Modification of Byron shire coastal hazard lines

Author:
Carley, J.T.; Rayner, D.S.

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THE UNIVERSITY OF NEW SOUTH WALES
water
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laboratory
Manly Vale N.S.W. Australia

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Water Research Laboratory
School of Civil and Environmental Engineering
University of New South Wales ABN 57 195 873 179
King Street
Manly Vale NSW 2093 Australia

Telephone: +61 (2) 9949 4488
Facsimile: +61 (2) 9949 4188

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Title	Modification of Byron Shire Coastal Hazard Lines
Author(s)	James Carley and Duncan Rayner

Client Name	Byron Shire Council
Client Address	Coastal and Estuary Officer Byron Shire Council PO Box 219 MULLUMBIMBY NSW 2482
Client Contact	Mr Ben Fitzgibbon ben.fitzgibbon@byron.nsw.gov.au
Client Reference	

The work reported herein was carried out at the Water Research Laboratory, School of Civil and Environmental Engineering, University of New South Wales, acting on behalf of the client.

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1. INTRODUCTION

1.1 Overview

The NSW Government (1990) "Coastline Management Manual" identifies seven separate coastal hazards, namely:

- Beach erosion
- Shoreline recession
- Coastal entrance behaviour
- Sand drift
- Coastal inundation
- Slope and cliff instability
- Stormwater erosion.

The hazards of beach erosion and shoreline recession (due to ongoing underlying processes and future sea level rise) are generally combined into a "coastal hazard line" for various planning periods.

1.2 Hazard Lines for Byron Shire

Within the Byron Shire Council (BSC) area, the original coastal hazard lines are known as the "Part J lines" (BSC, 2002). The Part J lines originated in 1988 and were derived from work undertaken in Gordon *et al.* (1978). Three erosion precincts (Part J lines) were supplied by BSC and identified as present day (Precinct 1), 2050 erosion line (Precinct 2) and the 2100 erosion line (Precinct 3).

Additional coastal hazard lines were developed by WBM (2000, 2002). These hazard lines used contemporary coastal engineering techniques. Reduced ongoing underlying recession was found by WBM compared with Gordon *et al.* (1978) which was attributed to a period of reduced storminess. The WBM work used sea level rise projections (relative to 1990) of 0.2 m for 2050 and 0.5 m for 2100.

The latest NSW Government NSW Sea Level Rise Policy Statement (2009) states a projected sea level rise of up to 0.4 m for 2050 and 0.9 m for 2100. This recent policy

necessitated a revision of the WBM hazard lines, which was undertaken by WRL at the request of BSC.

At the request of BSC, figures are not provided in this report, but rather GIS shape files of the modified coastal hazard lines have been provided electronically to BSC.

With the exception of the revised sea level rise values, all other assumptions used previously by WBM were also adopted by WRL. The analysis was undertaken on the scale of typical values for embayments or sections of coast, and was not undertaken down to the level of individual properties. Therefore, a detailed analysis for a single property may produce a slightly different hazard line location due to site specific factors such as dune volume and height. The presence of underlying rock may also alter the hazard line location. Similarly, protection works (except the Jonson Street protection works) were not considered in the modified hazard lines. Ad hoc and temporary protection works may offer some resistance to erosion, but they are generally not engineered to current standards and could not be guaranteed to withstand a design event.

The Jonson Street protection works for the Memorial Pool are not considered to meet current coastal engineering standards. They will require upgrading or rebuilding to meet their required function. The hazard lines developed in this report assume that the Jonson Street protection works for the Memorial Pool do not fail, however, intervention is required for this assumption to be met.

The purpose of this exercise was to show whether the Part J planning lines used by BSC remain landward of hazard lines calculated using revised sea level projections from the NSW Government (2009). This report is limited to the hazards of beach erosion and shoreline recession.

2. PREVIOUS HAZARD LINES (WBM)

2.1 Setback Components

2.1.1 List of Setback Components

There are five key components of coastal setback defined by WRL, namely:

S1: Allowance for short term storm erosion;
S2: Allowance for ongoing underlying recession;
S3: Allowance for recession due to future sea level rise;
S4: Allowance for dune stability (Zone of reduced foundation capacity);
S5: Allowance for beach rotation.

For the purposes of this study only components S1 to S4 were considered, with S5 not considered as beach rotation is not quantifiable with the data presently available.

2.1.2 Brief Description of Setback Components

S1: ***Allowance for short term storm erosion***, is for erosion due to an oceanic storm or series of storms. In NSW it is generally calculated using the work of Gordon (1987) as a basis, together with photogrammetric survey data and/or ground surveys for the subject beach, and an adjustment for wave exposure and erosion potential. It is generally expressed in m^3/m above Australian Height Datum (AHD). The maximum value measured in NSW is 320 m^3/m (NSW Government, 1990).

S2: ***Allowance for ongoing underlying recession***, is a long term trend in the beach planform, which may be receding or accreting. It is generally estimated from photogrammetric survey data extending over approximately 50 years. It is generally expressed in terms of m/year. On the northern NSW coast, recession rates are generally higher near the southern hooks of bays.

S3: ***Allowance for recession due to future sea level rise***, is a projection of future shoreline recession due to a rise in mean sea level. It is usually calculated with the Bruun Rule. A rule of thumb is that on open coasts, the Bruun Factor is typically in the range 50 to 100. That is, coastal recession will be 50 to 100 times the sea level rise. Specific calculations taking account of the measured profile, wave climate and sand characteristics are preferred. There is considerable controversy regarding the Bruun Rule, however, there are few

alternatives which can provide an immediate answer. Obviously, long term monitoring is preferable, but is not feasible if an answer is required now.

S4: ***Allowance for dune stability***, encompasses an additional setback component relating to the geotechnical stability of dunes as described in: Nielsen, A F, Lord, D B and Poulos, H G (1992), "Dune Stability Considerations for Building Foundations", *Engineers Australia, Vol CE34 No 2, June.* This method delineates a *stable foundation zone* and a *zone of reduced foundation capacity.* In this method, buildings constructed seaward of the *stable foundation zone* (SFZ) need to be constructed on piles due to the reduced bearing capacity in the *zone of reduced foundation capacity* (ZRFC).

S5: ***Allowance for beach rotation***, involves either a cyclic or one way change in the alignment of a beach's planform due to changes in the wave direction over medium (weeks to months) to long (decades) term time scales. It is a well known seasonal phenomenon in Perth WA, where the beach planform alignment is influenced by north-west storms in winter and south-west seabreezes in summer. The work on beach rotation presented by Short *et al.* (2000) involved more than 20 years of ongoing monthly surveys at Narrabeen NSW, which is approximately 3.6 km long. Short *et al.* found that beach rotation accounted for about 30% of beach width variation (along the 3.6 km long Narrabeen Beach). Regular long term monitoring is the only method available to properly track beach changes, so that extremes, averages, cycles and rotation can be properly identified. It was not considered by WBM (2000) or this report.

2.2 WBM Allowances

The *allowance for short term storm erosion* (S1) was obtained directly from WBM (2000) and is shown in Table 2.1.

The *allowance for ongoing underlying recession* (S2) was obtained directly from WBM (2000) and is shown in Table 2.2. Table 2.2 presents the minimum, maximum and best estimate recession rates determined by WBM. It should be noted that for the purposes of this study, the maximum estimated recession rate from WBM was used at the request of BSC to produce a conservative hazard line locations.

The *allowance for recession due to sea level rise* (S3) was determined by use of the Bruun Rule. The Bruun Factor (BF) used to determine the setback allowance for Sea Level Rise (SLR) was determined from WBM (2000) (Table 2.3). The *allowance for recession due to sea level rise* is defined by S3=BF x SLR.

The allowance for dune stability (S4) was obtained directly from WBM (2000) and reproduced in Table 2.4 of this report, but this setback component was not incorporated into the hazard line locations at the request of BSC. A similar approach was used by WBM.

Table 2.1
Allowance for Short Term Storm Erosion (S1) (WBM, 2000)

Precinct	S1: WBM allowance for short term storm erosion*			
	Volume (m^3/m) relative to 1999 erosion scarp	Typical dune height (m)	Volume (m^3/m) relative to 1994 erosion scarp	Equivalent horizontal allowance relative to 1999 erosion scarp (m) (by WRL)
Belongil Creek to Crabbes Creek (incl. Brunswick Region)	170	5	220	34
Memorial Pool to Belongil Creek	200	5 (5 to 7.5)	250	40
Pass to Memorial Pool	100	5	150	20
Cape to the Pass	50	5	100	10
Tallow Beach	150	7	200	21

* See WBM (2000) Section 11.2 (p 120)

Note: Referenced from a regionally smoothed alignment of the 1999 erosion scarp with an allowance made for the loss between 1994 and 1999 which was assessed as 50 m^3/m.

Table 2.2
Allowance for Ongoing Underlying Recession (S2) (WBM, 2000)

Precinct	S2: WBM allowance for ongoing underlying recession		
	Low (m/yr)	Mid (m/yr)	High (m/yr)
South Golden Beach*	0.05	0.10	0.20
New Brighton (north)*	0.05	0.10	0.20
Brunswick (Sheltering Palms to New Brighton south i.e. 2 km north of walls)	0.15	0.30	0.60
Brunswick heads	0.05	0.10	0.20
North of Belongil Creek	0.15	0.30	0.60
Border St to Belongil Creek	0.60	0.80	1.00
Memorial Pool to Border St	0.90	1.20	1.50
Pass to Memorial Pool	0.05	0.10	0.20
Tallow Beach	0.05	0.10	0.20
Tallow Beach (up to 2 km north of Broken Head)	0.15	0.30	0.60

* Implied in WBM (2000) Figure 5.27 (p93)

Indurated sand (coffee rock) and rock and geocontainer protection works are not considered (except Memorial Pool works)

Note: Recession rate is variable in southern hooks WBM (2000, Figure 5.27)

Table 2.3
Bruun Factor Used to Determine Allowance for Recession Due to SLR (S3) (WBM, 2000)

Precinct	S3: WBM allowance for recession due to sea level rise (Bruun Factor)
New Brighton	55
Belongil Spit	70
Tallow Beach	50

Note: These values fit within the "rule of thumb" range of 50 to 100.

Table 2.4
Allowance for Dune Stability (S4) (WBM, 2000)

Precinct	S4: WBM allowance for dune stability (width of zone of reduced foundation capacity)	
	Assumed Average Dune Height (m AHD) (1)	Indicative width of zone of reduced foundation capacity (m) (2)
Beaches south of Cape Byron	7	13.6
Cape Byron to The Pass	5	10.7
The Pass to Memorial Pool	5	10.7
Memorial Pool to Border St (Epicentre)	8	15.0
Beach Resort	6.5	12.9
Border St to Belongil Creek	5	10.7
Belongil Creek to Crabbes Creek	5	10.7

1. The surface of the dunal system was assumed to be approximately level
2. Distance measured landward from the top of the erosion escarpment following slope readjustment

3. MODIFIED HAZARD LINES (WRL)

Hazard lines (excluding the *Zone of Reduced Foundation Capacity*, S4) represent the idealised upper edge of a dune erosion scarp at the end of the planning period and following a major storm erosion event. The values for the components derived by WBM (2000) represent contemporary coastal engineering practice and were extensively peer reviewed.

The values for S1 to S3 (Tables 2.1 to 2.4) obtained from WBM (2000), and modified with the latest NSW Government Sea Level Rise Policy Statement (2009) values of 0.4 m (2050) and 0.9 m (2100). The values used to determine the revised hazard lines are shown in Table 3.1.

A range of recession rates were outlined by WBM (2002), with a low, mid and high rate for each site (Table 2.2). As previously stated, at the direction of BSC, the high values were incorporated into the 2050 and 2100 hazard lines.

The allowance for Dune Stability (width of zone of reduced foundation capacity), in component S4, was not included in the final hazard lines at the direction of the BSC. This component is often considered on a case by case basis, depending on the site specific conditions. WBM (2002) outlined general values for Byron Shire based on dune height (Table 3.6).

As with WBM (2000) hazard lines, WRL setback calculations don't consider coastal protection works except for the Jonson Street protection works and natural headlands. Likewise, except for emergent natural headlands, underlying rock or indurated sand is also not considered. The present day, 2050 and 2100 hazard line calculations are shown in Tables 3.2, 3.3 and 3.4, and summarised in Table 3.5.

Table 3.1
WRL Allowance Factors for Determining Hazard Lines

Precinct	S1: WRL allowance for short term storm erosion (m)	S2: WRL allowance for ongoing underlying recession (m/yr) (1)	S3: WRL allowance for recession due to sea level rise (Bruun Factor)	S4: WRL typical allowance for dune stability (zone of reduced foundation capacity) (m) (2)
South Golden Beach	34	0.2	55	11
New Brighton (north)	34	0.2	55	11
Brunswick (Sheltering Palms to New Brighton south i.e. 2 km north of walls)	34	0.6	55	11
Brunswick Heads	34	0.2	55	11
North of Belongil Creek	34	0.6	70	11
Border St to Belongil Creek	40	1.0	70	11
Memorial Pool to Border St	20	1.5	70	11
Pass to Memorial Pool	20	0.2	70	11
Cape Byron to the Pass	10	0.0	n/a (3)	11
Tallow Beach	21	0.2	50	11
Tallow Beach (up to 2 km north of Broken Head)	21	0.6	50	11

1. Highest recession rate adopted – WBM (2000) presented low, high and best estimate.
2. A shire wide typical dune height of 5 m AHD was adopted
3. No Bruun Rule recession due to dominance of longshore processes

Table 3.2
Present Day Horizontal Setback Distances (from 1999 Scarp)

Precinct	S1: WRL allowance for short term storm erosion (m)	S4: typical WRL allowance for dune stability (zone of reduced foundation capacity) (m)	WRL total horizontal setback distance (m) S1 (excludes S4)
South Golden Beach	34	11	34
New Brighton (north)	34	11	34
Brunswick (Sheltering Palms to New Brighton south i.e. 2 km north of walls)	34	11	34
Brunswick Heads	34	11	34
North of Belongil Creek	34	11	34
Border St to Belongil Ck	40	11	40
Memorial Pool to Border St	20	11	20
Pass to Memorial Pool	20	11	20
Cape Byron to the Pass	10	11	10
Tallow Beach	21	11	21
Tallow Beach (up to 2 km north of Broken Head)	21	11	21

Table 3.3
2050 SLR (0.4 m) Horizontal Setback Distances (from 1999 Scarp)

Precinct	S1: WRL allowance for short term storm erosion (m)	S2: WRL allowance for ongoing underlying recession (m) (1)	S3: WRL allowance for recession due to sea level rise (Bruun Factor)	S4: typical WRL allowance for dune stability (zone of reduced foundation capacity) (m) (3)	WRL total horizontal setback distance (max) (m) S1+S2+S3 (excludes S4)
South Golden Beach	34	10	22	11	68
New Brighton (north)	34	10	22	11	68
Brunswick (Sheltering Palms to New Brighton south i.e. 2 km north of walls)	34	30	22	11	86
Brunswick	34	10	22	11	68
North of Belongil Creek	34	30	28	11	92
Border St to Belongil Creek	40	50	28	11	118
Memorial Pool to Border St	20	75	28	11	123
Pass to Memorial Pool	20	10	28	11	58
Cape Byron to the Pass	10	0	n/a (2)	11	10
Tallow Beach	21	10	20	11	52
Tallow Beach (up to 2 km north of Broken Head)	21	30	20	11	72

1. Highest recession rate adopted.

2. No Bruun Rule recession due to dominance of longshore processes

3. Adopting a shire wide typical dune height of 5 m AHD. Not included in final WRL lines by direction of BSC.

Table 3.4
2100 SLR (0.9 m) Horizontal Setback Distances (from 1999 Scarp)

Precinct	S1: WRL allowance for short term storm erosion (m)	S2: WRL allowance for ongoing underlying recession (m) (1)	S3: WRL allowance for recession due to sea level rise (Bruun Factor)	S4: typical WRL allowance for dune stability (zone of reduced foundation capacity) (m) (3)	WRL total horizontal setback distance (max) (m) S1+S2+S3 (excludes S4)
South Golden Beach	34	20	50	11	104
New Brighton (north)	34	20	50	11	104
Brunswick (Sheltering Palms to New Brighton south i.e. 2 km north of walls)	34	60	50	11	144
Brunswick	34	20	50	11	104
North of Belongil Creek	34	60	63	11	157
Border St to Belongil Creek	40	100	63	11	203
Memorial Pool to Border St	20	150	63	11	233
Pass to Memorial Pool	20	20	63	11	103
Cape Byron to the Pass	10	0	n/a[#]	11	10
Tallow Beach	21	20	45	11	87
Tallow Beach (up to 2km north of Broken Head)	21	60	45	11	127

1. Highest recession rate adopted.

2. No Bruun Rule recession due to dominance of longshore processes

3. Adopting a shire wide typical dune height of 5 m AHD. Not included in final WRL lines by direction of BSC.

Table 3.5
Summary of Setback Distances from 1999 Erosion Scarp

Precinct	Present Day (m) S1 (Excludes S4)	2050 (m) S1+S2+S3 (Excludes S4)	2100 (m) S1+S2+S3 (Excludes S4)
South Golden Beach	34	68	104
New Brighton (north)	34	68	104
Brunswick (Sheltering Palms to New Brighton south i.e. 2 km north of walls)	34	86	144
Brunswick	34	68	104
North of Belongil Creek	34	92	157
Border St to Belongil Creek	40	118	203
Memorial Pool to Border St	20	123	233
Pass to Memorial Pool	20	58	103
Cape Byron to the Pass	10	10	10
Tallow Beach	21	52	87
Tallow Beach (up to 2 km north of Broken Head)	21	72	127

S4 component not included in final WRL lines by direction of BSC.

Table 3.6
WBM (2002) Width of Zone of Reduced Foundation Capacity

Crest elevation of dune (m AHD)	S4: Indicative Width of Zone of Reduced Foundation Capacity (m)
4	9.3
5	10.7
6	12.2
7	13.6
8	15.0
9	16.4
10	17.9

4. DISCUSSION

Three erosion precincts ("Part J lines") are currently used for BSC planning, namely: present day (Precinct 1), 2050 erosion line (Precinct 2) and the 2100 erosion line (Precinct 3).

More recent hazard lines were calculated by WBM (2000, 2002). WRL's present day erosion line is unchanged from WBM (2000, 2002), and remains seaward of the immediate Part J line (Precinct 1).

WRL's 2050 and 2100 hazard lines incorporating revised sea level rise values and high ongoing recession rates also remain seaward of the 2050 Part J (where present) and 2100 Part J erosion lines (BSC, 2002). WRL's 2050 and 2100 hazard lines are located landward of the hazard lines from WBM (2000, 2002) due to the use of higher sea level rise values. This is due to a new policy (NSW Government, 2009) rather than any deficiency in the work of WBM, which reflected common practice at the time.

The Part J planning lines have been demonstrated to remain landward of the hazard lines calculated incorporating contemporary coastal engineering techniques and the latest revised sea level rise projections.

5. REFERENCES AND BIBLOGRAPHY

Byron Shire Council (2002), "Development Control Plan 2002 - Part J - Coastal Erosion Lands".

Gordon, A D, Lord, D B and Nolan, M W (1978), *Byron Bay - Hastings Point Erosion Study* Report # PWD 78026, Department of Public Works, NSW Government.

Gordon, A D (1987), *Beach Fluctuations and Shoreline Change – NSW,* Proceedings of 8th Australasian Conference on Coastal Engineering, Launceston, The Institution of Engineers Australia, 103-107.

Nielsen, A F, Lord, D B and Poulos, H G (1992), "Dune Stability Considerations for Building Foundations", *Engineers Australia, Vol CE34 No 2, June.*

NSW Government (1990), *NSW Coastline Management Manual.*

NSW Government (2009b), *NSW Sea Level Rise Policy Statement,* Department of Environment and Climate Change NSW, ISBN 978-1-74232-464-7 DECCW 2009/708, October 2009.

Short, A D, Trembanis, A C and Turner, I L (2000), *Beach Oscillation, Rotation and the Southern Oscillation, Narrabeen Beach, Australia*, Proceedings Coastal Engineering 2000, ASCE, 2439-2452.

WBM (2000), "Byron Shire Coastline Hazard Definition Study" – Final Report, Brisbane.

WBM (2002), "Byron Shire Coastline Hazard Definition Study (Addendum prepared for BECTON)" – Final Report, Brisbane.