LOCAL ADAPTATION RESPONSES IN CLIMATE CHANGE PLANNING IN COASTAL QUEENSLAND[1]

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ABSTRACT: This paper reviews adaptation actions in climate change strategies by four urban Queensland coastal councils (e.g. Cairns, Gold Coast, Redland, and Sunshine Coast), and two community-based climate action plans for Bribie Island, and the Noosa Biosphere. The actions in these six plans are analysed for their adaptive response categories: *Emphasising Nature*, *Emphasising Development* and *Managed Nature* (Vasey-Ellis 2009), along with *Council Governance* of climate change, and *Emphasising Community*. Climate change planning and infrastructure responses by Queensland coastal councils mainly focus on protecting coastal development from erosion and other climate hazards, and building community resilience, supplemented by 'soft' environmental actions protecting nature. While some climate change plans for coastal areas included actions for shoreline erosion, coastal inundation, and storm surges, only two addressed sea level rise impacts. This review found an integrated mix of adaptation actions for nature, governance and community is required for enhanced adaptive capacity at the local level.

KEY WORDS: Climate Change and Adaptation, Resilience, Planning

1. INTRODUCTION

Climate change adaptation and mitigation is now a key issue for local governments, especially coastal councils (Demeritt and Langdon 2004; England 2006; LGAQ 2007; Ministry for the Environment 2009; Nursey-Bray 2009, 2010; Vasey-Ellis 2009; Hunter et al. 2010; ALGA 2011; Pillora 2011). There is a significant focus on coastal planning for climate change impacts on metropolitan areas (Hebert and Taplin 2006), and local communities (Westcott, 2004), including sea level rise (Walsh et al. 2004; Wang et al. 2010; Abel et al. 2011) and vulnerability to flooding (Baum, Horton and Choy 2008). In Queensland, climate change impacts on coastal areas include the effects of tropical cyclones, storm surges, flooding, sea level rise (SLR), tidal inundation, and shoreline erosion. Recent news articles highlight planning issues, building codes, insurance

risk, and the cost of impacts on coastal areas from tropical cyclones (Bita 2011), state-wide flooding during summer 2010/2011 (*The Courier Mail* 2011; Walker and Bita 2011), and SLR impacts on Queensland's coast (Abel et al. 2011; Collins 2011; Houghton 2011; PIA 2011; Williams 2011). A projected SLR of 1.1m by 2100 will affect low-lying infrastructure and buildings in local government areas (LGAs) of coastal Queensland, mainly Brisbane, Gold Coast, Moreton Bay, Fraser Coast, Mackay, and Townsville (DCCEE 2011a). The Local Government Association of Queensland established a Coastal Councils Adaptation Taskforce (C-CAT) in early 2011 to address this risk, with 25 coastal councils now members. The mayor of Bundaberg Regional Council was the Queensland representative on the National Coasts and Climate Change Council. The *Queensland Coastal Plan* now requires councils to prepare coastal hazard adaptation plans for those parts of their urban areas at risk, related to a projected SLR of 80cm by 2100, with related guidelines for coastal management, protection and hazards (DERM 2012a, b, c).

The growing impacts of coastal development, climate change and sea level rise are key issues in the heavily populated areas of Southeast Queensland (Abel et al. 2011; Dedekorkut et al. 2010; McDonald, 2010; Noosa Biosphere, 2010; Wang, Stafford Smith, McAllister, Leitch, McFallan and Meharg 2010; Waterman, 2009; Waterman et al. 2009). Moreover, *ongoing coastal development and population growth in areas such as Cairns and South East Queensland...are projected to exacerbate risks from sea level rise and increases in the severity and frequency of storms and coastal flooding by 2050* (IPCC 2007, cited in SCC 2010: 13). Councils applying for Queensland state government grants for new infrastructure projects must also address adaptation (i.e. site, design, and materials) to minimise climate impacts (DIP 2010). In planning for climate change, councils thus need to promote adaptive capacity which is *the ability of built, natural, and human systems to accommodate changes in climate (including climate variability and climate extremes) with minimal potential damage or cost* (SCC 2010: 56). Council planning for Queensland coastal areas focuses on hazards and risk management, with new planning guidelines to assess risks to communities and a three to five year phase of coastal hazard plans to allow councils time to prepare adaptation strategies (DERM 2012c). Climate adaptation strategies have been reviewed in the *SEQ Regional Plan* (Dedekorkut et al. 2010), but not in climate change plans by local councils (Zeppel 2011).

Only five Queensland coastal councils have prepared climate change strategies or action plans, including Brisbane (BCC 2007); Cairns (CRC 2009, 2010); Gold Coast (GCCC 2009); Redland (RCC 2010), and Sunshine Coast (SCC 2010). These climate change plans cover the main urban centres in South East Queensland (SEQ) and the far north Queensland coast, with these larger coastal councils also leaders in the Cities for Climate Protection program (Table 1). A climate change plan was in progress for Moreton Bay Regional Council, between Brisbane and the Sunshine Coast, with actions approved by council members in September 2011 for this plan. Three SEQ coastal councils (i.e. Gold Coast, Moreton Bay and Sunshine Coast) have also prepared shoreline erosion management plans, a coastal dune policy, and beach nourishment programs for key beaches (Table 1). Only one inland Queensland council, the Southern Downs, had a climate change adaptation action plan.

The climate change plan for Brisbane was not analysed in this paper, as only two adaptation actions addressed coastal impacts from storm surge and SLR (BCC 2007). This climate change action plan for Brisbane City focused on carbon mitigation and eco-efficiency measures (i.e. energy, water, waste, transport), and minimising negative impacts of climate change from storms, flooding and heatwaves (BCC 2007). Adaptation strategies in the plan were amending the City Plan to reduce exposure to flooding and storm surges, and disaster management planning. The adaptation actions all related to risk management measures: *Funding adaptation measures such as relocation of buildings and infrastructure from high risk areas as necessary* (Action 3c); *Upgrade the Q100 flood level; Enhanced stormwater and flood-related infrastructure requirements* (Action 13a)*; Require forward planning for Council assets, especially water supply, wastewater treatment plants, stormwater, roads and bridges* (Action 22a)*; Establish flooding and storm surge response plans* (Action 23a)*;* and *Understanding sea level rise and storm surge impacts on Brisbane* (Action 30a). State planning policies on flooding still don't consider SLR or storm surge impacts (PIA 2011). This paper instead reviews adaptive actions in climate change strategies by Cairns, Gold Coast, Redland, and Sunshine Coast councils, and for Bribie Island and Noosa Biosphere. The paper identifies what adaptation actions for nature, governance and community are required for enhanced adaptive capacity at the local level.

Table 1. Climate Change Strategies for Queensland Coastal Regions. Source: Queensland council websites and climate change or coastal management strategies

Council/Region	Climate Change Plan/Strategy
Brisbane City Council	*Brisbane's Plan for Action on Climate Change and Energy 2007*
Cairns Regional Council	*Climate Change Strategy 2010-2015* Coastal Management Issues Beach protection/erosion control: Clifton Beach, Holloways Beach
Gold Coast City Council	*Climate Change Strategy 2009-2014* Coastal Management Issues Gold Coast Shoreline Management Plan (2009); Ocean, Beaches and Foreshore Strategy (2012); Planning Scheme Policy 15: Management of Coastal Dune Areas; Northern Gold Coast Beach Protection Strategy; Kirra Beach Restoration Project; Tweed River Entrance Sand Bypassing Project; Beach nourishment: Southern Palm, Burleigh, southern Gold Coast beaches
Redland City Council	*Confronting our Climate Future: Climate and Energy Action Plan 2010-2015*
Sunshine Coast Council	*Climate Change and Peak Oil Strategy 2010-2020* Coastal Management Issues Waterways and Coastal Management Strategy 2011-2021 (Coastal Foreshores: 2 climate change actions); Beach nourishment: Noosa Main Beach, Mooloolaba Beach; Beach protection/erosion control: Noosa
Bribie Island (Moreton Bay RC)	*Climate Proofing Bribie: A Climate Adaptation Action Plan 2010* Coastal Management Issues Shoreline Erosion Management Plan (Bribie Island, Southern Pumicestone Passage, Redcliffe); Beach nourishment: Woorim Spit/Dog Beach
Noosa Biosphere (Sunshine Coast RC)	*Noosa Climate Action Plan* (2011)

Notes: RC= Regional Council

The Redland City Council strategy, *Confronting our Climate Future*, was prepared by council staff based on climate change information from scientists, and consultants that had produced a climate change risk assessment and adaptation plan for the Redlands area (RCC 2010). The Gold Coast *Climate Change Strategy* was prepared by council staff utilising climate information supplied by third parties (GCCC 2009). The Redland and Gold Coast climate strategies were partly funded by the Australian government's Local Adaptation Pathways Program. The Sunshine Coast Climate change strategy was prepared by council staff with assistance from the University of the Sunshine Coast and incorporated input from interested stakeholders (SCC 2010). The climate change strategy for Cairns was prepared by staff from Cairns Regional Council and built on an existing climate change adaptation action plan (CRC 2009, 2010). These plans did not mention community consultation.

The Bribie Island community in the Moreton Bay Regional Council area developed their own climate adaptation plan facilitated by a Climate Proofing Bribie Working Group in partnership with SEQ Catchments and the University of the Sunshine Coast (Chapman 2010). The Noosa Biosphere in the northern Sunshine Coast also prepared a *Noosa Climate Action Plan* in partnership with SEQ Catchments and the University of the Sunshine Coast, involving conservation, emergency services and residents groups in workshops and presentations by climate experts (Noosa Biosphere 2011). This Noosa climate plan was an entry for the Insurance Council of Australia's prize for a more resilient Australia (Noosa Biosphere 2010).

Queensland Coastal Councils

There are 35 coastal councils in Queensland, covering nearly half (47%) of all councils in the state. In total, there are 73 councils across Queensland (city, regional, shire, and Aboriginal shire); with a separate Weipa Town Authority managing this mining town on Cape York Peninsula. The coastal councils comprise four city councils (i.e. Brisbane, Gold Coast, Redland, and Townsville); 14 regional councils (i.e. Bundaberg, Cairns, Cassowary Coast, Fraser Coast, Gladstone, Gympie, Isaac, Mackay, Moreton Bay, Northern Peninsula Area, Rockhampton, Sunshine Coast, Torres Strait Island, and Whitsunday); eight shire councils (i.e. Aurukun, Burdekin, Burke, Carpentaria, Cook, Hinchinbrook, Mornington,

and Torres); and nine Aboriginal shire councils (i.e. Hope Vale, Kowanyama, Lockhart River, Mapoon, Napranum, Palm Island, Porpmuraaw, Wujal Wujal, and Yarrabah). The coastal shire and Aboriginal shire councils are all located in North Queensland, Cape York and around the Gulf of Carpentaria. This paper focuses on three coastal councils in SEQ (i.e. Gold Coast, Redland, and Sunshine Coast), and the Cairns council in Northern Queensland.

Climate Change Impacts on Queensland Coastal Areas

Some 85% of Queensland's population lives on or near coastal areas, with 73% of Queensland's coastline comprising open sandy beaches (DERM 2011). The coastal local government areas in South East Queensland (SEQ) are among the top ten areas in Australia at risk of inundation from flooding, sea level rise (SLR) and storm surges (Dedekorkut et al. 2010), with 245,000 people at risk of SLR impacts by 2030 (Wang et al. 2010). Over 70% of commercial buildings in SEQ are located within 5km of the shoreline; with the *SEQ Regional Plan 2009-2031* allowing for 502,000 more houses along the SEQ coast by 2031. Climate change impacts on Queensland's coastal areas include: more severe tropical cyclones (e.g. Cyclone Yasi, 2011 and Cyclone Larry, 2006); storm surges; flooding (Baum et al. 2008); sea level rise; coastal inundation (high tide/king tide/storm tide); beach/dune erosion; shoreline recession; and estuary instability. These climate impacts affect beaches, dunes and shorelines and cause damage to coastal buildings, roads, electricity, ports, airports, schools, hospitals, industrial sites, landfills, recreation areas, water and sewerage plants; and emergency facilities. The climate change impacts on coastal infrastructure from SLR and storm events include: structural damage and fatigue; accelerated degradation of foundations and materials; increased ground movement; groundwater changes; and flooding (DCCEE 2009).

In coastal Queensland, up to 4,700km of roads, 570km of railways and 1,400 commercial buildings are at risk from SLR of 1.1m by 2100 (DCCEE 2011a) (Table 2). Key Queensland airports are also located in vulnerable low-lying coastal areas prone to flooding, such as Brisbane, Cairns, and Coolangatta on the Gold Coast. With 0.8m SLR by 2100, the *Queensland Coastal Plan* states 94,000 buildings will be partially inundated (with 10,650 buildings in Brisbane); while 65,000 properties will be affected by storm surge inundation. In SEQ, almost 9,000 homes

are within 110m of erodible shoreline; 32,500 homes are exposed to a 2.5m storm tide; with 61,500 homes at risk from storm tides by 2030 (DERM 2012a). Queensland has the highest number of at risk residential buildings in Australia's coastal zone located within 55m (n=5,400) or 100m (n=15,200) of 'soft' coastlines. Between 48,300 and 67,700 houses, worth $15 to $20 billion, are at risk from SLR of 1.1m by 2100 (DCCEE 2011b). The cost and effect of storm surges, SLR and beach erosion on infrastructure and the visual amenity of coastlines are recognised as a major risk and concern for coastal management and zoning in Queensland (Miles, Marshall, Kinnear and Greer 2008). Despite this high level of exposure and vulnerability to climate change impacts in Queensland (Bajracharya, Childs and Hastings 2011), few coastal councils have completed a climate change risk assessment (i.e. Moreton Bay and Redland, SEQ) or prepared a climate change plan. The *Queensland Coastal Plan* now requires councils to prepare coastal hazard adaptation plans for at-risk urban areas (DERM 2012c).

Table 2. Buildings and Infrastructure in Coastal Queensland Affected by Sea Level Rise of 1.1m by 2100. Source: *Climate Change Risks to Australia's Coast* (DCCEE 2011a, b)

Residential Buildings:	Moreton Bay/Sunshine Coast (1,850-2,250 buildings within 100m; 430-800 buildings within 55m); Mackay, Gold Coast, Fraser Coast, Bundaberg, Cairns
Commercial Buildings:	Gold Coast (n=166-243); Moreton Bay (n=155-226); Fraser Coast (n=167-213); Townsville (n=117-199); Mackay (n=95-193); Bundaberg, Sunshine Coast
Light Industrial Buildings:	Mackay (n=336-502); Moreton Bay (n=156-250); Brisbane (n=160-247); Gold Coast, Townsville, Bundaberg, Rockhampton, Fraser Coast, Sunshine Coast, Whitsunday
Roads:	Mackay and Fraser Coast (352-475km); Gold Coast (301-408km); Rockhampton (305-395km); Moreton Bay, Burdekin, Bundaberg, Townsville, Carpentaria, Sunshine Coast
Rail:	Burdekin (78-104km); Mackay, Bundaberg, Rockhampton, Whitsunday (33-69km), Sunshine Coast, Townsville, Isaac, Cairns, Hinchinbrook

2. CLIMATE CHANGE ADAPTATION RESPONSES

This paper reviews adaptation actions in climate change strategies prepared by four urban Queensland coastal councils (e.g. Cairns, Gold Coast, Redland, and Sunshine Coast), and two community-based climate action plans for Bribie Island, *Climate Proofing Bribie* (Chapman 2010), and the *Noosa Climate Action Plan* (Noosa Biosphere 2011). The actions in these plans are analysed for their adaptive response categories: *Emphasising Nature*, *Emphasising Development* and *Managed Nature* (Vasey-Ellis 2009), along with *Council Governance* of climate change, and *Emphasising Community*. Vasey-Ellis (2009) lists a number of adaptation options in coastal planning for each of these key categories (Table 3). The category, *Emphasising Nature*, focuses on protecting the environment (e.g. beaches, dunes, habitat, park land, plants, waterways, and wildlife) to buffer the effects of climate change on nature and also to protect developed areas from climate hazards. The adaptation options for this category include: Relocate and prevent development or unsustainable land use, Designate protected land, Create setback buffers, Create wetlands and revegetate vulnerable areas. The category, *Emphasising Development*, focuses on protecting the built environment through insurance, building codes and engineering responses to limit damage to council, public and private property (i.e. assets, infrastructure, hazards, and risk). The adaptation options include: Private insurance for vulnerable properties, Developers accept full risk, Elevate buildings and change building codes, and Build hard structures. *Managed Nature* refers to 'natural' engineering options such as replacing beach sand by pumping or trucks. The adaptation options include: Beach nourishment, and Build artificial reefs. Two additional adaptive response categories devised by the author were used in this analysis of climate actions: Emphasising Community and Council Governance of climate change. *Emphasising Community* refers to public access, consultation, engagement, health risks, or safety issues in regard to climate impacts. *Council Governance* refers to internal council processes for dealing with climate change issues through frameworks, leadership, policy, strategies, staff training, and reports. These additional categories were used as climate change impacts affect both local communities and councils (i.e. infrastructure, services, and safety). The climate actions stated in climate change strategies for Cairns, Gold Coast, Redland, Sunshine Coast, Bribie Island, and Noosa are analysed according to which main adaptation response category they best fit (i.e. Emphasising Nature, Emphasising Development, Managed

Nature, Emphasising Community, and Council Governance). These five categories thus provide a comprehensive analysis of adaptation actions.

Table 3. Adaptive Response Categories. Source: Vasey-Ellis (2009)

Emphasising Nature
• Relocate and prevent development
• Designate additional park protected land
• Create setback buffers
• Prevent unsustainable land use
• Create wetland buffers and revegetate vulnerable areas
Emphasising Development
• Private insurance for vulnerable properties
• Let developers accept full risk
• Elevate buildings and change building codes
• Build hard structures
Managed Nature
• Build artificial reefs
• Beach nourishment
***Emphasising Community**
• Public access
• Community consultation and engagement
• Health risks and safety issues
***Council Governance**
• Climate change policies, strategies and reports
• Staff training on climate change actions

Notes: * = adaptive response categories added by the author

3. CLIMATE CHANGE STRATEGIES BY QUEENSLAND COASTAL COUNCILS

Five Queensland coastal councils have prepared climate change strategies or action plans, including Brisbane (BCC 2007); Cairns (CRC 2009, 2010); Gold Coast (GCCC 2009); Redland (RCC 2010) and Sunshine Coast (SCC 2010). These climate change plans cover the main urban centres in SEQ and the far north Queensland coast. The climate change action plan for Brisbane was not analysed, as only two adaptation actions addressed impacts from storm surge and SLR on the Brisbane

coastline. This paper analyses the adaptation actions in climate change plans for Cairns, Gold Coast, Redland and Sunshine Coast councils; and in other community-based climate plans for Bribie Island and Noosa.

The climate action plans for Bribie Island, Noosa, Cairns, Gold Coast, Redland, and Sunshine Coast included strategies for climate change mitigation and adaptation, environmental protection and building community resilience to climate change (Table 4). Specific actions for adaptation were included in the strategies for Sunshine Coast (n=25) and Cairns (n=9). The Sunshine Coast adaptation actions were further divided between *Objective 5: Identify and plan for climate change risks* (n=14), and *Objective 6: Adapt to the impacts of climate change* (n=11). The climate strategies for Bribie Island, Noosa, Gold Coast and Redland included a mix of both mitigation and adaptation actions in key areas, including the natural environment (i.e. biodiversity, shoreline, and water), planning and infrastructure (Bribie, Noosa, Gold Coast) or development and council assets/services, plus community safety and resilience (Redland). The Cairns strategy had a 'transition' section with nine actions about community resilience. Specific actions for council governance and leadership on climate change responses were included in strategies for Cairns, the Gold Coast, and Sunshine Coast. The Bribie Island and Noosa plans included specific adaptation actions for shoreline and emergency management. Other climate actions for mitigation and/or energy use in the Cairns, Redland and Sunshine Coast climate change strategies were not included in this analysis of adaptation responses.

Table 4. Adaptation Actions in Queensland Climate Change Plans. Sources: Chapman (2010), Noosa Biosphere (2011), CRC (2010), GCCC (2009), RCC (2010), SCC (2010)

Climate Actions	Bribie* Island	Noosa#	Cairns	Gold Coast	Redland	Sunshine Coast
Biodiversity	23	39	4	0	11	6
Planning and Infrastructure, Council Assets	22	26	7	14	25	10
Shoreline or Coastal	10	12	0	0	0	1
Water	10	0	0	0	0	3
Emergency/ Safety	6	11	0	0	13	2
Health and Lifestyle/ Resilience	0	37	6	0	16	2
Economy/ Development	0	35	0	0	19	1
Agriculture	0	21	1	0	0	0
Governance/ Leadership/ Services	0	0	18	21	14	27
TOTAL	**71**	**181**	**36**	**35**	**98**	**52**

Notes: *Moreton Bay Regional Council is responsible for implementing 85% of the 71 actions in the *Climate Proofing Bribie* plan
#Sunshine Coast Regional Council is responsible for implementing 99 actions (55%) in the *Noosa Climate Action Plan*

4. ADAPTATION RESPONSE CATEGORIES IN CLIMATE CHANGE PLANS

The relevant actions in the six climate change strategies were analysed according to which main adaptation response category they best matched. These included the three adaptation response categories employed by Vasey-Ellis (2009) to assess Victorian coastal planning: emphasising development, emphasising nature and managed nature, along with two other response categories, council governance and emphasising community, added by the author. This analysis highlighted the varied responses to climate adaptation actions by councils and communities (Table 5). The Cairns, Sunshine Coast, and Gold Coast strategies focused

on council governance to implement climate actions, along with actions emphasising nature to protect the environment, assets, and public areas. Emphasising nature was the main adaptation response in the community action plans for Bribie Island (n=52, 73%) and Noosa (n=88, 48%), and the council plan for Redland (n=48, 49%), by protecting the environment and facilities from adverse climate effects. Emphasising community was the second adaptation response category in the strategies for Redland, Bribie Island, Noosa, and Cairns, with actions focused on community resilience and safety from climate hazards. There were only two actions for the response category, managed nature, with an artificial reef (Bribie Island) and controlling vegetation for fire management (Redland). The beach nourishment and sand replenishment at beaches on the Gold Coast, Sunshine Coast and in Cairns (see Table 1) were not mentioned as adaptation actions in climate plans by these councils. Instead, these beach recovery actions are covered in separate coastal management plans. Climate actions in the four council plans focused on protecting council, public and private property in at-risk coastal areas, along with mitigation actions to reduce council and community emissions, and insurance for council assets. This is due to the high level of coastal development and population growth in both SEQ and in Cairns, and council liability to reduce risk from climate impacts through planning and adaptation. Overall, in these six climate plans, the total actions by adaptation response categories were: emphasising nature (46.7%), emphasising community (22.8%), council governance (21.5%), and emphasising development (8.4%). The four council plans had a key focus on governance actions to address climate change impacts (33% vs. 15% in Noosa plan and 0% in Bribie Island plan). However, the community-based plans relied on their respective local councils to implement 55% (Noosa) to 85% (Bribie Island) of their climate adaptation actions.

Table 5. Adaptive Responses in Queensland Climate Change Plans
Sources: Chapman (2010), Noosa Biosphere (2011), CRC (2010), GCCC (2009), SCC (2010), RCC (2010)

Adaptive Categories	BI	NB	Cairns	Gold Coast	Sunshine Coast	Redland	Total Actions	Council Actions
Emphasising Development	4	16	4	4	6	6	40 (8.4%)	20 (9%)
Emphasising Nature	52	88	8	7	19	47	221 (46.7%)	81 (37%)
Emphasising Community	14	49	9	5	8	23	108 (22.8%)	45 (20.3%)
Council Governance	0	28	15	19	19	21	102 (21.5%)	74 (33.4%)
Managed Nature	1	0	0	0	0	1	2 (0.4%)	1 (0.4%)
Total Actions	71	181	36	35	52	98	473	221

Notes: BI = Bribie Island, NB = Noosa Biosphere

Coastal climate change adaptation actions were included in strategies for Bribie Island, Noosa, Redland and the Sunshine Coast. The climate plan for Redland City included actions for sea level rise impacts and coastal inundation of beaches and foreshores (Table 6), to protect natural and built environments. Planning options, legislation, and costs were all considered for Redland assets and areas vulnerable to inundation by storm tide, flooding or sea level rise. Some 22 actions (out of 98) addressed coastal climate change impacts on Redland council assets and infrastructure including landfills; beaches/foreshores; and public open space. These coastal adaptation actions were for storm tides/surges/water (n=14), sea level rise (n=9), and coastal inundation (n=9). Coastal wetlands were listed as soft infrastructure in the Redland City climate action plan. The Noosa and Bribie Island plans included actions for shoreline management such as erosion control and dune protection. Coastal management actions in the Noosa plan addressed SLR (n=4), storm surge/coastal inundation (n=3), beach erosion (n=2), and saltwater intrusion on groundwater (n=1). Adaptive actions in the Noosa plan included sandbags, levee banks and planned retreat from vulnerable coastal areas.

Table 6. Redland City Coastal Adaptation Actions for Sea Level Rise
Source: RCC (2010)

Redland City Council Climate and Energy Action Plan 2010-2015
1. Emphasising Nature
Investigate options, develop strategies, costs and scenarios for defending or retreating from sea level rise impacts along foreshores and the coastline (Action 2a)
Determine location of at risk coastal and marine infrastructure (under future climate scenarios for storm tide/flooding and sea level rise) (Action 2a)
Complete storm tide hazard, sea level rise, flooding and inundation mapping of areas of the city not currently mapped (Action 7a)
Investigate planning options (including Redland Planning Scheme mechanisms) that reduce the impacts of sea level rise on existing development exposed to inundation risks (Action 7b)
Advocate the State Government regarding enabling legislation to provide Council with the mechanisms for land resumption or compensation in response to sea level rise predictions (Action 7d)
2. *Emphasising Community*
Developing community engagement mechanisms for planning responses to sea level rise along foreshores (Action 7b)
3. *Council Governance*
Complete the registering of existing stormwater infrastructure on the asset register (Action 2a)

Notes: Coastal adaptation actions in: Council Property, Assets & Infrastructure (Action 2a); Development in Redland City (Actions 7a, b, d)

Coastal adaptation actions in the Sunshine Coast climate change strategy addressed longer-term changes in sea level and temperatures and climatic extremes from storms, cyclones and floods. Responses included vulnerability and hazard mapping of major risk areas due to climate change along with coastal erosion and inundation impacts in coastal management. There was only one coastal adaptation action (of 15) in this strategy: *Develop a coastal management strategy with shoreline erosion management plans where appropriate* (SCC 2010, p. 51). Storm surges are eroding popular Sunshine Coast beaches such as at Noosa. Coastal adaption actions in the Bribie Island plan also related to shoreline management (n=9) due to erosion of beaches on both sides of the island. The actions in the Bribie plan address community involvement in

preparing a shoreline erosion management plan, and other 'soft' options such as groundcover on dunes, protecting mangroves, education about dunes as a wave buffer, an artificial reef to protect beaches, and reducing impacts from boat wash and propellers. Environmental planning needs to protect coastal ecosystems as a vital climate buffer and defence.

5. CONCLUSIONS

The *Queensland Coastal Plan* (DERM 2012a, b, c) requires all coastal councils to prepare coastal hazard adaptation plans for those parts of their urban areas at risk from a projected sea level rise of 80cm by 2100. This paper reviewed adaptation actions in climate change strategies by four Queensland coastal councils, Cairns, Gold Coast, Redland, and Sunshine Coast, and two community-based climate action plans for Bribie Island and the Noosa Biosphere. The climate actions in these plans were analysed according to the adaptive response categories of emphasising nature, emphasising development and managed nature (Vasey-Ellis 2009), along with two other additional categories, emphasising community, and council governance of climate actions. This extended the framework of adaptation actions to recognise the key role of communities and council governance systems in addressing climate change impacts. These five adaptive response categories can be applied for a comprehensive analysis of adaptation actions in climate change plans prepared by councils and communities for other regions.

The climate change strategies for Cairns, Gold Coast, and the Sunshine Coast mainly focused on council governance of climate actions, while adaptive actions emphasising nature were the main focus of the Bribie, Noosa and Redland plans. It is to be expected that climate change plans by councils focus more on council governance and protecting property while community-based climate plans have a stronger focus on environmental protection. However, the Redland City climate plan strongly emphasised nature in adaptation actions while the Sunshine Coast climate strategy gave equal priority to emphasising nature and council governance actions. Both these areas rely on nature-based tourism and have a residential population that supports environmental amenity and protection. Overall, the adaptive actions by the four urban coastal councils focused on emphasising nature (37%), council governance (33%), emphasising community (20%), and emphasising development (9%). Emphasising nature (64%) was also the main adaptive response of Victorian coastal councils (Vasey-Ellis 2009). This study

found an integrated mix of adaptation actions for nature, governance and community is required for enhanced adaptive capacity at the local level. Adaptive capacity is *the ability of built, natural, and human systems to accommodate changes in climate...with minimal potential damage or cost* (SCC 2010: 56). Future research could identify which adaptation actions are most likely to be implemented by councils and local communities.

Councils have statutory obligations to protect the community and the environment from the impacts of climate change through adaptation. Queensland coastal councils adopted a mix of adaptive strategies similar to Victoria, but coastal climate hazards and actions were only considered in the Redland City (n=22), Noosa (n=12) and Bribie Island (n=10) plans. While some climate plans for coastal areas included actions for shoreline erosion, coastal inundation, and storm surges, only two addressed sea level rise impacts (i.e. Redland, and Noosa). Queensland State planning policies on flooding still don't consider SLR or storm surge impacts (PIA 2011). This analysis of adaptation actions in climate change plans found climate change planning and infrastructure responses by Queensland coastal councils mainly focus on protecting coastal development from erosion and other climate hazards, and building community resilience, supplemented by 'soft' environmental actions protecting nature as a buffer. In Queensland, there is less protection of coastal ecosystems and liability laws favour developers with a lower priority for nature-based adaptation options and growing pressure for built defences to protect valuable coastal assets (Abel et al. 2011). Further research needs to examine coastal adaptation actions in climate change plans prepared by local councils in other regions, in terms of protection versus planned retreat and their overall focus on nature, development, communities, and governance. The cost of coastal protection (e.g. sea walls, rock walls, geobags, and levee banks) needs to be compared with expenditure on 'soft' environmental actions (i.e. dune protection, beach nourishment, and revegetation). Adaptive management of climate change impacts will be an ongoing challenge for communities along Australia's coastline.

Postscript

The Queensland Coastal Plan – State Planning Policy 3/11: Coastal Protection was suspended from operation on 8 October 2012, and replaced by a Draft Coastal Protection State Planning Regulatory Provision (Draft SPRP), by the Queensland Minister for State Development, Infrastructure and Planning. This draft SPRP suspends the operation of four regional plans in coastal Queensland, and prioritises the approval of coastal-dependent land uses and property protection works to 'defend land uses and infrastructure from coastal processes.' The State Policy for Coastal Management is still in effect.

REFERENCES

Abel, N., Gorddard, R., Harman, B., Leitch, A., Langridge, J., Ryan, A. and Heyenga, S. (2011). Sea level rise, coastal development and planned retreat: Analytical framework, governance principles and an Australian case study. *Environmental Science & Policy,* 14(3), pp. 279-288.

Australian Local Government Association (ALGA) (2011). *Towards a National Planning Framework for Climate Change Mitigation and Adaptation.* ALGA: ACT. Online version accessed 8 November 2011, http://www.alga.asn.au/.

Bajracharya, B., Childs, I. and Hastings, P. (2011). Climate change adaptation through land use planning and disaster management: Local government perspectives from Queensland. 17th Pacific Rim Real Estate Society Conference, 16-19 January 2011. November 2011, http://www.prres.net/papers/Bajracharya_Childs_Hastings_Climate_change_disaster_management_and_land_use_planning.pdf.

Baum, S., Horton, S. and Choy, D.L. (2008). Local urban communities and extreme weather events: Mapping social vulnerability to flood. *Australasian Journal of Regional Studies,* 14(3), pp. 251-273.

Bita, N. (2011). Elemental struggle. *The Weekend Australian,* Inquirer, 12-13 February, pp. 1, 4.

Brisbane City Council (BCC) (2007). *Brisbane's Plan for Action on Climate Change and Energy 2007.* Brisbane City Council: Brisbane.

Cairns Regional Council (CRC) (2009). *Climate Change Adaptation Action Plan.* Cairns Regional Council: Cairns.

Cairns Regional Council (CRC) (2010). *Climate Change Strategy 2010-2015.* Cairns Regional Council: Cairns.

Chapman, S. (2010) *Climate Proofing Bribie: A Climate Adaptation Action Plan.* SEQ Catchments.

Collins, R. (2011). Rebuilding a resilient state. *WME magazine,* 22(8), p. 28.

Dedekorkut, A., Mustelin, J., Howes, M. and Byrne, J. (2010). Tempering growth: Planning for the challenges of climate change and growth management. *Australian Planner,* 47(3), pp.203-215.

Demeritt, D. and Langdon, D. (2004). The UK climate change programme and communication with local authorities. *Global Environmental Change,* 14, pp. 325-336.

Department of Climate Change and Energy Efficiency (DCCEE) (2009). *Climate change risks to coastal infrastructure, industry and essential Services.* Fact sheet, DCCEE. Online version accessed16 November 2011, http://www.climatechange.gov.au/en/publications/coastline/.

Department of Climate Change and Energy Efficiency (DCCEE) (2011a). Analysis by local government area – Queensland. In *Climate Change Risks to Coastal Buildings and Infrastructure: A Supplement to the First Pass National Assessment* (p. 16). June 2011. Online version accessed16 November 2011, http://www.climatechange.gov.au/en/publications/coastline/.

Department of Climate Change and Energy Efficiency (DCCEE) (2011b). *Climate change-potential impacts and costs: Queensland.* Fact Sheet, DCCEE. Online version accessed16 November 2011, http://www.climatechange.gov.au/en/climate-change/impacts/.

Department of Environment and Resource Management (DERM) (2012a). *Queensland Coastal Plan.* Online version acessed16 May 2012, http://www.derm.qld.gov.au/coastalplan/pdf/qcp-web.pdf.

Department of Environment and Resource Management (DERM) (2012b). Queensland coastal plan. Online version acessed16 May 2012, http://www.derm.qld.gov.au/coastalplan/.

Department of Environment and Resource Management (DERM) (2012c). *Queensland Coastal Plan: Guideline for Preparing Coastal Hazard Adaptation Strategies.* Queensland coastal plan. Online version acessed16 May 2012, http://www.derm.qld.gov.au/coastalplan/pdf/adaptation-strategy-guideline.pdf.

Department of Infrastructure and Planning (DIP) (2010). Climate Ready Infrastructure Initiative. Online version accessed16 November 2011, http://www.climatechange.qld.gov.au/pdf/factsheets/8govlship-n3.pdf.

England, P. (2006). *Climate Change: What are Local Governments Liable For?* Issues Paper 6, Urban Research Program, Griffith University: Brisbane.

Gold Coast City Council (GCCC) (2009). *Climate Change Strategy 2009-2014.* Gold Coast City Council: Gold Coast.

Hebert, K. and Taplin, R. (2006). Climate change impacts and coastal planning in the Sydney greater metropolitan region. *Australian Planner,* 43, pp. 34-41.

Houghton, D. (2011). Creeping tide set to drown our coast, *The CourierMail,* 8-9 January, pp.56-57.

Hunter, P., Burkitt, Z. and Trangmar, B. (2010). Local government adapting to climate change: Managing infrastructure, protecting resources, & supporting communities. In R.A.C. Nottage, D.S. Watt, J.F. Bornman and K. Jones (Eds) *Climate Change Adaptation in New Zealand: Future Scenarios and some Sectoral Perspectives* (pp. 122-133). New Zealand Climate Change Centre: Wellington.

Intergovernmental Panel on Climate Change (IPCC) (2007). *Climate Change 2007 Synthesis Report.* Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. R.K. Pachauri and A. Reisinger (Eds). IPCC: Geneva, Switzerland.

Local Government Association of Queensland (LGAQ) (2007). *Adapting to Climate Change: A Queensland Local Government Guide.* LGAQ: Brisbane.

McDonald, J. (2010). *Climate Change Adaptation in South East Queensland Human Settlements: Issues and Context.* A report for the South East Queensland Climate Adaptation Research Initiative, Griffith University: Brisbane.

Miles, B., Marshall, C., Kinnear, S. and Greer, L. (2008). *Climate Change and the Implications for Local Government in Queensland: A Risk Assessment*. Institute for Sustainable Regional Development, Central Queensland University: Rockhampton.

Ministry for the Environment (2009). *Preparing for Coastal Change: A Guide for Local Government in New Zealand.* Ministry for the Environment: Wellington.

Noosa Biosphere (2010). *Climate Proofing the Noosa Biosphere*. An entry for the Insurance Council of Australia's prize for a more resilient Australia, Noosa Biosphere Ltd.

Noosa Biosphere (2011). *Noosa Climate Action Plan*. Draft September2011, Noosa Biosphere, SEQ Catchments, University of the Sunshine Coast.

Nursey-Bray, M. (2009). Climate change, coastal communities and governance: Developing solutions for change, Australia. In E. Dahl, E. Moksness and J. Stottrup (Eds) *Integrated Coastal Zone Management.* Wiley-Blackwells Press: Australia.

Nursey-Bray, M. (2010). Local governance for local governments: A framework for addressing climate change. *Commonwealth Journal of Local Governance,* 7, pp. 168-186.

Pillora, S. (2011). *Australian Local Government and Climate Change*. Working Paper No. 1, Australian Centre of Excellence for Local Government, UTS: Sydney. Online version accessed16 November 2011, http://www.acelg.org.au/upload/ACELG_ClimateChangeReport_April11_v02_full.pdf.

Planning Institute Australia (PIA) (2011). Mitigating the adverse impacts of flood, bushfire and landslide. *Policy & Advocacy Bulletin,* June, pp. 9-10. Online version accessed16 November 2011, http://www.planning.org.au/news/.

Redland City Council (RCC) (2010). *Confronting our Climate Future: Climate and Energy Action Plan 2010-2015.* Redland City Council: Cleveland.

Sunshine Coast Council (SCC) (2010). *Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020.* Sunshine Coast Regional Council: Maroochydore.

The Courier Mail (2011). Dangerously unprepared. *The Courier Mail,* 29 January, pp. 62-63.

Vasey-Ellis, N. (2009). Planning for climate change in coastal Victoria. *Urban Policy and Research,* 27(2), pp. 157-169.

Walker, J. and Bita, N. (2011). Summer of fury exposes planning failures. *The Weekend Australian,* Inquirer, 12-13 February, p. 8.

Walsh, K.J.E., Betts, H., Church, J., Pittock, A.B., McInnes, K.L., Jackett, D.R. and McDougall, T.J. (2004). Using sea-level rise projections for urban planning in Australia. *Journal of Coastal Research,* 20, pp. 586-598.

Wang, X., Stafford Smith, M., McAllister, R.R.J., Leitch, A., McFallan, S. and Meharg, S. (2010). *Coastal Inundation under Climate Change: A Case Study in South East Queensland.* Report for South East Queensland Climate Adaptation Initiative, CSIRO.

Waterman, P. (2009). Demonstrating 'climate proofing' for coastal local government authorities and communities in the South East Queensland and Burnett-Mary regions. Proceedings of the Queensland Coastal Conference 2009, 12-15 May, Sea World Resort, Gold Coast.

Waterman, P., Chapman, S., Sargent, S., Laves, G., English, K and Morvell, G. (2009). Climate proofing as a regional development Strategy. SEGRA 2009 Conference. Online version accessed16

November 2011, http://www.segra.com.au/pdf/PeterWatermanRefereedPaper.pdf.

Westcott, G. (2004). The theory and practice of coastal area planning: Linking strategic planning to local communities. *Coastal Management,* 32, pp. 95-100.

Williams, B. (2011). Plan to tackle rising sea fear. *The Courier Mail,* 8 April, p. 21.

Zeppel, H. (2011). Planning for climate change by Queensland coastal councils. Proceedings of the 20th NSW Coastal Conference, Tweed Heads, 8-11 November 2011. Online version accessed 15 May 2012, http://www.coastalconference.com/2011/papers2011/Heather%20Zeppel%20Full%20Paper.pdf.