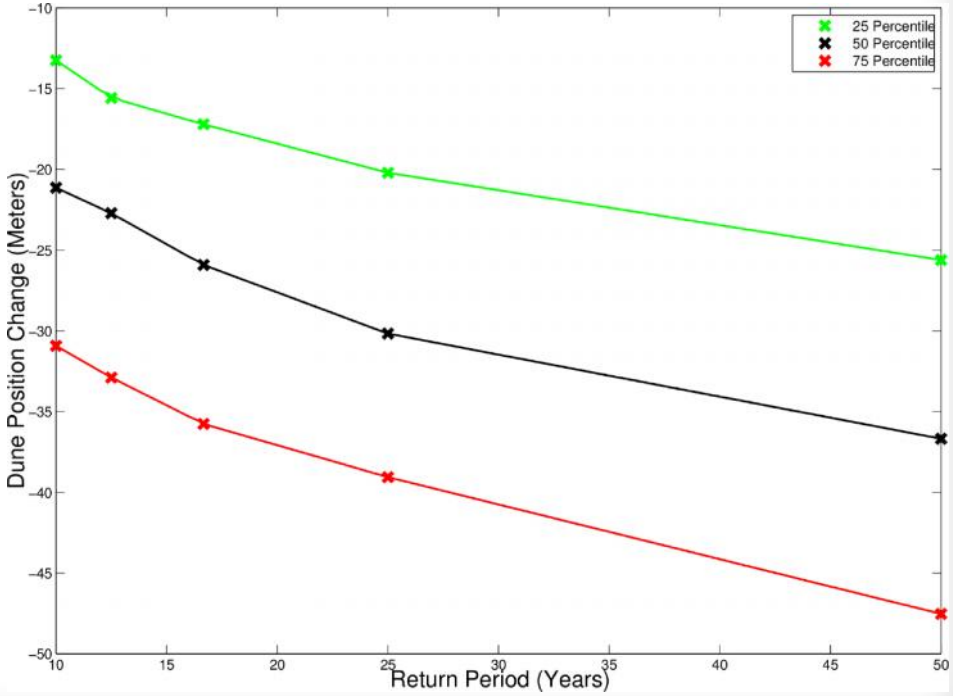
Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).

Biggest:
1/50 year event.

Second Biggest:
1/25 year event

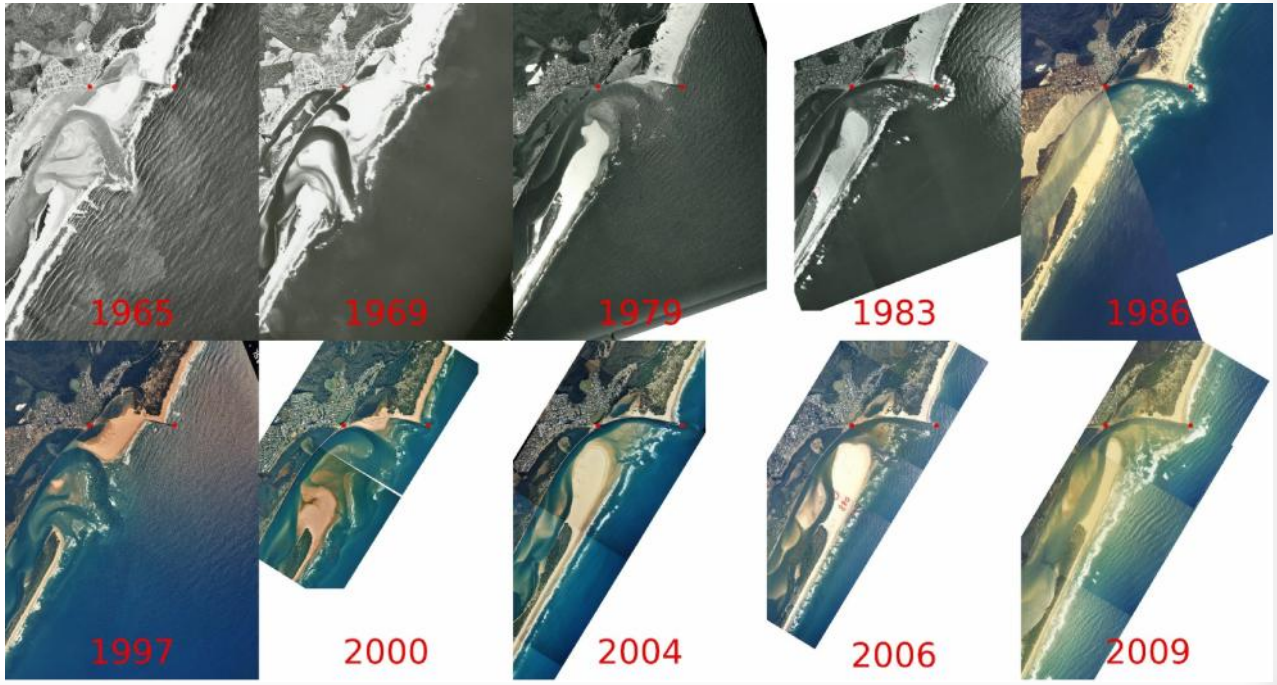
Third Biggest:
1/16.6 year event.





Methodology DETAILS

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



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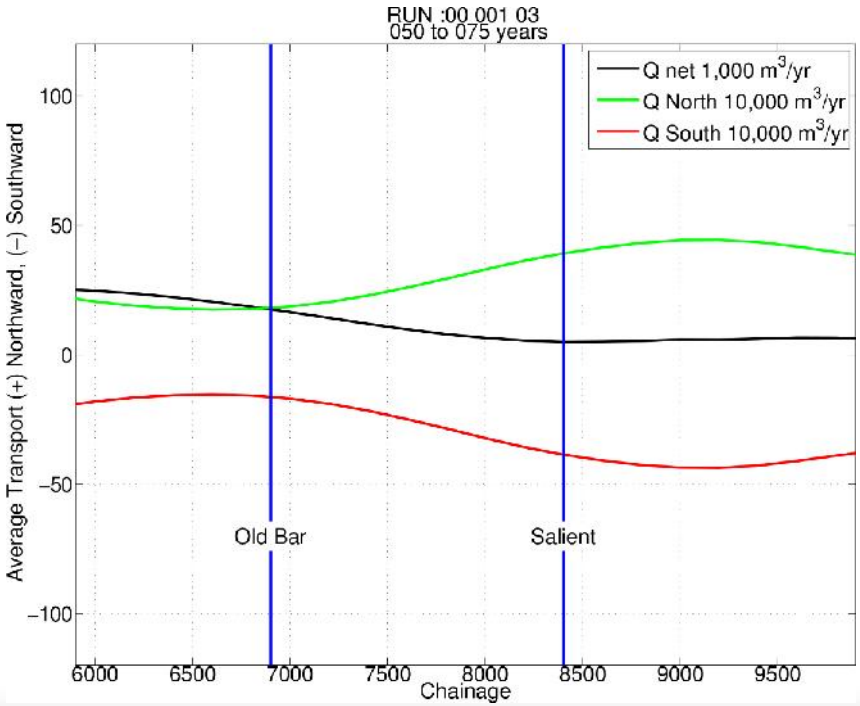
Simulate shoreline evolution for ~ 50 year time horizons to develop storm erosion return periods (RP).



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)

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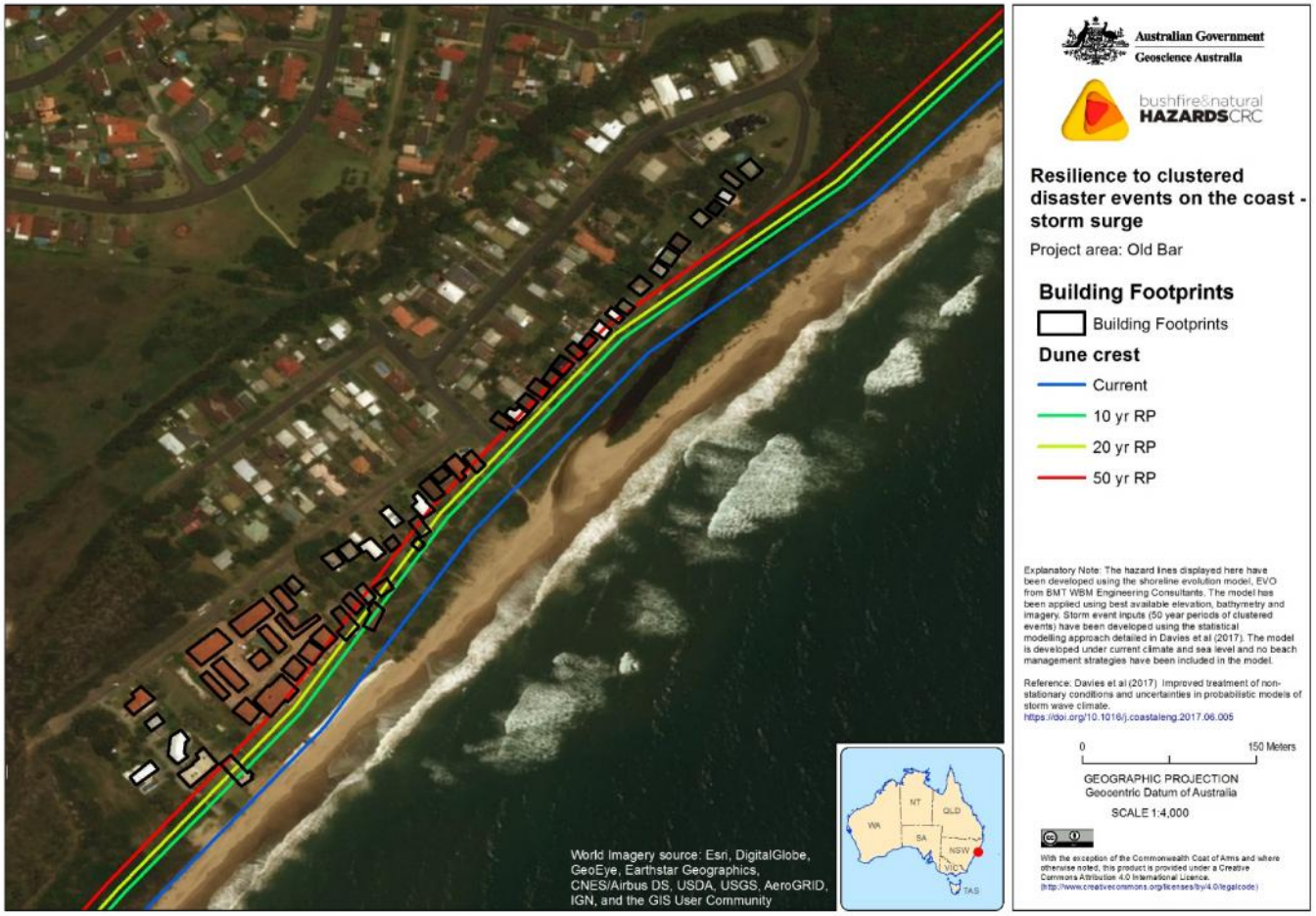

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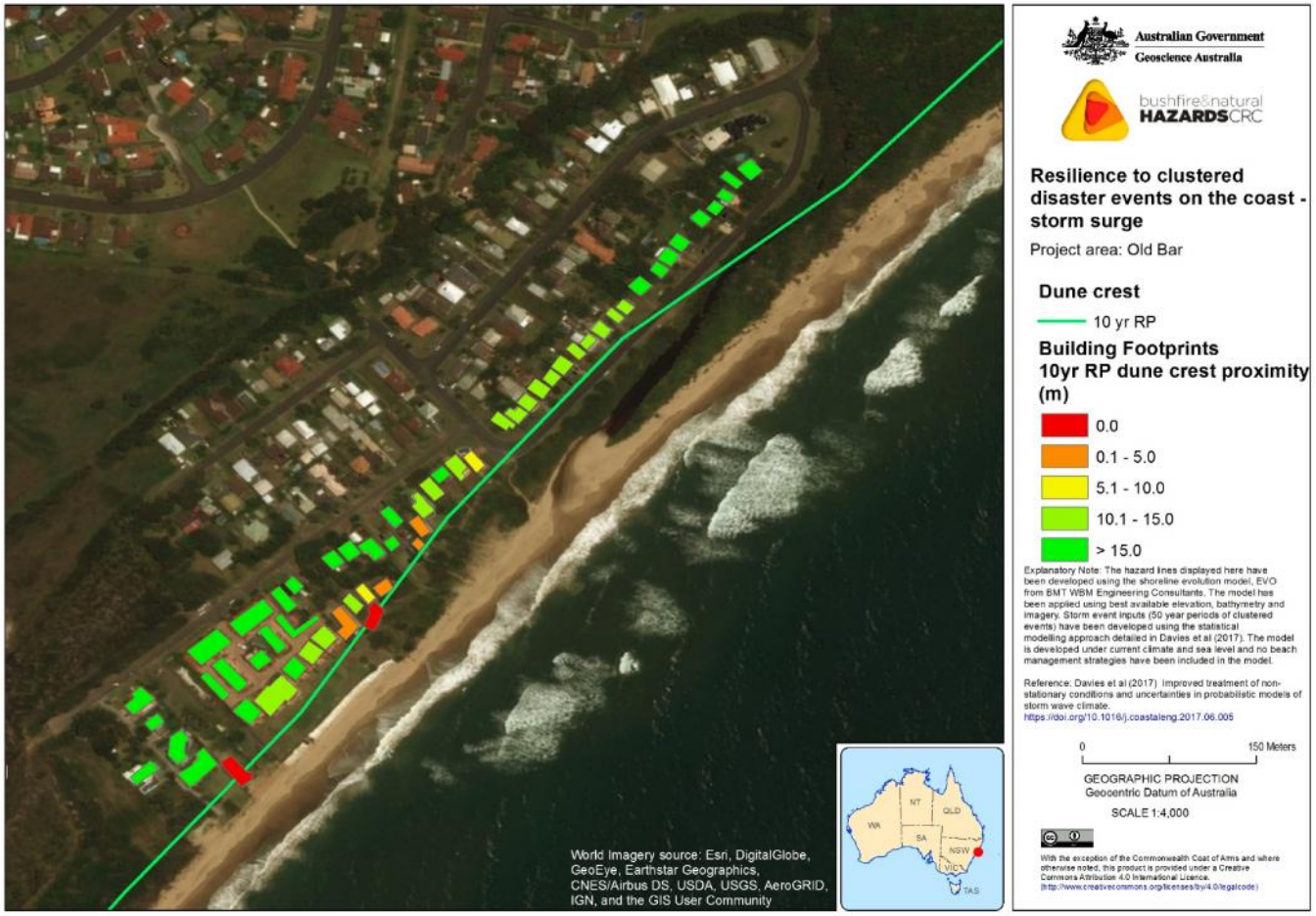

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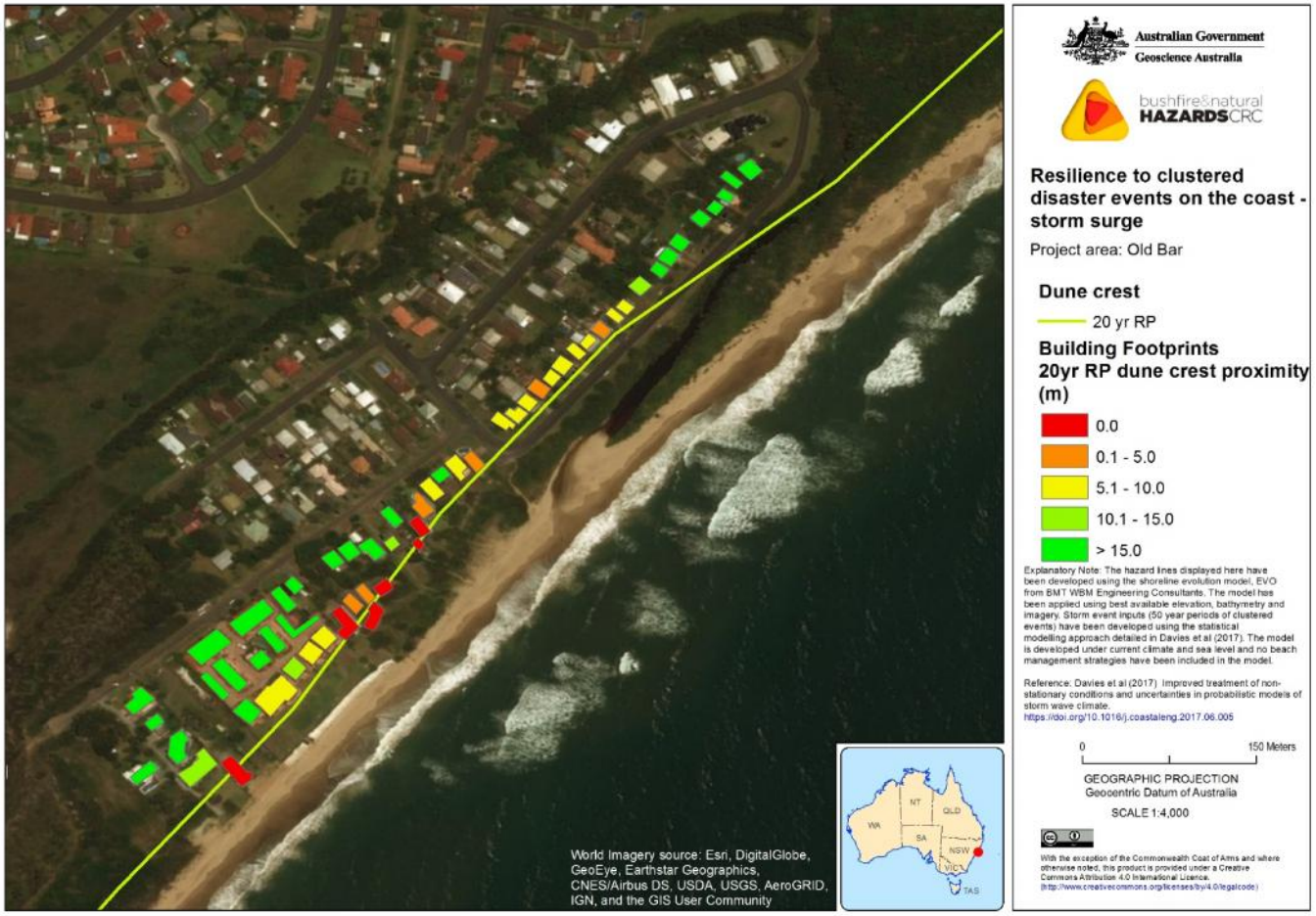
RESULTS



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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.
3) Release of shoreline modelling codes and user manual.
4) Final project reports.

22 June, 2015

06 June, 2016