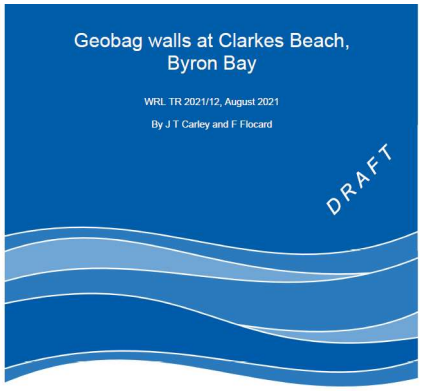
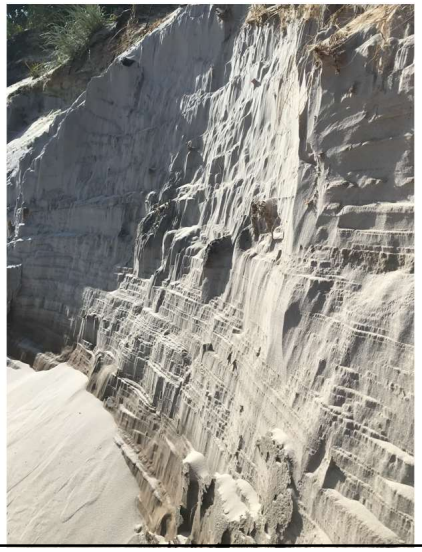
Recent coastal change and emergency management in Byron Bay



James Carley – Principal Coastal Engineer
Water Research Laboratory, UNSW Sydney
Catherine Knight – Crown Lands
Bill Payne – Ardil Payne

1

Clarkes Beach cafe



2

Photos: James Carley 18/12/2020 top, 23/04/2021 bottom

3

Recent coastal studies

The major studies have been:

- PWD (Gordon et al., 1978)
- WBM (2002)
- Gordon (2011)
- BMT WBM (2013)
- WRL (Carley et al, 2016)
- Patterson (2010)
- Goodwin et al. (2013)
- Carley et al. (2017)
- Murray/GCCM (2020)

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Foreshore features

2007 to 2020 change

Minimal erosion of the 3 m AHD contour from The Pass to the Captain Cook car park/ Thompsons Rock
just east of Reflections,

Due to the predominance of rock outcrops (including Thompsons Rock) backing the beach

Horizontal erosion of 13 to 26 m between the Captain Cook car park and Jonson Street

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Erosion in 2020

Clarkes Beach and Main Beach Byron Bay have experienced beach erosion in 2020 and 2021 that has been described as “unprecedented” (but is not unexpected).

This has resulted in:

- the loss of vegetation,
- closure of many beach access ways
- exposure of normally buried rocks and reefs
- diminished beach amenity
- unearthing of indigenous artefacts
- the potential collapse of built assets such as those within the Reflections Holiday Park, Clarkes Beach, Byron Bay (Reflections) and the Beach Byron Bay Cafe building

6

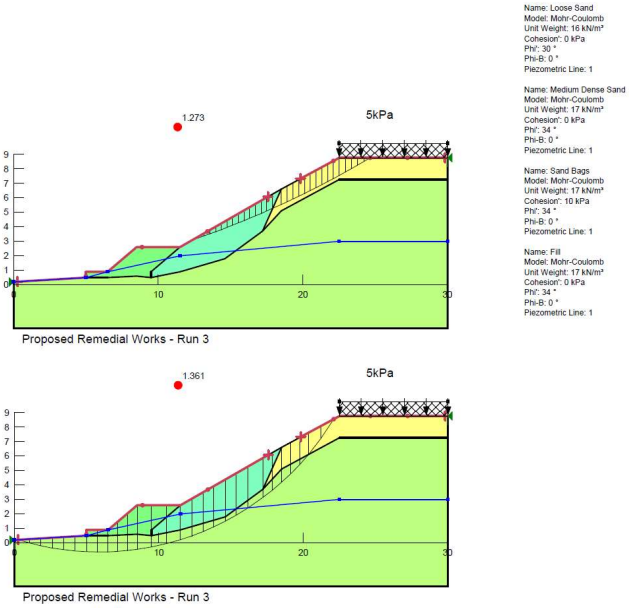
Erosion in 2020

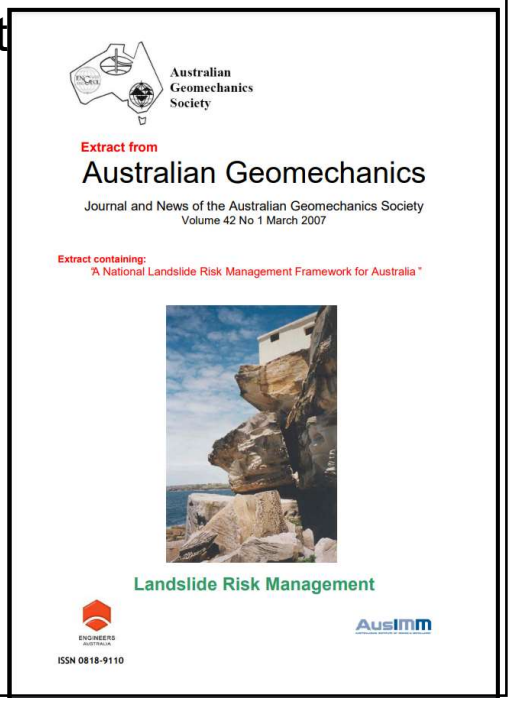
The Cafe was determined by coastal, geotechnical and structural engineers to be at imminent risk of collapse onto the beach.

Interim geobag seawalls were designed and constructed so as to prevent this collapse, while longer term management is being developed.

7

Geotechnical engineer assessment





8

Front page news Wamberal 1978

HIGHEST DAILY SALE IN N.S.W. (ABC AUDIT)

The Daily Telegraph

FOOD STOCKS DWINDLE: p3

Phone 20924 SYDNEY, WEDNESDAY, JUNE 21, 1978 Price 15c

Home slides to its doom

A second house crashed into the sea at Terrigal last night.

The second house starts to slide last night as the earth below it gives way.

New crisis

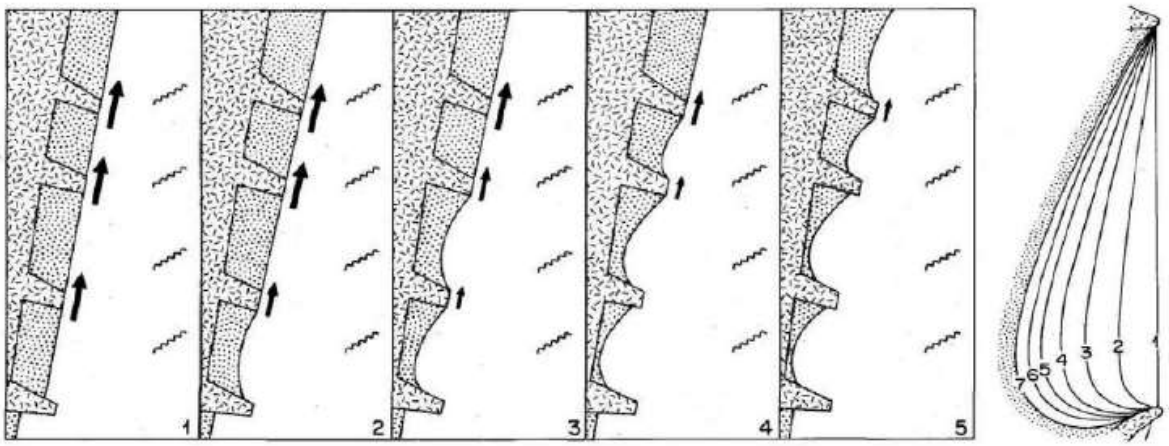
9

Foreshore 4 July 2020

arch

Figure 2.1 Foreshore features 4 July 2020 – prior to Café geobags (Nearmap)

10



Source: Stephens et al., (1981)

Figure 3.2 Coastal evolution on a littoral drift coast

11

PWD 1978 study

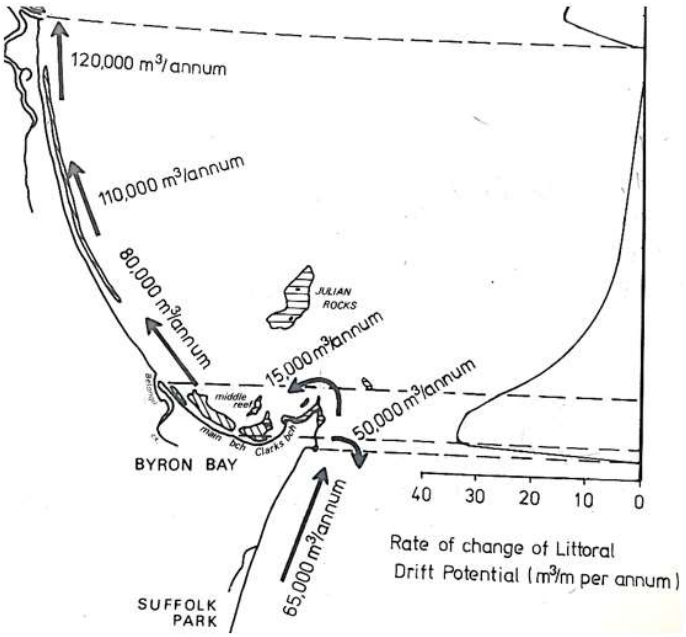


Figure 3.1 Sand transport estimates (PWD, Gordon et al, 1978)

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BMT 2013 study

Figure 3.3 Conceptual sand transport (BMT WBM, 2013)

13

2013 Hazard study was based on 2007 profile
We are now 33% of the way from 2007 to 2050

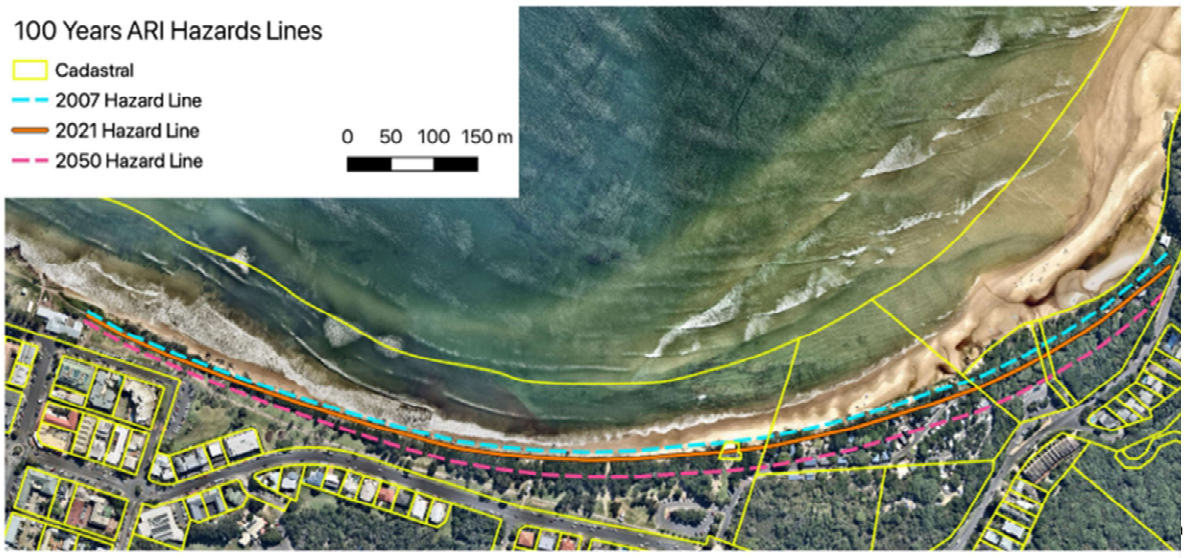

Figure 4.2 Erosion-recession hazard lines – embayment view (BMT WBM (2013), 2021 line by WRL

14

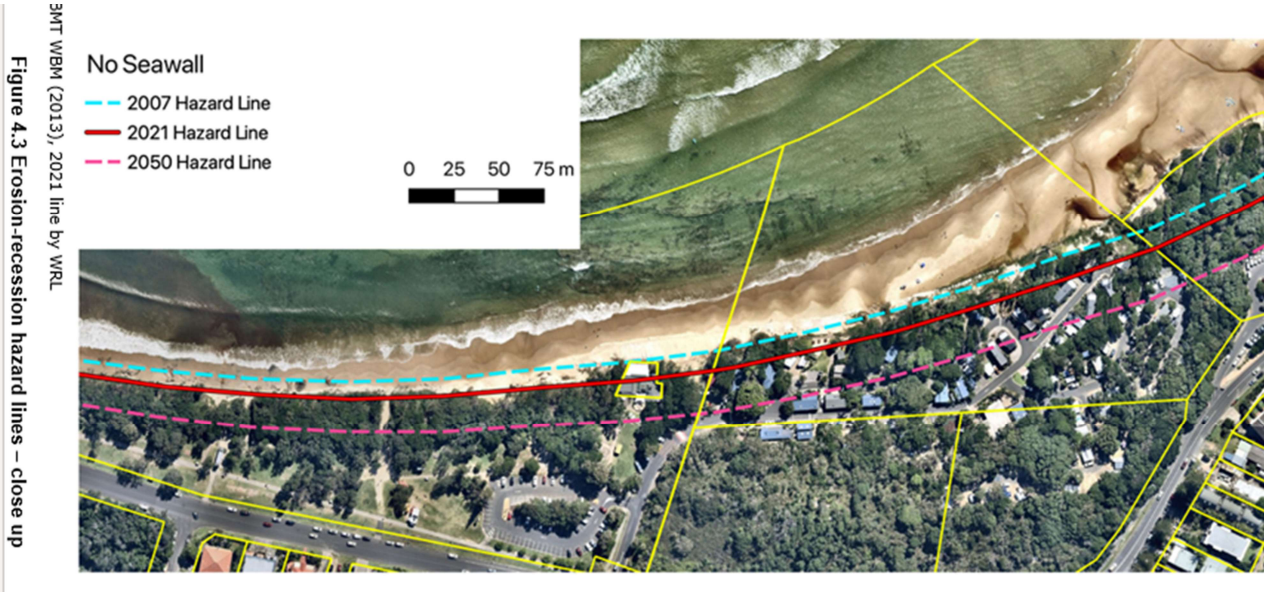

Figure 4.3 Erosion-recession hazard lines – close up

BMT WBM (2013), 2021 line by WRL

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(b) Shoreline recession

(CMM, 2019): Shoreline recession refers to continuing landward movement of the shoreline or a net landward movement of the shoreline over a specified time. As shoreline recession occurs, the beach fluctuation zone is translated landward.

Source: Chloe Dowsett

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Photogrammetry transects
Byron Bay

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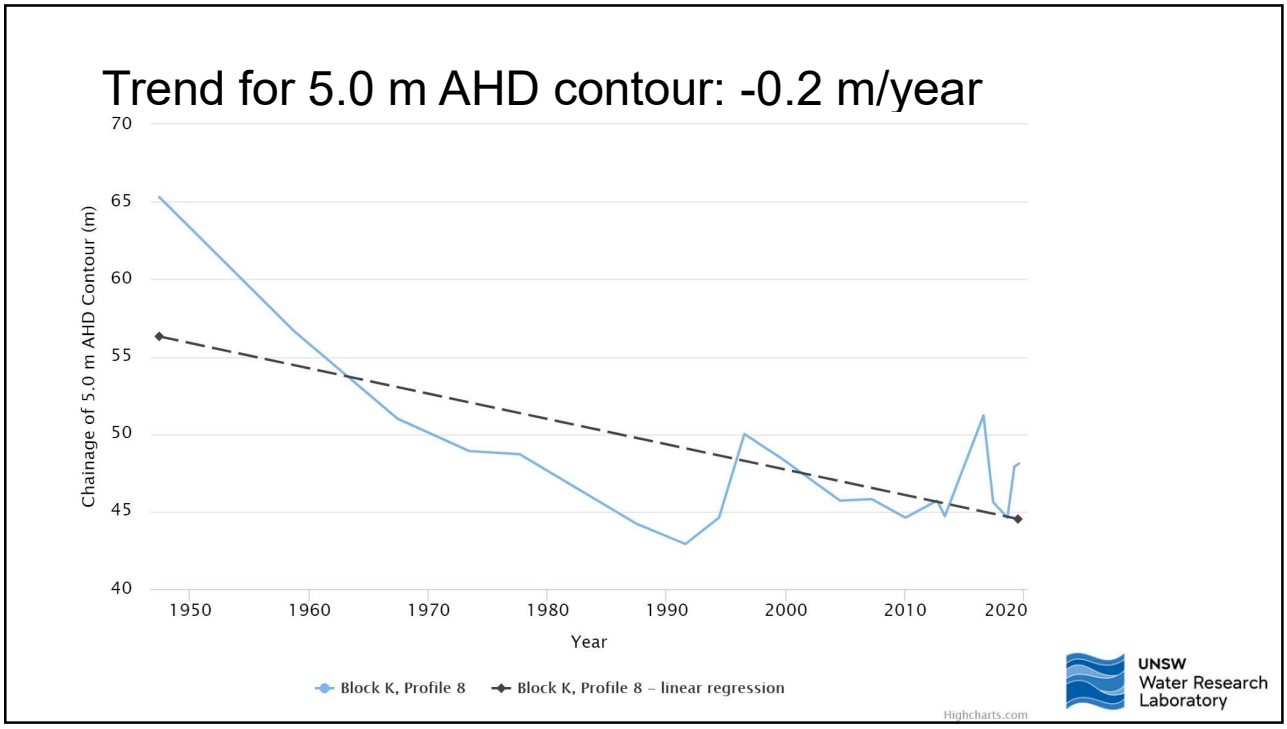
Trend for 5.0 m AHD contour: -0.2 m/year
Chainage of 5.0 m AHD Contour (m)
70
65
60
55
50
45
40
1950
1960
1970
1980
1990
2000
2010
2020
Year
Block K, Profile 8
Block K, Profile 8 – linear regression
Highcharts.com
UNSW
Water Research
Laboratory

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Coastal change components

- Probabilistic storm demand (Carley et al., 2016; Gordon, 1987):
- 1 year ARI: 5 m3/m
- 2 year ARI: 26 m3/m
- 5 year ARI: 53 m3/m
- 10 year ARI: 74 m3/m
- 20 year ARI: 95 m3/m
- 50 year ARI: 122 m3/m
- 100 year ARI: 150 m3/m

- Underlying recession (best estimate): -0.2 m/year
- Recession due to sea level rise: (best estimate) effective Bruun Factor of 88,
- For a dune elevation of about 7 m AHD, the width of the ZRFC is about 14 m, subject to further specialist geotechnical analysis

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Measured sea level rise +3.0 mm/y measured

Table 5.2 Land movement and sea surface height trends 1992-2019 (Watson, 2020)

Station	Name	Vertical Land Motion (mm/year)	Altimetry SLR (mm/year)	Relative SLR (mm/year
21	Tweed Heads	-2.0	+2.8	+4.8
22	Brunswick Heads	+0.2	+3.2	+3.0
23	Yamba	-1.0	+3.2	+4.2

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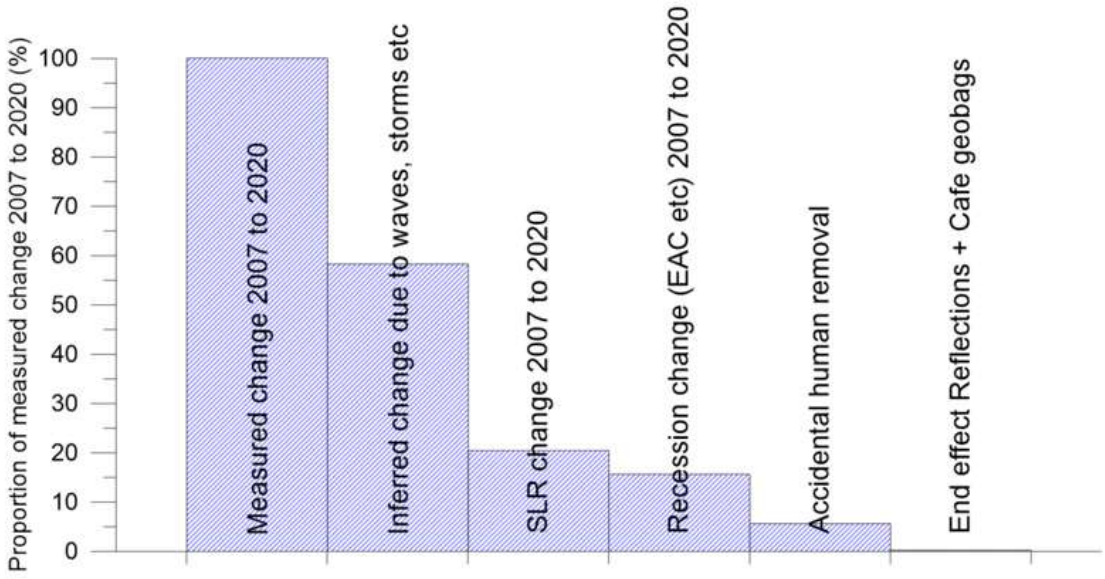

Figure 5.3 Indicative contributions to measured sand change above AHD (2007 to 2020)

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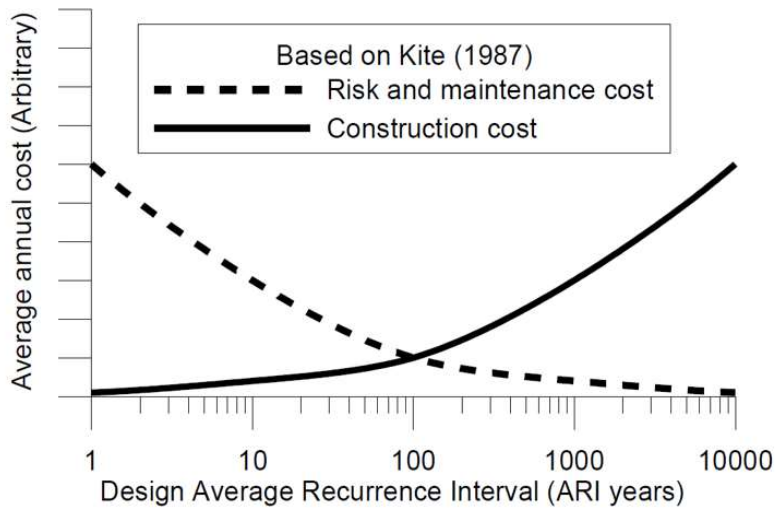

Figure 6.3 Balance between risk, maintenance and capital cost

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Geobag walls

Interim geobag (0.75 m3) walls were constructed fronting Reflections in July 2019 in two lengths of approximately 70 m each, with a total effective length of approximately 160 m.

In October/November 2020, an approximately 90 m long geobag wall was constructed in front of the Beach Byron Bay Cafe.

The new wall is contiguous with and westward of the Reflections geobag wall.

An additional course of geobags was added to a large section of the crest of the Café geobag wall in December 2020 in response to a large storm wave event

The wall was offset seaward of the base of the erosion escarpment to provide geotechnical stability to the Café building and the sand dune.

It was backfilled with compatible sand at a stable angle of repose.

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Geobag design

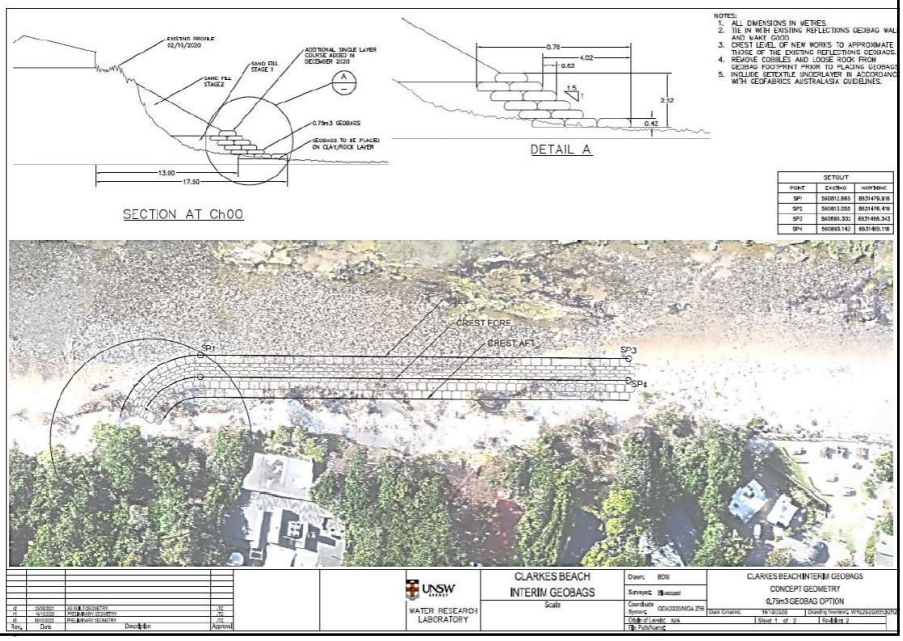


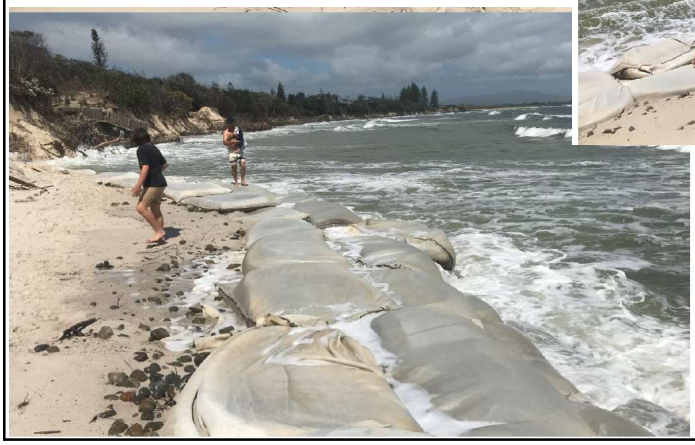
Figure 2.6 Plan and cross section of Cafe geobags – as modified

24

(Photo: Catherine Knight)

Figure 2.4 Geobag walls fronting Café December 2020

25



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December 2020: 1 to 2 year ARI event

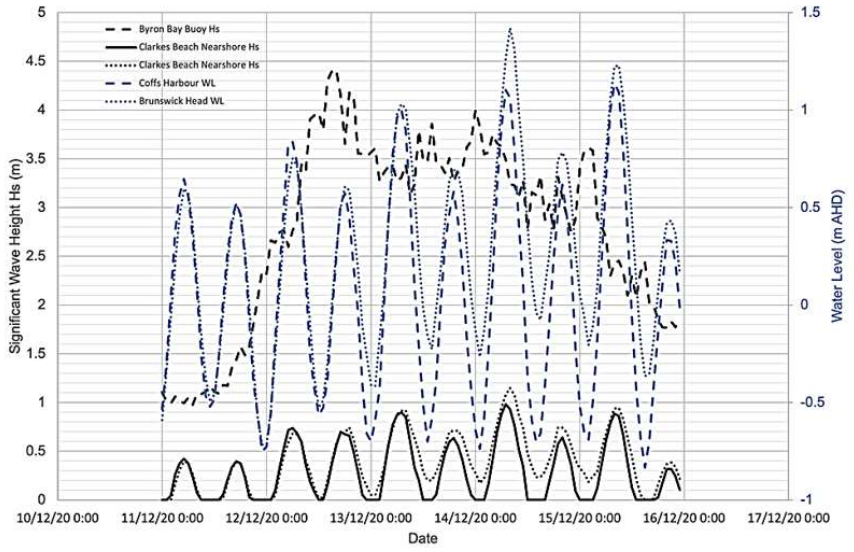

Figure 6.12 Waves and water levels for December 2020 storm event

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Reef exposed

28

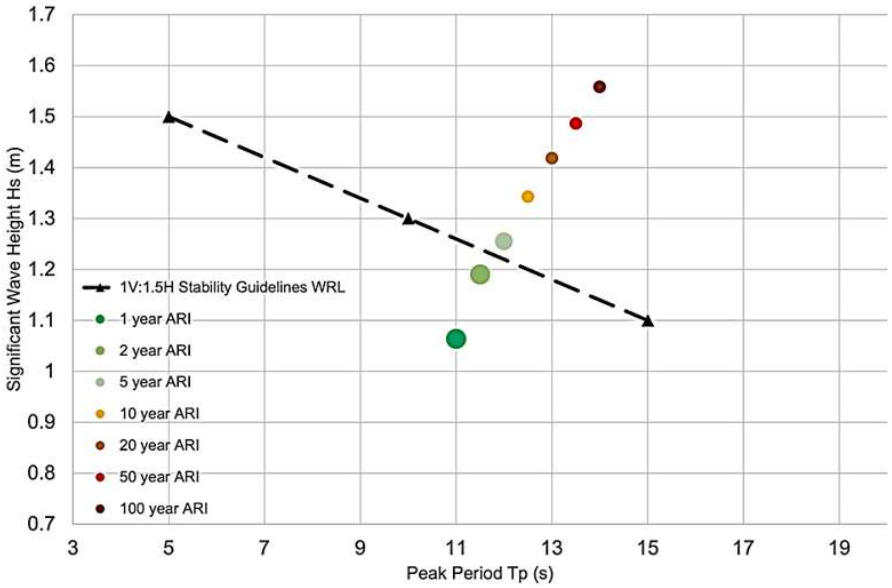

Figure 6.9 Geobag stability estimate

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Seawall end effects

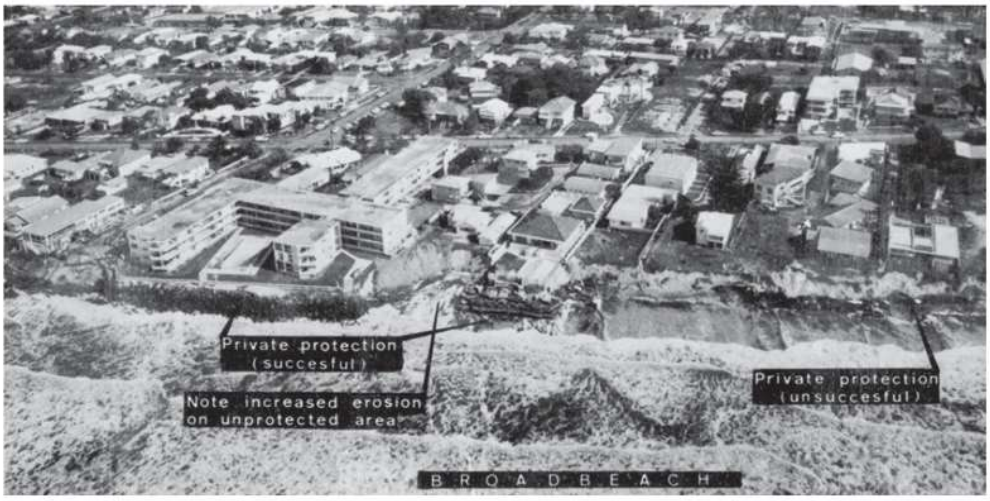

Figure 7.1 Seawall end effect Gold Coast 1967 (Delft, 1970)

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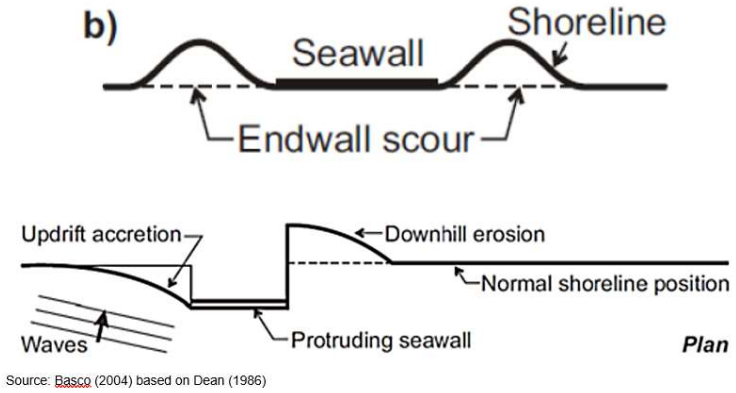
End effects



Source: Basco (2004) based on Dean (1986)

Figure 7.2 Seawall end effect on swash aligned (top) and drift aligned beaches (bottom)

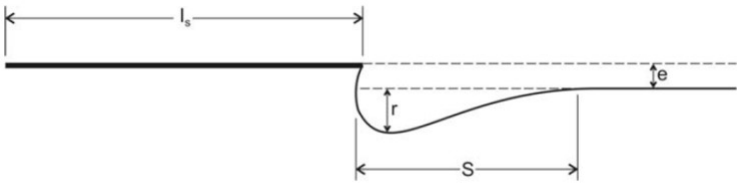


Figure 7.3 Seawall end effect variables

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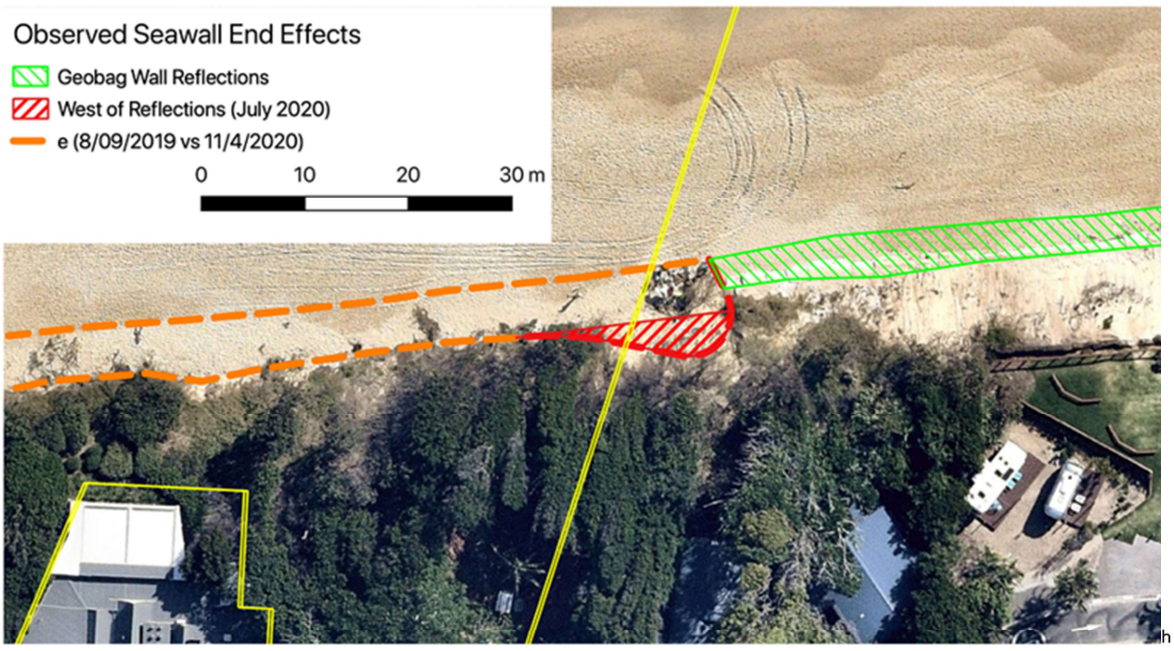

Figure 7.6 Observed end effect to date – Reflections only close up

32

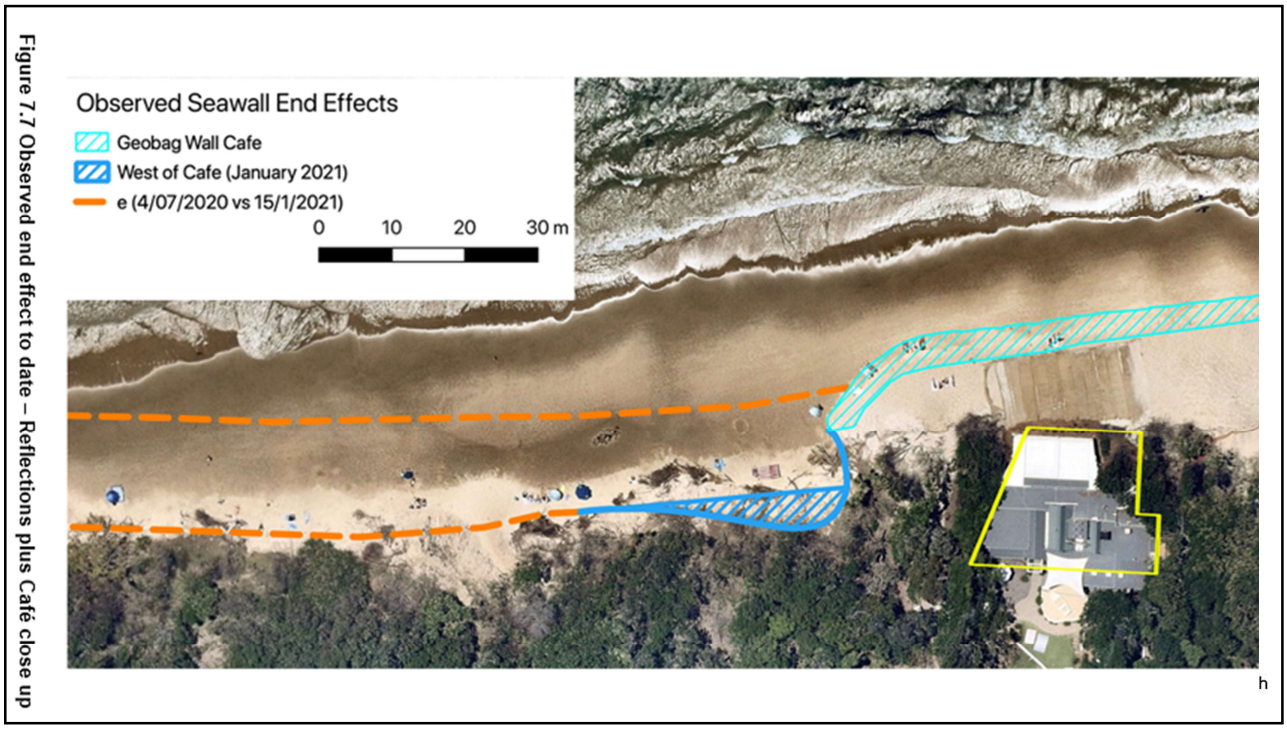

Figure 7.7 Observed end effect to date – Reflections plus Café close up

33

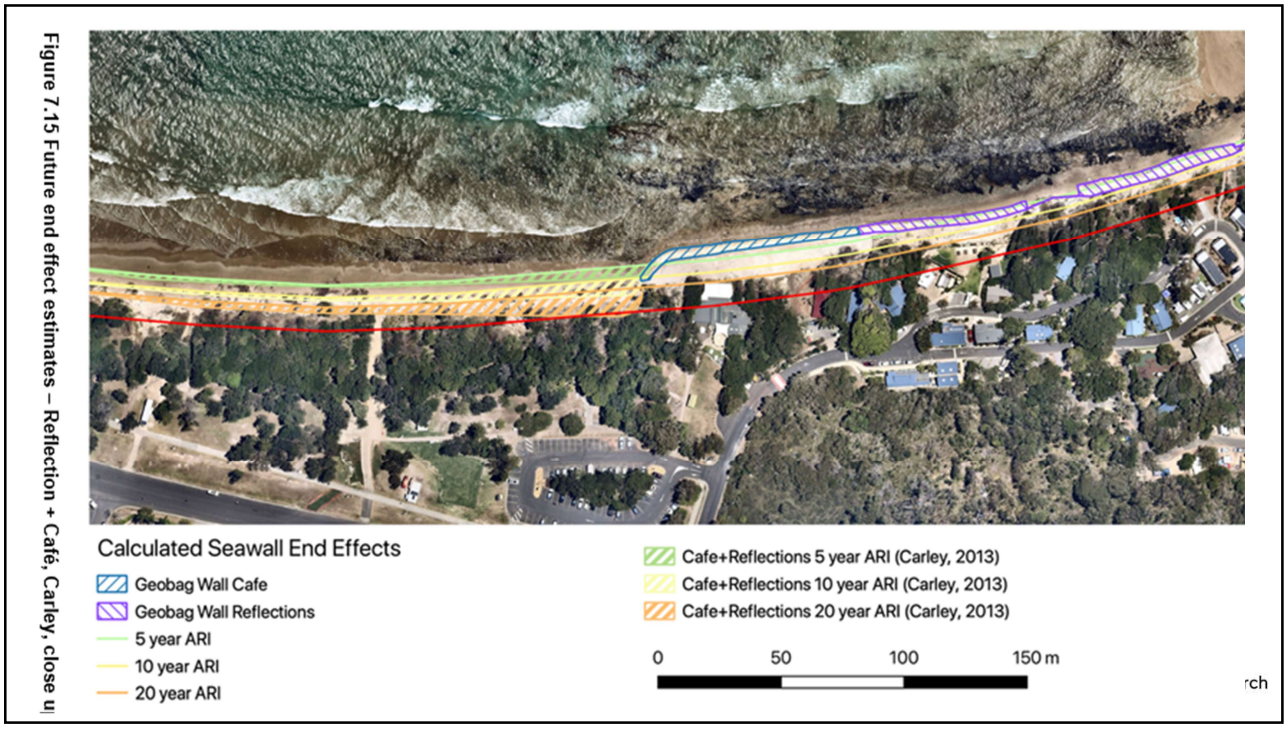

Figure 7.15 Future end effect estimates – Reflection + Café, Carley, close u

34

26/11/2020

35

17/07/2021

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Bob Dean approximate principle

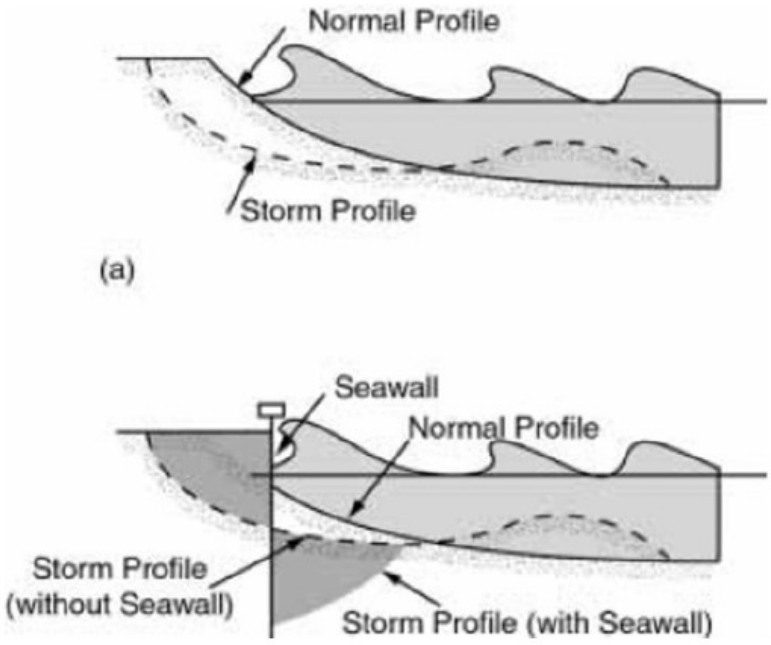

Figure 7.16 Dean (1986) approximate principle of locked up sand

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Sand trapped by wall through recession

This yields the quantities shown below for the case where the beach remains eroded:

- Sand locked up by recession acting on Café geobags: 208 m^3/year
- Sand locked up by recession acting on Reflections geobags 368 m^3/year
- Sand locked up by recession Reflections + Café geobags: 576 m^3/year

The proposed beach nourishment with imported sand associated with the works can offset this locked up sand.

The BMT WBM (2013) hazard study estimated an uncertainty of ±20% on the recession components.

This quantum is a suitable initial allowance for uncertainty.

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Monitoring

ource: Chloe Dowsett

Figure 8.2 View from proposed CoastSnap station

Source: Chloe Dowsett
Note: Image was taken prior to construction of Café geobags. Reflections geobags are visible. Due to distance, geobags are not highly visible, but exposure can be observed, and can be detected by automated routines

Figure 8.3 Zoomed image from proposed CoastSnap station

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Management of the works

Until such time that the interim works can be removed:

- Management of public safety risk through regular inspection of the beach and dune, removal of vegetation at risk of imminent collapse, grading of the erosion scarp to a maximum gradient of 1V:1.5H (34°)
- Establishment of a rolling easement of vegetation, through additional revegetation to replace that lost due to erosion/recession within the end effect area
- Restoration or consolidation of neighbouring beach accesses in consultation with Byron Shire Council
- Sand management through importation of nourishment sand in conjunction with Byron Shire Council

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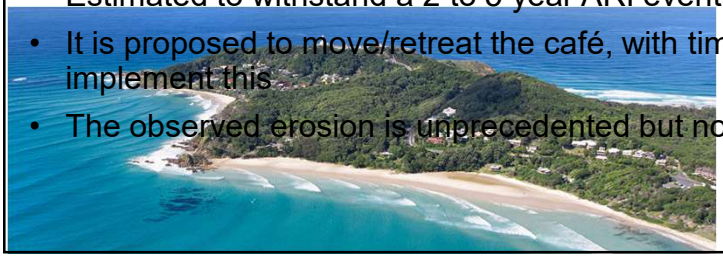
Summary

- We are now well beyond 2007 ”immediate” hazards (33% to 2050)
- Clarkes Beach is receding at approx 0.2 m/year
- Multiple complex processes are causing this
- Built assets in Reflections Holiday Park and Clarkes Beach Café were at imminent risk of collapse
- Interim geobag walls were constructed in 2019 and 2020 to stop this collapse
- Initial life 90 days, to be extended to 5 years
- Already subjected to a 1 to 2 year ARI event
- Estimated to withstand a 2 to 5 year ARI event
- It is proposed to move/retreat the café, with time required to plan, negotiate and implement this
- The observed erosion is unprecedented but not unexpected



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