COASTAL HAZARDS, CLIMATE CHANGE AND ADAPTATION, ROCHES BEACH, LAUDERDALE CLARENCE CITY, TASMANIA

James Carley
Water Research Laboratory
University of New South Wales
WRL - THE ORGANISATION

- Part of UNSW
- Established at Manly Vale 1959
- Birthplace of coastal engineering in Australia

ACTIVITIES
- Teaching
- Research
- Commercial consulting by full time project staff

PROJECT METHODS
- Physical Modelling
- Numerical Modelling
- Fieldwork
- Desktop Design
Coastal hazards are not new

Lauderdale Canal Entrance
1924 to 2008
REPORT ON
COAST PROTECTION STUDY
ROCHES BEACH,
LAUDERDALE

PITT & SHERRY PTY.LTD.
in conjunction with
PROFESSOR D.G. FOSTER
UNIVERSITY OF N.S.W.

JUNE 1988

PARKS AND ENVIRONMENT
LIBRARY
134 Macquarie St, Hobart

LANDS DEPARTMENT
TASMANIA.
Roches Beach Studies

WRL studies
- 1988: Pitt+Sherry and Prof Doug Foster
- 2008: Clarence coastal study incl adaptation
- 2009: Beach scraping for Cremorne & Roches
- 2011: Hazard line reassessment
- 2011: Trial groyne investigation
- 2011: Storm damage assessment
Roches Beach Studies

Other studies

- 1959: Prof J L Davies
- 2006: Chris Sharples (Tasmania wide)
- 2006: Gerry Byrne
- 2006: Bill Cromer
- 2007: Chris Sharples (Roches Beach)
- 2007: John Hunter (Hobart extreme sea levels)
- Ongoing: Chris Sharples UTAS
WRL 2008 study
Coastal hazard lines and options for entire Clarence LGA developed coast

Technical reference group:
Mark Hemer (CSIRO)
John Hunter (UTAS)
Chris Sharples (UTAS)
Key Coastal Hazards and Processes

Key hazards (out of ~10)

• Erosion
• Inundation
• Groundwater

Key coastal processes (out of ~10)

• Waves
• Water levels
Wave buoys

- Cape Sorell Wave Buoy
- Eden Wave Buoy

Map showing locations of wave buoys.
Analysis of Cape Sorell (top) and Wedge Island wave buoy data (Data source: BoM and CSIRC)

UNSW - School of Civil and Environmental Engineering

Water Research Laboratory
ERA-40 DIRECTIONAL WAVE CLIMATE

TASMANIA
Hₜ from C-ERA-40
DIRECTION from ERA-40
ERA40 142.5E 47.5S
1957 to 2002 (45 years)
SWAN Wave Modelling

Ocean swell waves
Technical assessment: SWAN wave modelling fine grid
SWAN output

Clifton Beach West (Hs0 = 1 m)

Offshore Wave Direction (deg from N)

Local Significant Wave Height (m, at 20 m contour)

- Tp = 10 sec
- Tp = 15 sec
- Tp = 20 sec

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Water Research Laboratory
Wind waves
Present day water levels
Tide, storm surge, but not local waves

Based on Pugh (1987) and Hunter (2007)
- Hobart Extrapolation
- Fremantle WA DPI (2004)
- Sydney NSW (Haradasa et al, 1991)
- Port of Hobart (2005) Data Points

EXTREME WATER LEVEL (m AHD, m ~MSL)

AVERAGE RECURRANCE INTERVAL (years)
Historical events

Lauderdale inundation July 1974
IPCC (NCCOE, 2004) Sea level rise projections

SEA LEVEL RISE for ~2100
0.9 m from NCCOE (2004) SLR curves based on IPCC (2001)
7 m IPCC (2007) for total melting of the Greenland ice sheet
70 m if all the world’s ice sheets were to melt (GACGC, 2006)
Sea level rise scenarios adopted

Most states (QLD, NSW, VIC, SA, WA) have adopted Sea level rise for planning to 2100 of 0.8 to 1.0 m

<table>
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<th>SLR Scenario</th>
<th>Year and Sea Level Rise relative to 1990 (m)</th>
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<tr>
<td>“High” range scenario</td>
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WRL 2008 coastal hazard lines and areas
Due to the study covering most of Clarence coast,
Single values were used for setback lines and inundation for Roches Beach
Hazard line reassessment (2011)
Long term change from photogrammetry
Wave climate along beach
Sand transport (northward)

Figure 4-1: Mean Net Yearly Alongshore Sediment Transport Calculated using the CERC and Kamphuis (2002) Formula
Sand transport

Figure 4-2: Bathymetry Offshore of Roches Beach with a Sediment Lobe evident Northwest Lauderdale Headland
Components of inundation

- Tide
- Barometric setup
- Wind setup
- Wave setup
- Wave runup
### Table 2-2: 100 yr ARI Swell and Wind-Wave Setup and Run-up along Roches Beach

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<thead>
<tr>
<th>Profile</th>
<th>Approximate Chainage (m)</th>
<th>Swell Waves</th>
<th>Wind Waves</th>
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(1) Regional scale storm surge including wind and barometric setup is included in measurements on the Hobart tide gauge.

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Water Research Laboratory
Inundation levels

<table>
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<tr>
<th>Profile</th>
<th>Approximate Chainage (m)</th>
<th>Tide gauge water level</th>
<th>Still water level (incl wave and wind setup)</th>
<th>Design floor level (excl wave runup)</th>
<th>R2% Wave runup</th>
<th>Design floor level on frontal dune (incl wave runup)^2</th>
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</table>

1 Chainage from southern end of Roches Beach at approximately CCC topographic survey Profile 1
2 Includes 0.3 m freeboard

Water Research Laboratory
Erosion and recession setbacks

3.7 Risk Areas for Coastal Erosion and Recession

Allowances for setbacks for erosion and recession are shown in Table 3-3. Setback distances comprise the following factors:

- S1: Allowance for storm erosion
- S2: Allowance for long term (underlying) recession
- S3: Allowance for beach rotation and/or medium term fluctuations in sediment supply
- S4: Allowance for reduced foundation capacity (to Stable Foundation Zone)
- S5: Allowance for future recession (Bruun Rule).

The design setback (DS) is defined as:

\[ DS = S1 + N \times S2 + S3 + S4 + S5 \]  \hspace{1cm} (3-2)
S1: Storm Erosion modelling

Roches Beach - Profile 10

- Initial Profile
- Swell Final
- Windwave Final

Profile response to Swell and Wind-wave design events at Profile 10, Roches Beach
S1: Erosion modelling

Figure 3-4: Erosion predicted by SBEACH above 0 m AHD during design swell and wind-wave.
## Table 3-1: Photogrammetry Details

<table>
<thead>
<tr>
<th>Aerial photography date</th>
<th>Photo Scale</th>
<th>Maximum elevation error (m)</th>
<th>Spatial accuracy (± m) (horizontal)</th>
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S2: Underlying recession

Chainage 2450m Contour Position

Trend \approx -0.15 \text{ m/yr}

Evolution of Planform on Littoral Drift Coast (Source: Stephens, Roy and Jones, 1981)
S2: Long term change from photogrammetry
S4: Dune stability

Angle of repose of dune sand: \( i \approx \phi = 34^\circ \)

Safe angle of repose of dune sand: \( \alpha = \tan^{-1}\left(\frac{\tan \phi}{1.5}\right) = 24^\circ \)

All levels to AHD
Erosion Hazard Lines for coastal setback
S5: Recession due to sea level rise

Illustration of Bruun Rule
**2011 Detailed summary of setback allowances**

Table 3-3: Allowances for Erosion and Recession

<table>
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<tr>
<th>Profile</th>
<th>Approximate Chainage (m)</th>
<th>Horizontal storm erosion (m)</th>
<th>Underlying recession (m/year)</th>
<th>Allowance for rotation or medium term fluctuations (m)</th>
<th>Stable Foundation zone (m)</th>
<th>Design Brunn factor</th>
<th>Brunn recession 2050 mid SLR (m)</th>
<th>Brunn recession 2050 high (m)</th>
<th>Brunn recession 2100 high SLR (m)</th>
<th>Total present (m)</th>
<th>2050 high SLR (m)</th>
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2011 storms

8 June 2011
9-10 July 2011

1 hour wave height $H_s = 10.0$ m approximately a 4 year ARI;

48 hour wave height: $H_s = 7.0$ m, approximately a 40 year ARI.

Site visit by Dr Tom Shand
From WRL

Figure 1  MSLP Chart for 8 July 2011 (source: BoM 2011)
2011 storms

Photograph 1 Erosion north of Bambra Reef

Photograph 2 Wave overtopping north of Bambra Reef resulting from run-up

Photograph 3 Bambra Reef and either newly placed riprap rock evident at end of Bambra St (photo: M. Dell, 15 July 2011)

Photograph 4 Erosion immediately south of rock revetment fronting No. 2 Bambra Street
2011 storms

Photograph 5 Over-steepened dune scarps of up to 1.5 m high along much of Northern Roches Beach

Photograph 6 Small hessian sandbags placed along dune crest at No. 118 Balook Street

Photograph 7 Additional sand placed to raise the crest level at Balanada Street

Photograph 8 Southern revetment now holds land at least 5 m further seaward than adjacent shoreline
2011 storms

Photograph 9 Northern end of southern revetment with outflanking evident
(Photo: M. Dell, 15 July 2011)

Photograph 10 Erosion of land backing the southern revetment evident where waves have overtopped the lowered wall
2011 storms

9-10 July 2011

1 hour wave height $H_s = 10.0 \text{ m}$

48 hour wave height: $H_s = 7.0 \text{ m}$,
Storm waves 9-10 July

9-10 July 2011

• 1 hour wave height $H_s = 10.0 \text{ m}$
  • approximately a 4 year ARI;

• 48 hour wave height: $H_s = 7.0 \text{ m}$,
  • approximately a 40 year ARI.
Water levels 9-10 July 2011

Predicted tide 1.54 m CD
Measured Port of Hobart 1.72 m CD, 0.89 m AHD
< 1 year ARI ~0.2 m “storm surge”
Summary / conclusions / discussion

- Rigorous contemporary coastal engineering studies have been undertaken.
- Roches Beach has receded over the last 50 years.
- Erosion, recession, inundation and potential sea level rise are the dominant coastal hazards to consider for planning.
- Numerous feasible adaptation options are available.
The end