

DEFEND OR RETREAT?: COASTAL DEVELOPMENT IN QUEENSLAND WITH INCREASING SEA LEVELS

A. Introduction

The recent floods throughout Queensland, which resulted in significant damage to homes, businesses and infrastructure estimated at \$5 billion,^{1,2} together with Cyclone Yasi with the cost of reconstruction estimated at \$800 million³ resulted in the creation of the Queensland Reconstruction Authority ("QRA") to quickly rebuild a more resilient Queensland.⁴ However, the QRA is not expressly required to take into account sea level rise ("SLR") and climate change. In addition, the Government appointed a Commission of Inquiry (the "COI") to investigate the events leading to the flooding, all aspects of the response and its aftermath⁵ but its terms of reference did not specify the need to consider climate change and SLR.

It has not been established that these events were caused by climate change, as they may have been caused by natural climate variability as a result of the El Niño/La Niña-Southern Oscillation ("ENSO") phenomenon.⁶ However, these events, together with the urgent rebuilding that is taking place, provide a catalyst for the community to decide how best to maintain and manage development in future consistent with environmental management principles⁷ whilst taking into account how to adapt to SLR.

SLR will occur even with increased emissions reduction,⁸ requiring adaption. Queenslanders in adapting should ask: what should we build, or rebuild; and where? Should existing and future infrastructure be protected by artificial structures ("defend strategy"), or should it be positioned, or repositioned, above the SLR levels ("retreat strategy")?

This paper researches whether Queensland's laws consider SLR and whether they facilitate communication for effective decision making to adapt to SLR, and particularly in response to the recent events. It discusses SLR resulting from climate change and researches adaption defend and retreat strategies. The Byron Shire and Gold Coast plans and the Queensland coastal plan are reviewed to suggest the appropriate strategy for the Gold Coast. Recommendations were also made to resolve anomalies that emerged from the research.

¹ Rosanne Barrett, 'Supply 'at risk' if Wivenhoe levels cut ', *The Australian* April 18 2011
<<http://www.theaustralian.com.au/news/nation/supply-at-risk-if-wivenhoe-levels-cut/story-e6frg6nf-1226040603141>>

² Queensland Government, *Section one: Facing the Challenge* (2011)
<<http://www.qldreconstruction.org.au/u/lib/Section1-State-Plan-QRA.pdf>>

³ Queensland Government, *Queensland Reconstruction Authority* (2011)
<<http://www.qldreconstruction.org.au/>>

⁴ Ibid

⁵ Queensland Government, *Queensland Floods Commission of Inquiry* (2011)
<<http://www.floodcommission.qld.gov.au/>>

⁶ NCCOE, 'Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering' (Engineers Australia, 2004)
<www.engineersaustralia.org.au/shadomx/apps/.../fmsdownload.cfm?...>

⁷ Sean Hoobin, 'Queensland Floods Commission of Inquiry: WWF submission for the interim report' (World Wildlife Fund, 2011)
<http://www.floodcommission.qld.gov.au/_data/assets/file/0014/2552/WWF_Hoobin_Sean.pdf>

⁸ CSIRO, *Climate change in Australia: technical report 2007* (2007)
<http://www.climatechangeinaustralia.gov.au/technical_report.php>

B. Literature review

1. Recent events in Queensland

The 2010/2011 natural disasters in Queensland were predicted at least 10 years ago by the TAR.⁹ A reminder of these predictions for Australia are found in AR4 Chapter 11's referral to TAR in paragraph 11.1.1 which had predicted *three key phenomenon*:¹⁰

- *'Increasing coastal vulnerability to tropical cyclones, storm surges and sea-level rise;*
- *Increased frequency of high-intensity rainfall, which is likely to increase flood damage; and that*
- *Australia has significant vulnerability to climate change expected over the next 100 years'.*

However, it appears as if the Queensland community has not yet recognised the need to adapt to climate change. Cyclone Yasi in North Queensland, which was the worst cyclone in living memory,¹¹ and the 2010/2011 flooding throughout Queensland resulting in three quarters of the state of being declared a disaster zone¹² should have come as no surprise. And yet the COI's¹³ terms of reference include considering land use through local and regional planning systems to minimise infrastructure and property impacts from floods without reference to SLR.

If, despite all the environmental and planning laws that were already in place, the Queensland community was not properly prepared for these recent events; is Queensland ready for the predicted SLR this century, given that Australia is significantly vulnerable to climate change¹⁴ and is an adaption strategy identified?

2. Queensland legislation

A review of the *Queensland Reconstruction Authority Act 2011* (the "QRA Act")¹⁵, the *Sustainable Planning Act 2009* ("SPA")¹⁶, the *Coastal Development and Management Act 2005*¹⁷ (the "Coastal Act"), the *Environmental Protection Act 1994*¹⁸ and the *State Development and Public Works Organisation Act 1971*,¹⁹ (the "5 key Acts") confirms no reference to SLR in any of them.

Only the SPA, sections 5 and 11, make reference to climate change, but considers the effect of development on *climate change*, rather than *the effect of climate change on development*, which it is suggested must be considered because SLR is occurring pervasively whether or not Queensland's activities have an effect on the environment. Queensland must respond

⁹ R Basher et al, *UN IPCC Third Assessment Report - Climate Change 2001: Working Group II: Impacts, Adaptation and Vulnerability: Chapter 12* (2001)

<http://www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/>; ibid

¹⁰ Kevin Hennessy et al, 'Australia and New Zealand. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Chapter 11' (2007) <<http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter11.pdf>>

¹¹ Paul Colgan, Owen Vaughan and Helen Davidson, *Courier Mail* 4 February 2011 <<http://www.couriermail.com.au/news/north-queensland-braces-for-cyclone-anthony-as-cyclone-yasi-breeds-behind-it/story-e6freon6-1225998711771>>

¹² Queensland Government, *Queensland floods* (2011) <<http://www.qld.gov.au/floods/>>

¹³ Queensland Government, *Introduction Queensland Floods Commission of Inquiry*

¹⁴ Hennessy et al, *Recent events in Queensland*

¹⁵ Queensland Reconstruction Authority Act 2011

¹⁶ Sustainable Planning Act 2009

¹⁷ Coastal Protection and Management Act 1995

¹⁸ Environmental Protection Act 1994

¹⁹ State Development and Public Works Organisation Act 1971

appropriately to reduce vulnerability as suggested by TAR,²⁰ and the absence of SLR in the 5 key Acts is quite extraordinary when SLR is likely to have a significant impact on the coastline.

3. Climate change resulting in sea level rise

'Throughout the 21st century and beyond, sea levels across the world's oceans are expected to continue rising due to thermal expansion of sea water, melting of land-based glaciers and ice caps and contributions from the icesheets of Antarctica and Greenland'.²¹ On 5 May 2011 the Courier Mail reported that, "The ice of Greenland and the rest of the Arctic is melting faster than expected and could help raise global sea levels by as much as 1.5m this century, researchers say".²²

On 7 April 2011, the Queensland Environment Minister, launched the Queensland Coastal Plan (the "*coastal plan*").²³ She reported that 'almost 94,000 homes and businesses between Coolangatta and Ingham were expected to be at least partially inundated by sea level rises by 2100, and that a further 65,000 properties would be hit by storm tide inundation.' These figures were based on an 0.8m sea level rise, with a replacement value of at-risk buildings thought to be about \$10 billion.²⁴

It appears that the Queensland Government now recognises the dangers of SLR, 10 years after the TAR had identified the *three key phenomenon* (including SLR) resulting from, 'the bias toward population and economic growth in coastal areas,' and that Australia must 'reduce vulnerability by conscious planning including changes in zoning and engineering design criteria'.²⁵

Perhaps the indicea of the *three key phenomenon* assisted urgent Queensland Government action, because the latest *coastal plan*,²⁶ required by s30 of the Coastal Act, now refers to SLR. Whilst the 5 key Acts ignore SLR, even the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* ("EPBC Act"), which may apply to Queensland's coastline in circumstances of national environmental significance,²⁷ also ignores SLR. This is surprising given that the Commonwealth recognises the dangers of SLR; however, it may be that, as mentioned above, laws focus on the development impact upon the environment, rather than climate change SLR impact upon development.

4. Response strategy to sea level rise ("SLR")

Australia has been described as 'One of the most vulnerable developed nations with respect to climate change'.²⁸ This report states, "Whereas considerable effort has been directed toward climate change mitigation during the past two decades, comparatively little research effort has gone into climate change adaptation, and as such, implementations of adaptation

²⁰ Basher et al, Recent events in Queensland above Paragraph 12.9.6

²¹ CSIRO, Introduction above Chapter 5 paragraph 5.7.2

²² Associated Press, 'Sea level risk worsens: Need for greater urgency as Arctic ice melting faster', *Courier Mail* (Brisbane), 5 May 2011, 24

²³ Brian Williams, 'Plan to tackle rising sea fear', *Courier Mail* (Brisbane), 8 April 2011, 21

²⁴ Ibid

²⁵ Basher et al, Recent events in Queensland above, paragraph 12.9.6

²⁶ Queensland Coastal Plan 2011

²⁷ Environment Protection and Biodiversity Conservation Act 1999

²⁸ M.D. Short et al, 'Assessment of the Challenges in Adapting Water Resources and Infrastructure to Climate Change—Literature Review' (2010) *Water @ UNSW* citing Garnaut, R. (2008b). Introduction. In: *The Garnaut Climate Change Review*, Cambridge University Press, Port Melbourne, Victoria, ISBN 9780521744447: xvii-xlv. Garnaut (2008)

measures are currently very limited."²⁹ This concern was echoed by Engineers Australia (EA) in 2008 when it expressed 'concern about the slow progress of adaptation and that action could take place in parallel with research'.³⁰

Garnaut³¹ suggested that the Commonwealth establish an Australian climate change policy institute, and within 2 years a paper, *Adapting to Climate Change in Australia*, reported that a SLR 'of up to one metre or more by 2100 cannot be ruled out which would have more serious implications for coastal settlements and infrastructure'.³² It added that 'coastal management should be given National priority status even though State and Local Government managed the coastal zone, because of the sheer investment and critical infrastructure in this area requiring increased maintenance for government, as well as residential and other private infrastructure with even modest SLR making many existing coastal assets vulnerable'.³³

Less than a year later, Queensland's coastal zone demonstrated its vulnerability, and urgent action has commenced to rebuild through QRA. s62 of the *QRA Act*³⁴ empowers the QRA to make a development scheme, and have regard to planning instruments, plans, policies or codes, but it is not bound by a requirement of any one of them [s63(4)]. This means that \$5 billion worth of reconstruction in Queensland, most of which is in vulnerable areas, can take place without being bound by considerations of SLR. Even if it is ultimately established that the flooding and cyclones was an ENSO phenomenon, the recent events are an ideal opportunity for a climate change response that *must start now*.³⁵

Garnaut suggested that adaptation should be a local initiative, and that the Government should create the conditions for effective decision making by 'communities, households and businesses as they begin (and continue) to adapt to climate change'.³⁶ The principle of *localism* was echoed by Minister Simon Crean in March 2011 at a sea change conference talking about 'Regional Development in Coastal Australia', saying "And whilst it is true the partnership of collaboration between all levels of government and the private sector is vital to come into answers about this. It will be through the lens of localism that will best drive that partnership."³⁷ At the same conference, CSIRO's Anne Leitch spoke about 'Improving communication about sea level rise to residents' because she said, "Facts are uncertain, values in dispute, stakes high and decisions urgent."³⁸ One needs to ask whether Queensland's laws, including the *coastal plan*, provide sufficient communication and guidance to enable the community to decide how to effectively and practically adapt to SLR.

Only the *coastal plan* expressly considers SLR.³⁹ The legislative framework involving coastal land is complex and fragmented with the 5 key Acts being relevant. In addition, the *coastal plan* refers to 'decision-makers decisions regarding coastal land and infrastructure having to

²⁹ Ibid, page 4 citing (Parry *et al.*, 2007).

³⁰ Engineers Australia, 'INQUIRY INTO CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS ON COASTAL COMMUNITIES' (30 May 2008 2008) <www.engineersaustralia.org.au/shadomx...>

³¹ Ross Garnaut, 'Chapter 15 Adaptation and mitigation measures for Australia' (2008) <http://www.garnautreview.org.au/pdf/Garnaut_Chapter15.pdf>, page 368

³² Commonwealth of Australia, 'Adapting to Climate Change in Australia. An Australian Government Position Paper' (Commonwealth of Australia, 2010), page 5

³³ Ibid, page 12

³⁴ Queensland Reconstruction Authority Act 2001

³⁵ Commonwealth of Australia, Response strategy to sea level rise ("SLR"), page 6

³⁶ Garnaut, Response strategy to sea level rise ("SLR"), page 364

³⁷ National Sea Change Task Force Inc, 'Preliminary report: 2011 Australian Coastal Councils Conference' (11 April 2011) page 11

³⁸ National Sea Change Task Force, (Paper presented at the 2011 Australian Coastal Councils Conference, Torquay, Victoria, 28-30 March 2011)

<<http://www.seachangetaskforce.org.au/Conference.html>>

³⁹ Queensland Coastal Plan 2011, page 3

consider decision-making processes contained within examples of 11 Acts.⁴⁰ These 11 Acts include two of the 5 key Acts, which means that at least a total of 14 Acts may have application to coastal development.

Whilst the QRA consults and communicates with the community⁴¹, it has no express responsibility to consider SLR. Accordingly, the complexity of Queensland's laws are unlikely to provide the communication tools that Garnaut suggests for adaptation, which supports Morrison's research that the law does not yet enable communication in the climate change environment.⁴²

Furthermore, the *coastal plan* also provides that, 'Owners and occupiers of private land may undertake activities on their land provided they do so in accordance with relevant laws and policies'⁴³. When there are at least 14 Acts that may impact upon coastal development activities, these owners may have some difficulty ensuring they comply, which cannot facilitate effective decision-making.

The responses to climate change include mitigation and adaptation. "*Mitigation* involves actions that are intended to reduce the magnitude of our contribution to climate change. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks. *Adaptation* consists of actions undertaken to reduce the adverse consequences of climate change, as well as to harness any beneficial opportunities. Adaptation actions aim to reduce the impacts of climate stresses on human and natural systems."⁴⁴

Academic research has confirmed that 'mitigation would slow but not stop the expected rise in sea level in the next few decades and that the benefits of mitigation policies lie well into the future beyond 2050, such that adaptation to global sea level rise was essential'⁴⁵. Garnaut echoed this in 2008 saying, 'Mitigation will come too late to avoid substantial damage from climate change.'⁴⁶

Accordingly, this paper focuses on **adaptation**.

a. **Adaptation**

Engineers Australia referred to the three adaptation strategies⁴⁷ defined by the IPCC in 1996⁴⁸ of retreat, accommodate (which is not considered in this paper), or protect (defend). EA lamented the lack of funding for research, the lack of engineering expertise in Government and identified a nationwide inconsistency in implementation of measures.⁴⁹

⁴⁰ Ibid, page 4

⁴¹ Queensland Government, Introduction *Queensland Reconstruction Authority* Message to Queensland

⁴² C Morisson and Walmsley R, 'Is the law a useful communication tool in a changing climate?' (Paper presented at the 19th NSW Coastal Conference, Bateman's Bay, 2010) <<http://www.coastalconference.com/2010/papers2010/Craig%20Morrison%20full%20paper.pdf>>

⁴³ Queensland Coastal Plan 2011, page 4

⁴⁴ NCCARF, *National Climate Change Adaptation Research Facility* (2007)

<<http://www.nccarf.edu.au/climate-change-adaptation>>

⁴⁵ Robert J Nicholls, Frank MJ Hoozemans and Marcel Marchand, 'Increasing flood risk and wetland losses due to global sea level rise: regional and global analyses' (1999) 9(1999) *Global environmental change* S 69

Garnaut, Response strategy to sea level rise ("SLR"), page 363

⁴⁷ NCCOE, Introduction page 37

⁴⁸ IPCC, 'Climate change 1995 - economic and social dimensions of climate change. Contribution of Working Group III to the Second Assessment Report of the Intergovernment Panel on Climate Change' (1996); *ibid*

⁴⁹ NCCOE, Introduction page 37

The Federal government, may have to take primary responsibility for sea level rise because it is a matter of national significance.⁵⁰ The Economist reported that, "Beyond encouraging climate-friendly development, governments need to take some focused measures in three areas: infrastructure, migration and food. The Dutch, who have centuries of experience of protecting themselves against high water, are already working out how to adapt and build infrastructure to minimise the risks of flooding as sea levels rise and the rain-fed Rhine grows friskier."⁵¹

Even Garnaut recognised that government must intervene for 'building capacity for dealing with events that can overwhelm individual communities or the natural environment.'⁵² QRA reports that urgent rebuilding under *Operation Queenslander* is funded 75% by the Commonwealth and 25% by Queensland,⁵³ demonstrating the need for intervention, and it is curious that the Federal Government as recognising the need to adapt,⁵⁴ is not insisting that *Operation Queenslander* adapts to SLR.

One of the difficulties that emerged from the research is the need for communication to and within the community about the appropriate adaptation strategy, and Associate Professor Geoff Wescott on 28 March 2011 said that 'even where the community recognises the problem and that there are defend and retreat strategies available, the decision about the appropriate strategy and who is responsible to pay for it becomes confused and angry'.⁵⁵

A Federal Parliamentary enquiry heard that more than 700,000 Australian homes were vulnerable to rising sea levels, with up to \$150 billion worth of homes, property and infrastructure at risk of seawater inundation⁵⁶. 2 years later, the Federal government referred to the vulnerability of coastal assets and the magnitude of investment in infrastructure as a matter of national significance⁵⁷ and yet there is no coherent national adaption strategy or methodology identified. NCCARF was created by the Federal government to carry out research⁵⁸ and one of its research networks (ACCARNSI)⁵⁹ has reported on adaption,⁶⁰ but after identifying the issues, stated that further research was required. The lack of direction from the Federal Government confirms EA's complaints about a nationwide inconsistency in implementation of measures and the lack of action on adaption.

Earlier in 2004, the NCCOE⁶¹ of Engineers Australia developed an engineering impact assessment methodology to respond to climate change impacts by considering the relative likely importance of changes to the key environmental variables that had been the subject of climate change scenario modelling, and then considering the possible secondary effects that

⁵⁰ Commonwealth of Australia, Response strategy to sea level rise ("SLR") page 5

⁵¹ The Economist, 'Climate change: How to live with climate change', *The Economist* Nov 25 2010 <http://www.economist.com/node/17575027?story_id=17575027>

⁵² Garnaut, Response strategy to sea level rise ("SLR") page 364

⁵³ Queensland Government, Introduction *Section 2 Queensland Reconstruction Authority*, page 10

⁵⁴ Commonwealth of Australia, Response strategy to sea level rise ("SLR")page 3

⁵⁵ National Sea Change Task Force, Response strategy to sea level rise ("SLR"), Associate Prof Geoff Wescott, Deakin University, Facilitating Community Discussion of Adapting to The Impacts Of Climate Change, Slide 16

⁵⁶ Ben Doherty, 'Rising sea could flood 700,000 homes', *The Age* (Melbourne), 2008 <<http://www.theage.com.au/environment/rising-sea-could-flood-700000-homes-20081016-52es.html>>

⁵⁷ Commonwealth of Australia, Response strategy to sea level rise ("SLR") page 12

⁵⁸ NCCARF, Response strategy to sea level rise ("SLR") About NCCARF

⁵⁹ The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI), *The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI)* (<<http://www.nccarf.edu.au/settlements-infrastructure/>> this

⁶⁰ Short et al, Climate change resulting in sea level rise page 1

⁶¹ National Committee on Coastal and Ocean Engineering

may flow from these primary changes. The key environmental variables (K1 to K6) included mean sea level and other climatic factors.

There were 13 secondary variables selected (S1 to S13) including local sea level, effects on structures, coastal flooding, beach response, foreshore stability etc. and tables were provided to give assistance.⁶²

A decision matrix was provided with the key environmental variables in columns and the secondary variables in rows (containing subsets of important issues relating to those secondary variables). The resulting design methodology⁶³ then required a combined risk and sensitivity analysis. The reason for the sensitivity analysis was that the natural environment was changing with time, when hitherto such change was not assumed in assessing risks.⁶⁴ This recognition that 'steady state assumptions' no longer applied with climate change was echoed by Carmichael et al six years later.⁶⁵

NCCOE's design methodology then provided a design philosophy including a recognition that 'a low consequence of failure with a high probability would have a *least regrets* design strategy which would consider cost to repair or replace and the environmental impacts, whereas a high consequence of failure with a low probability would attract a *robust* design philosophy to prevent failure, and perhaps adapt to climate change scenarios throughout its lifetime.' The appropriate 'design criteria were selected after statistical analysis, followed by a sensitivity analysis to assess and review the design assumptions, and adjust them if required.'⁶⁶ The outcome of the methodology was a design that may be one of defence or retreat.

More recently Carmichael et al considered three main choices for new infrastructure impacted by climate change by building:

1. To today's conditions and abandon in the future thereby restricting its longevity;
2. For today's conditions with a view to being able to modify or upgrade in the future such that it adapts to changing climate;
3. For future conditions, with it being overdesigned in the near future but adequate in the longer term.⁶⁷

EA (2008) suggested that new developments in areas subject to coastal hazards should be minimised, implying a retreat strategy. However, it recognised that it would be cost-effective to protect existing settlements against SLR and that the building codes, design parameters as well as physical works needed to be revised⁶⁸ which suggests a defend strategy.

b. **Defend**

Defence or protection of the shoreline 'involves the construction of seawalls or other defences to maintain coastal assets in their current location'⁶⁹. Arguably the first world

⁶² NCCOE, Introduction page 19

⁶³ Ibid, page 19

⁶⁴ Ibid, page 1

⁶⁵ DG Carmichael and MCA Balatbat, 'The incorporation of uncertainty associated with climate change into infrastructure investment appraisal' (2010) *Australian Climate Change Adaptation Network for Settlements and Infrastructure* page 1

⁶⁶ NCCOE, Introduction, pages 19 through to 30

⁶⁷ Carmichael and Balatbat, *Adaptation above* page 1

⁶⁸ Engineers Australia, Response strategy to sea level rise ("SLR") page 5

⁶⁹ Australia Government, 'Climate Change Risks to Australia's Coast

A FIRST PASS NATIONAL ASSESSMENT' (2009)

<<http://www.climatechange.gov.au/~media/publications/coastline/cc-risks-full-report.pdf>> Appendix 1, page 152

country that best defends is the Netherlands 'with half of its territory below sea level, much of the rest threatened by coastal or river flooding and which expects to invest an extra U.S. \$10 billion to \$25 billion in flood and sea defences over the next century.'⁷⁰ The Dutch have significant expertise and necessity to defend because, "With two-thirds of our population living at or below sea level, in a densely populated delta, the importance of dealing with sustainability and climate change is a 'no brainer', a matter of survival," said Dutch Ambassador Renée Jones-Bos.⁷¹

However, it has been reported that even the Dutch 'may not be able to cope with SLR and increased rainfall, such that the government has devised a national water plan overhauling the country's defences and costing billions of euros.'⁷² Professor Fresco was reported to have said that Dutch complacency was being challenged and they were rethinking their approach to water as, "not only as something to be controlled, but also something which is part of our environment, our habitat and something that we have to live with." One adaption solution proposed was the construction of floating houses,⁷³ which points to an emerging retreat strategy in a nation that traditionally defends.

If a country with two thirds of its population under the sea level which has kept out the sea to survive, now recognises that defence is not always practical, then Australia, and Queensland in particular needs to take note.

c. **Retreat**

'Planned or managed retreat involves a decision to withdraw, relocate or abandon assets that are at high risk of being affected by climate change hazards in the coastal zone. In the longer term, planned retreat often provides the most cost-effective approach to managing risks to medium to high value of assets exposed to inundation or erosion risk.'⁷⁴

The Byron Shire plans and the Gold Coast plans will now be investigated in the context of defence or retreat.

5. **Byron Shire plans**

The Byron Shire Plan consistently references sea level rise.⁷⁵ The report identifies the strategies of retreat or to hold the coastal alignment in one of many ways.⁷⁶ It provided a model for decision criteria, 8 policy and 4 financial criteria⁷⁷, which were applied to the three possibilities of structural (protect/defend), nourishment (of the beach) or retreat⁷⁸. These decision criteria were applied to the Belongil Beach and New Brighton Beach using a cost benefit analysis with thorough calculations of the 11 possible options involving defence, nourishment or retreat⁷⁹. Byron Bay is one of the few places in Australia where there has been planned retreat to deal with climate change,⁸⁰ and the decision criteria are very comprehensive.

⁷⁰ Colin Woodward, 'Netherlands Battens Its Ramparts Against Warming Climate ' (2001) (4 September, 2001) *National Geographic News*

⁷¹ Dutch Water Sector, *South Florida and Dutch Collaborate on Climate Change, Sea-Level Rise* (2010) <<http://www.dutchwatersector.com/news/?p=309>>

⁷² BBC, *Netherlands learns to go with the flow* (22 April 2011 2009) BBC <<http://news.bbc.co.uk/2/hi/science/nature/7942169.stm>>

⁷³ *Ibid*

⁷⁴ Australia Government, Response strategy to sea level rise ("SLR") page 152

⁷⁵ Dean Patterson and Craig Witt, 'Byron Coastline Management Study' (WBM Oceanics Australia, 2003)

⁷⁶ *Ibid*,

⁷⁷ *Ibid*, page V

⁷⁸ *Ibid*, page IV

⁷⁹ *Ibid*, page V

⁸⁰ Australia Government, Response strategy to sea level rise ("SLR") page 152

The best performing option for Belongil Beach was nourishment with a terminal wall for emergency protection.⁸¹ In the case of New Brighton nourishment, or nourishment plus a terminal wall for emergency protection, were considered the best options.⁸² In the event that sand was unavailable for ecological reasons, then in both cases, the favourable option was retreat. More generally in relation to coastal erosion the recommended strategies were essentially for retreat, except in the case of development under threat from inundation where the preferred strategy was defence.⁸³

The report stated that defence was considered to satisfy community expectations.⁸⁴ Beach nourishment contained uncertainties as to the ecological consequences and the source of sand which could make retreat the only option. As to retreat, the report conceded the 'adverse social impacts from property loss, dislocation and strict control over land use, and that planned retreat involved consideration of longer term inter-generational consequences as regards substantial ongoing resumption costs and costs to relocate infrastructure and roads'.⁸⁵

Overall Byron Shire prefers retreat, and this strategy was arrived at using objective decision criteria and detailed calculations. However, it is likely that if one applied these financial criteria to the more developed Gold Coast, could render retreat prohibitively expensive.

6. Gold Coast plans

The Gold Coast Planning Scheme 2003⁸⁶ ("GCPS") which was prepared in accordance with the superseded *Integrated Planning Act 1997* guides the growth and development of the Gold Coast, and has only one reference to sea level rise in a webpage on revetment walls.⁸⁷

The plan identifies 17 Desired Environmental outcomes ("DEO's") said to be the core of the planning scheme to achieve ecological sustainability by considering ecological, economic and social impacts.⁸⁸ A review of these outcomes was done to establish if there was an underlying adaption strategy within the DEO's.

None of the four ecological processes dealt with infrastructure.⁸⁹ The economic development DEO's include a focus on land use and demonstrated underlying themes of growth, cost minimisation, efficiency and cost benefit.⁹⁰

However, the 'community well-being' DEO Soc.7 suggests an adaptive strategy. It focuses on "The location and design of development to minimise the potential risk to life and property from known natural hazards." It accepts that with appropriate design recognising the natural hazards, the risks could be greatly reduced or mitigated. It added that if 'development was considered suitable, design measures and environmental management techniques could be utilised to further mitigate any risks.' Flood prone areas mitigation measures had to be accommodated by the local environment in a sustainable manner.⁹¹

⁸¹ Patterson and Witt, Byron Shire plans, page VIII

⁸² Ibid, pages VIII and IX

⁸³ Ibid, pages X to XIV

⁸⁴ Ibid, page VI

⁸⁵ Ibid, page VI

⁸⁶ City Council GoldCoast, *Gold Coast Planning Scheme 2003 Version 1.2 Amended October 2010* (2010) <http://www.goldcoast.qld.gov.au/t_standard2.aspx?pid=1395>

⁸⁷ Gold Coast City Council, *Revetment Walls*

(<http://www.goldcoast.qld.gov.au/t_standard2.aspx?pid=8085>

⁸⁸ Gold Coast City Council, Gold Coast plans, part 2, Division 1 Chapter 1, page 1

⁸⁹ Ibid, Desired Environmental Outcomes, page 2

⁹⁰ Ibid, Desired Environmental Outcomes, page 8

⁹¹ Ibid, Desired Environmental Outcomes, page 17

The Gold Coast Climate Change Strategy 2009 – 2014 ("GCCCS"), contains strategic outcomes including it being a leader in this field by (inter alia) ensuring 'climate change considerations and statutory responsibilities are incorporated in the development of new (and the review of existing) corporate strategies, plans and policies, and implementing 'Climate Change Impact Statements into Council's decision making and governance framework'.⁹² However, its express reference to SLR suggests that 'it is a *rare* likelihood but with the *catastrophic* consequence, and to which it attributed a medium priority, and stated that the risk would not occur during the lifetime of the strategy'.⁹³

Accordingly, although it may contain an adaptive strategy, SLR is not considered in the GCPS, and was said not to occur during the lifetime of the GCCCS.

7. The coastal plan

The *coastal plan* provides guidance as to defence or retreat for SLR. It deals with issues within the coastal zone under the SPA, and 'will inform regional plans as well as local government planning schemes and decisions on development applications.' It will also assist local governments with land in the coastal zone to 'provide detailed guidance about how to design and locate development to avoid coastal hazard risks—especially those increased by climate change-related sea-level rise.'⁹⁴ It defines *Coastal hazard area* as "the area that is at risk from storm tide inundation, coastal erosion, or permanent inundation due to sea level rise."⁹⁵

Accordingly, it will impact upon the GCPS and GCCCS.

Some examples from the *coastal plan* include:

1. 'Engineered erosion control structures may only defend permanent infrastructure where beach nourishment or landward retreat of the infrastructure is not a practical or cost effective option.'⁹⁶
2. 'In areas under constant threat of erosion, retreat from the erosion prone area is preferred. For existing development which has social and economic value, *erosion control works should be initiated only as a last resort in an instance when erosion presents an immediate threat to public safety, property, and/or infrastructure that is not expendable.*'⁹⁷
3. 'Local planning instruments must incorporate a coastal hazard adaptation strategy for urban localities expected to be within a high coastal hazard area by 2100. Adaptation assesses mitigation options that will mitigate the hazard, including retreat, avoidance, and defence and a cost-benefit analysis to determine the most cost effective works or actions, taking into account long-term social, financial and environmental factors.'⁹⁸

Residential and retail development is not coastal dependent,⁹⁹ which suggests that they fall within the retreat strategy. However, the *coastal plan* concedes that certain marine-related infrastructure is coastal dependent and has to be located in the coastal hazard area.¹⁰⁰ But

⁹² Gold Coast City Council, *Climate Change Strategy 2009 - 2014* (2009) page 11

<http://www.goldcoast.qld.gov.au/attachment/publications/strategy/climate_change_strategy.pdf>

⁹³ *Ibid*, Risk Response Matrix page 28

⁹⁴ Queensland Coastal Plan 2011, page 36

⁹⁵ *Ibid*, page 99

⁹⁶ *Ibid*, page 7

⁹⁷ *Ibid*, page 8

⁹⁸ *Ibid*, page 40

⁹⁹ *Ibid*, page 42

¹⁰⁰ *Ibid*, page 42

even that, it appears as if defence is not required as performance outcome 52 for private marine access precludes construction of erosion control structures.¹⁰¹

In addition, Annexure 3 – 'Storm-Tide Inundation Areas' provides some design criteria in tables 3.1 through to 3.3.¹⁰² These may assist registered professional engineers in designing or applying the current NCCOE guidelines to determine the appropriate strategy

C. Conclusions

The research established that Queensland's primary legislation does not consider SLR at all and it is only the *coastal plan* that recognises SLR. The *coastal plan* also provides specific guidance about the appropriate adaptation strategy, which is predominantly one of retreat. It is likely to have a significant impact upon development in Queensland in the future, and yet the QRA organising the current urgent \$5 billion rebuilding activity does not have to adapt to SLR because it has its own legislation that can ignore the *coastal plan*. SLR is expected to put \$10 billion of Queensland's assets at risk, and without consideration of SLR, Queensland is in danger of putting some, if not all, of the rebuilt environment at risk.

The Federal Government, which has consistently recognised the need to adapt to SLR has no specific adaption strategies that have yet emerged from all the research it is currently doing on climate change. Even as principal financier of QRA's reconstruction activities, it has no legislative basis to insist that QRA adapt to SLR when it recognises that adaptation to climate change must start now.

Even though retreat for the coastal zone is now the preferred strategy, the ability to facilitate communication within the Gold Coast community to implement retreat, together with the need for collaboration within all levels of government and the private sector remains of concern because of the complexity of Queensland's laws regarding coastal land. As identified in the research on Byron Shire, retreat involves consideration of significant social impacts of property loss, dislocation etc, as well as the intergenerational consequences of ongoing resumption and infrastructure relocation costs (the "real retreat costs"). The *coastal plan* and its adaption strategies, as subordinate legislation, did not have to undergo the more rigorous scrutiny required for primary legislation, so it is uncertain whether the Gold Coast community will accept the real retreat costs without dispute, when the reality of the implementation of the required strategy becomes apparent.

The GCPS and the GCCCS will need to be amended, and that will take time and involve debate within Council. In addition, with the potential for factual and values disputes and the high stakes on the Gold Coast and the decisions about who will have to pay for retreat, the implementation of the strategy is unlikely to have an easy journey. Furthermore, it is not clear whether the NCCOE guidelines are to be used by registered professional engineers in designing for development on the coastal land, or whether the criteria identified in the *coastal plan* can dovetail with those guidelines. Those guidelines may need revision since they are 7 years old and recent Federal Government research needs to be considered.

D. Recommendations

1. Section 5 of the SDA should include as a purpose "the effect of climate change on development."
2. In the current urgent *Operation Queenslander*, the QRA should apply the relevant adaptation strategies contained within the coastal plan for any development scheme, rather than just having to consider it under section 63(4) of the QRA Act.

¹⁰¹ Ibid, page 90

¹⁰² Ibid, pages 94 – 95

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