What's the magic number – How can councils consider and plan for rising sea levels?

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Abstract

Key words: sea level rise, climate change adaptation, coastal councils

As the impacts of sea level rise become widely accepted and understood, the need for coastal councils to demonstrate that they are preparing themselves and their communities for rising sea levels has become critical. Throughout Australia a number of different strategies and benchmarks have been prepared to assist councils in planning for, and adapting to rising sea levels. In NSW the introduction of the NSW draft Sea Level Rise Policy Statement and Technical Note in early 2009 has required councils to consider two benchmarks of 40 cm and 90cm for the planning horizons of 2050 and 2100 respectively. The potential impacts of these scenarios and capacity to address sea level rise varies considerably amongst coastal councils. In comparing strategies applied throughout Australia, this paper discusses some of the issues and needs faced by coastal councils in NSW when addressing the potential ramifications of sea level rise within traditional coastal management strategies of retreat, accommodate and protect.

1. Background and Context

1.1 Introduction

As the impacts of sea level rise become widely accepted and understood, the need for coastal councils to demonstrate that they are preparing themselves and their communities for rising sea levels has become critical. As a result policy makers, planners and coastal managers currently find themselves at the beginning of an unavoidable and necessary steep learning curve in responding to the impacts of climate change with little previous experience upon which to draw (Rigby 2005). Of immediate concern to councils is the appropriate level of consideration given to the cumulative impacts of sea level rise with extreme climate events on existing and future developments and then importantly how to effectively consider these within existing statutory and regulatory contexts (Lipman and Stokes 2003, McDonald and England 2007).

Managing the impacts of climate change including sea level rise is likely to be a costly activity for coastal communities and the spheres of Government that serve them. At present natural hazards are estimated to cost tax payers in NSW around $200 million a year in mitigation and response activities (Australian Department of Climate Change 2009). Along the NSW Coastline it is estimated that more than 200,000 buildings are vulnerable to the impacts of sea level rise and coastal inundation resulting from climate change. Within Sydney a sea level rise of just 20 centimetres together with a 1 in 50 year storm surge could push the coastline at Narrabeen back by 110 metres and cause local damage of around $230 million (Australian Department of Climate Change 2009).

Local governments are situated at the 'coal face' of the impacts likely to be felt by their constituents. There is an increased realisation that failing to respond adequately to climate change may expose local councils to voter dismay and potential legal liability

(McDonald and England 2007, Ghanem *et al* 2008). However, it is often difficult for councils to decide how to proceed in responding to the threats posed by climate change (Smith *et al* 2008). In light of this, this paper discusses some of the issues and needs faced by coastal councils in NSW when addressing the potential ramifications of climate change including sea level rise within traditional coastal management strategies of retreat, accommodate and protect.

To assist this discussion the paper is structured in the following manner:

1. Background and Context
2. Risk Management Responses
3. Possible Management Options (Retreat, Accommodate, Protect)
4. Discussion and Recommendations

Overall, it is the opinion of the authors that immediately deciding on a specific sea level rise number or scenario is important. But equally important is defining the processes and information required to allow for the consistent consideration and planing for rising sea levels by councils throughout NSW. This acknowledges that existing management and legislative processes have limited flexibility for integrating changing sea level rise numbers or benchmarks.

1.2 Coastal Management Structures in Australia and NSW

Management of the Australian coastline is the combined responsibility of all three spheres of government, with the majority under state and local jurisdiction. The overall role of the Commonwealth in the coastal zone is constitutionally limited, but it does play a significant role in the areas of funding both State and Local Governments as well as the implementation of international treaties. In Australia, it is the states that retain the legislative base for coastal planning and management, with local decision-making the responsibility of councils (Haward 1995, Thom 2003).

With specific reference to coastal management in New South Wales, there are a number of laws, regulations and policies that potentially apply to a council's activities in the coastal zone. This legislative framework currently provides councils with little prescriptive guidance as to how to respond the impacts of climate change including sea level rise.

Much of the day to day management associated with beaches, coastal areas and land use planning reside with local government. Local councils are responsible for local environmental planning and development approval under the *Environmental Planning and Assessment Act (1979),* the preparation of Coastal Zone Management Plans under *the Coastal Protection Act (1979)*, as well as the management of community land, including most beaches under the *Local Government Act (1993).* However the State also has clear responsibilities in policy/planning, natural resource management, as well as emergency management (Thom 2003).

The coastal zone management framework in NSW comprises four main aspects:

a) The legislation that applies, such as the *Coastal Protection Act 1979*.
b) The applicable State Government policies such as the *Coastal Policy 1997* and the *Coastal Hazards Policy 1988*.
c) The planning and management mechanisms available, like the process outlined in the *Coastline Management Manual 1990.*
d) State Government funding and advice programs such as the Coastal Management Program.

At present this framework provides councils with very little prescriptive guidance in relation to local management of the impacts of climate change including sea level rise. (NSW Environmental Defenders Office 2008).

1.3 Difficulties of considering Climate Change Impacts including Sea Level Rise in the NSW Planning System

The main law regulating land use in NSW is the Environmental Planning and Assessment Act 1979 (EP&A Act). The Act provides the framework and procedures within which environmental Planning Instruments (EPIs) are made. These EPIs then guide the processes of development assessment and regulation of competing land uses (Farrier and Stein 2008). The primary EPI used to guide planning and decision making at the local (i.e. council) level is the Local Environment Plan (LEP).

At a local level, the planning system (via the EP&A Act and specific LEPs) relies on a number of controls that designate a set of certainties to land use such as:

- The allowable use of the land (such as zoning controls)
- The intensity to which such land may be used for a certain purpose (development standards, common examples are height and floor space restrictions).
- Identification of land affected by natural hazards such as bushfire prone land, contaminated land, landslip, acid sulfate soil affectation etc.

Amongst other things, a stated objective of the EP&A Act is the "promotion and coordination of the orderly and economic use and development of land". This objective is often balanced against other stated objectives and considerations borne out of the relevant provisions of LEPs. This sometimes may compel decision makers to make value judgments across a broad range of sometimes competing issues including management of natural hazards, environmental protection, economic development and social harmony.

A common criticism of the NSW planning system is that it tends to lack certainty, especially for those wishing to undertake development of land for a specific use or purpose. Environmental policy writers and decision makers may however argue that the current NSW planning system provides as much certainty as is practically able, without derogating any potential for flexibility or merit considerations.

When considering the long term impacts of sea level rise and climate change, it is unusual for planning schemes to anticipate changed conditions decades into the future. The usual mechanism for planning schemes to deal with changing land uses or community expectations is to update the planning scheme periodically to recognise new conditions or desired outcomes (Attwater et al. 2008).

In NSW the introduction of the NSW draft Sea Level Rise Policy Statement and Technical Note in early 2009 is proposing to require councils consider two benchmarks of 40 cm and 90cm for the planning horizons of 2050 and 2100 respectively. The draft NSW Government Sea Level Rise Policy Statement is an important first step in providing all spheres of government with the necessary guidance to assist the consistent consideration of sea level rise impacts in the coastal, estuarine and floodplain environments of NSW. To ensure consistent and appropriate application of the Policy and benchmarks the NSW Government must immediately work with Local Government in developing an implementation framework and capacity building programs to build the resilience of coastal communities to sea level rise.

Rising sea levels, will put some previously 'approved' developments at risk and force the appropriateness of existing zonings or proposed re-zonings to be reconsidered in vulnerable areas. This will require some form of systemic recognition of expected future change, without precluding beneficial use in the short term and recognising the possibility of and need for appropriate adaptation in the future when conditions change (Attwater et al. 2008).

This issue needs to be clearly addressed within the framework of the NSW planning system in such a manner that provides some level of certainty for land owners, environmental decision makers and the wider coastal community. The key elements of such a response to the impacts of climate change including sea level rise would broadly comprise the following steps:

- The identification and assessment of coastal vulnerability;
- Clear mandatory considerations for the assessment of appropriate land use and development; and
- The clear articulation of future contingencies and management options for land that is identified as being vulnerable set to sea level rise.

1.4 Potential Liabilities in Responding to Sea Level Rise

In 2007 the Sydney Coastal Councils Group (SCCG) engaged the NSW Environmental Defenders Office to conduct an audit of legislation and policy instruments at all levels of government in Australia to determine the responsibilities and potential liabilities of coastal councils for climate change. The report found that there were few statutory obligations placed on councils to address climate change. Although provisions were identified that require the consideration of climate change impacts in objects clauses and as matters for consideration, councils retained significant discretion.

This discretion has created uncertainty amongst councils. Therefore the EDO (2008) concluded that there was a clear need for state government guidance and legislative reform that would assist councils in setting benchmarks for strategic planning in relation to coastal hazards, and in providing guidance on when and how to conduct adaptive activities.

One example of a council implementing measures to limit its liability to the potential impacts of climate change can be found in the Byron Bay Shire Council Byron Development Control Plan 2002. This Development Control Plan places strict controls on lands as being under immediate threat from coastal process. In the cases of Parks v Byron Shire Council 2003 and 2004 as well John Van Haandel v Byron Shire Council 2006 the NSW Land and Environment Court has affirmed the strategy of 'planned retreat' as a "best practice approach" (Maddocks 2009).

Court actions involving challenges to decisions on the basis that the decision-maker did not consider the potential impacts of climate change on proposed developments in vulnerable coastal areas are a relatively new phenomenon (Ghanem *et al* 2008). Two such cases, *Walker v Minister for Planning* decided by the New South Wales Land and Environment Court, and *Northcape Properties Pty Ltd v District Council of Yorke Peninsula* heard in the South Australian Supreme Court, have emphasized the need to consider the climate change impacts on coasts when approving new developments (Ghanem *et al* 2008).

2. Risk Management Responses and Possible Management Options

2.1 National Responses to Sea Level Rise

At the State Government level throughout Australia a number of different strategies and benchmarks have been prepared aiming to assist stakeholders including councils in planning for, and adapting to rising sea levels, summarised in Table 1 (SMEC 2009).

In summary, these strategies generally require that specific sea level rise scenarios be considered in policy development and planning. The issue for many planners and councils is how to meaningfully integrate and apply these figures in regulatory and statutory contexts. A recently undertaken survey of all 15 SCCG Member Councils in relation to draft NSW *Sea Level Rise Policy Statement* 2009 found that councils believed that the identified benchmarks needed to be implemented through an endorsed Environmental Planning Instrument (such as a State Environmental Planning Policy) and combined with funding and technical support, not simply articulated in a policy statement with limited direction on the processes for application.

State	Climate Change Adaptation Requirements in State Coastal Planning Policies
South Australia	The Coast Protection Board (2002) has adopted the median sea level predictions of the IPCC as part of its coastal planning policy – 0.3m sea level rise by 2050, and 1 metre sea level rise by 2100. For major developments, the full range of possible climate change impacts should be considered.
Tasmania	Tasmania has developed an approach based on a 1% annual exceedance probability; that is the probability of a high sea-level event having a 1% chance of occurring once or more in any one year (2008). To determine exceedance probabilities Tasmania coastline is classified into a number of 'tidal zones' and sea level rise projections are based on the IPCC's upper emissions scenarios (A1FI). For any given height of a location, the risk of a high sea level event flooding that point can be determined and the risk over time (up to 2100) can also be identified.
Queensland	The *State Coastal Management Plan* (2002) identifies a climate change adaptation principles that should be referenced in coastal planning. In assessing coastal erosion prone areas, a 0.3m rise in sea level over a 50 yr planning period and 0.8m rise in sea level over a 100 yr period should be adopted (2005).
Western Australia	The *State Coastal Planning Policy* (2006) suggests that coastal planning strategies should take into account coastal processes and sea level change. The Policy provides for a benchmark of 0.38m when assessing the potential for erosion on sandy shores.
Victoria	The *Victorian Coastal Strategy* (2008) provides a policy of planning for sea level rise of not less than 0.8m by 2100.
New South Wales	The draft *Sea Level Rise Policy Statement* (2009) indicates a sea level rise benchmark of 0.4m by 2050 and 0.9m by 2100, should be adopted in coastal planning.

Table 1: Summary of Climate Change Adaptation Requirements in State Coastal Planning Policies

It is clear that to ensure certainty and consistent application within each state that the provision of sea level rise benchmarks or sea level rise scenarios needs to be supplemented by the provision of the legislative and management frameworks necessary frameworks and technical guidance. This would ensure the benchmarks are implemented consistently and appropriately by all coastal councils. The provision of benchmarks or sea level rise scenarios without this additional guidance raises a number of questions including but not limited to:

- How potential sea level rise impacts are to be identified, mapped and communicated;
- What activities the benchmarks or scenarios apply to;
- How the benchmarks are to be integrated with other related legislation;
- How proposed developments demonstrate a capacity to not influence coastal processes, coastal access, coastal values and emergency management processes and procedures; and

- How to communicate the benchmarks to residents in vulnerable areas.

For each benchmark or sea level rise scenario to be applied consistently and appropriately requires each State Government to work with councils in identifying information needs and developing an implementation framework and capacity building programs to build the resilience of coastal communities to sea level rise.

2.2 Case studies of Risk Management for Natural Hazards

The case studies below look at the identification and management of natural hazards through the NSW Flood Prone Land Manual and Planning for Bushfire Protection. The aim of this is to examine the legislative, policy and technical frameworks in two New South Wales Government endorsed processes other than those articulated in the NSW Coastal Protection Act, NSW Coastal Policy and NSW Coastal Manual.

Case Study 1: Pittwater Council's Investigation of Climate Change Impacts on Flood Risk Management

Description
The Local Government Area (LGA) of Pittwater is located entirely on a peninsula and covers 125sq km. Its natural features include nine beaches with seven ocean rockpools, headlands and sandstone sea cliffs, natural waterways and native bushland including two National Parks.

Risk Profile
Pittwater is characterised by many small, steep urbanised catchments that are highly susceptible to flash flooding. Additionally, within its LGA Pittwater has many low lying properties close to the ocean, lagoons and estuaries that are affected by flooding from catchments rainfall as well as from tidal and ocean influences. Many properties within the Pittwater LGA presently experience some form of flooding and will be affected by the impacts of climate change including sea level rise including:

- 2,000 properties affected by flooding within the primary floodplain areas.
- 1500 properties affected by the Wave and Tidal Inundation on Pittwater waterway.
- 420 properties affected by coastal hazards.

Overall, about 1 in 5 properties in the Pittwater LGA have been identified as having some form of flood affectation. Therefore, the impacts of increasing ocean levels and increased rainfall intensities associated with climate change pose a significant challenge to Pittwater Council and its community.

Responding to flooding and sea level rise in the Pittwater LGA
The greatest challenge for coastal councils such as Pittwater is "where to start". Pittwater Council is already considering sea level rise in its strategic planning and to some extent in its development assessment process. However, coastal councils, including Pittwater, need to consider how to incorporate the State Government's Sea Level Rise Benchmark into local planning instruments and management plans in the absence of statutory or regulatory underpinning and in the knowledge that the benchmark planning level is highly likely to change in response to improved scientific information.

To assist in this process Pittwater Council has sought guidance from the following sources:

- The Intergovernmental Panel on Climate Change (IPCC);

- The Commonwealth Department of Climate Change and the CSIRO who have provided a more local perspective to the work of the IPCC; and
- The New South Wales (NSW) Department of Environment Climate Change and Water (DECCW) who could provide guidance on how to consider the impacts and ramifications of climate change and sea level rise as part of the Flood Prone Land and Coastal Policies.

As well as gathering information, Pittwater Council has sought a framework to develop, assess, recommend, implement and review adaptation strategies for climate change and sea level rise. Pittwater Council believes the Floodplain Management Process as required by the NSW Government Flood Prone Land Policy, and already used by council in its current Flood Risk Management Strategy, provides the ideal framework and methodology for an adaptation strategy for climate change and sea level rise.

Overall Pittwater Council is currently using its existing Floodplain Management Strategy and the existing framework of the NSW Government Floodplain Management Process as the key to developing, assessing, recommending, implementing and reviewing its adaptation strategies for climate change in floodplain, tidal and coastal areas (Ribbons 2008). This approach provides two clear advantages.

a) It enables councils to consider and manage the potential impacts of sea level rise and climate change using an existing policy and within an existing management framework that already designed to allow for a degree of uncertainty in relation to the timing and extent of extreme events.
b) It also offers councils exemption from liability for advice or action undertaken in relation to flood liable land if their actions are consistent with a plan prepared in accordance with the appropriate management manual under section 733 of the *NSW Local Government Act.* 1993.

Source: Ribbons (2008)

Case Study 2: Planning for Bush Fire Protection

Planning for Bush Fire Protection (PBP) represents the NSW Government's efforts to work jointly with local government and the private sector to link responsible planning and development control with the protection of life, property and the environment. Bush fire is a major challenge for the community. It has been a natural part of the Australian landscape and remains an ever-present threat.

In the period 24 December 2001 to 16 January 2002 bush fires caused the loss of 109 homes across New South Wales, with 40 others being damaged. Losses were particularly severe in Blue Mountains, Penrith, Wollondilly, Shoalhaven and Hawkesbury local government areas. More recently, in 2003, the devastating fires of the ACT severely damaged the suburbs of Duffy and Chapman, with some 500 homes being lost.

The aim of PBP is to integrate bush fire considerations into the NSW development assessment system to provide for the protection of human life (including firefighters) and to minimise impacts on property from the threat of bush fire, while having due regard to development potential, on-site amenity and protection of the environment.

More specifically, the objectives are to:

i. afford occupants of any building adequate protection from exposure to a bush fire;
ii. provide for a defendable space to be located around buildings;
iii. provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;

IV. ensure that safe operational access and egress for emergency service personnel and residents is available;
V. provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ); and
VI. ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting).

The response of the NSW Government to the mitigation of bushfire impacts on life and property provides an insight into the type of framework that can be applied to address natural hazards. Admittedly each natural hazard is unique and presents its own form of challenge, however the NSW Government response to the impacts of bushfires on effected communities provides the type of prescriptive and endorsed process that many coastal councils are seeking as they respond to sea level rise.

PBP provides a number of significant benefits that would aid coastal councils in their response to sea level rise:

- A process that results in the consistent identification and mapping of risk throughout NSW;
- The explicit requirement for councils to provide risk information on section149 (planning certificates) to properly identify bushfire prone land;
- A prescriptive process that incorporates mandatory considerations for councils in relation to any development in relation to land effected by specific environmental hazards;
- The incorporation of integrated approval requirements for certain types of development of bush fire prone land which in gives joint consent power to the a specified NSW Government department or agency;
- Provision of clear options and parameters for development of bush fire prone land and detailed guidance with regard to the following issues:
    (i) Risk management and reduction techniques for property.
    (ii) Design and construction requirements and techniques for development within bushfire prone areas.
    (iii) Supported by the BCA and Australian Standard 3959 – Construction of buildings in bushfire prone areas.

Source: NSW Rural Fire Service (2006)

Both of these case studies highlight the value of councils being provided with an endorsed process for assessing and managing natural hazards. The provision of such guidance ensures that the risk assessment is undertaken consistently by all relevant councils. In the case of PBP it has resulted in an accepted and transparent process that also assists in the communication of risk to residents and the community more broadly.

It should be noted that unlike the preparation of bushfire prone land maps, the preparation of Floodplain Management Strategies in not compulsory for councils containing flood liable land in NSW. The incentive for councils to implement the NSW Government Floodplain Management Process relates to councils being exempt from liability for advice or action undertaken in relation to flood liable land if their actions are consistent with a plan prepared in accordance with the appropriate management manual under section 733 of the Local Government Act (Ribbons 2008).

In the case of the Floodplain Management Process as required by the NSW Government Flood Prone Land Policy it is the responsibility of individual councils to define their flood prone lands. Under the bushfire risk management process in NSW, councils must prepare and fund bushfire prone lands maps for their LGA in accordance with the

guidelines prescribed by the NSW Rural Fire Service (Planning for Bushfire Protection 2006). This approach is strongly supported by the authors.

Based on both case studies, the authors propose for discussion, the following process (outlined in Figure 1) for the integration of sea level rise considerations into the strategic planning and development assessment actions of coastal councils. Recognising the value of working within an existing process and framework, Figure 1 uses the Coastal Management process as articulated in the NSW Coastal Protection Act and NSW Coastal Manual with additions taken from the Planning for Bush Fire Protection framework.

The aspects drawn from Planning for Bush Fire Protection are:

1. Through the NSW Sea level Rise Policy Statement the Minister directs councils to assess the potential risk of assists in the LGA and provides councils with a prescribed framework with supporting funding for identifying, assessing and mapping sea level rise risk. Once done by all councils this would result in consistent sea level rise maps for NSW.
2. In consultation with their communities, councils consider the appropriate short and long term management options for areas effected by sea level rise in the LGA. This should take into account a cost benefit analysis and feasibility of proposed options.
3. To ensure the consistent application, the NSW Coastal Protection Act and Environmental Planning and Assessment Act be amended to provide the following:
    - A requirement for councils to provide information on s149 (planning certificates) for properties affected by sea level rise risk in the short to medium term (up to 2050). Properties predicted to be effected by longer term sea level rise (up to 2100) would require notification through s149(5) (planning certificates)
    - Mandatory DA consideration requirements in the EP&A Act which :
        (i) Require integrated approval for certain types of development of land effected by sea level rise
        (ii) Provide mandatory development assessment considerations for councils in relation to any development in relation to land effected by sea level rise
    - The provision of clear options and parameters for development of land effected by sea level rise which give detailed guidance with regard to the following issues:
        (i) Risk management and reduction techniques for property
        (ii) Design and construction requirements and techniques for development within land affected by sea level rise. Delivered via neighborhood or precinct based Development Control Plans.
    (iii) Supported by the BCA and relevant Australian Standard for construction.

Adapting to climate change in the coastal zone will have a number of financial, environmental and social costs that will need to be balanced. Therefore an open and transparent discussion with local communities as well as Local, State and Commonwealth Governments on the management and funding arrangements required to ensure coastal communities are resilient to the impacts of climate change in the long term is required. These have been described in Figure 1 as transitional arrangements.

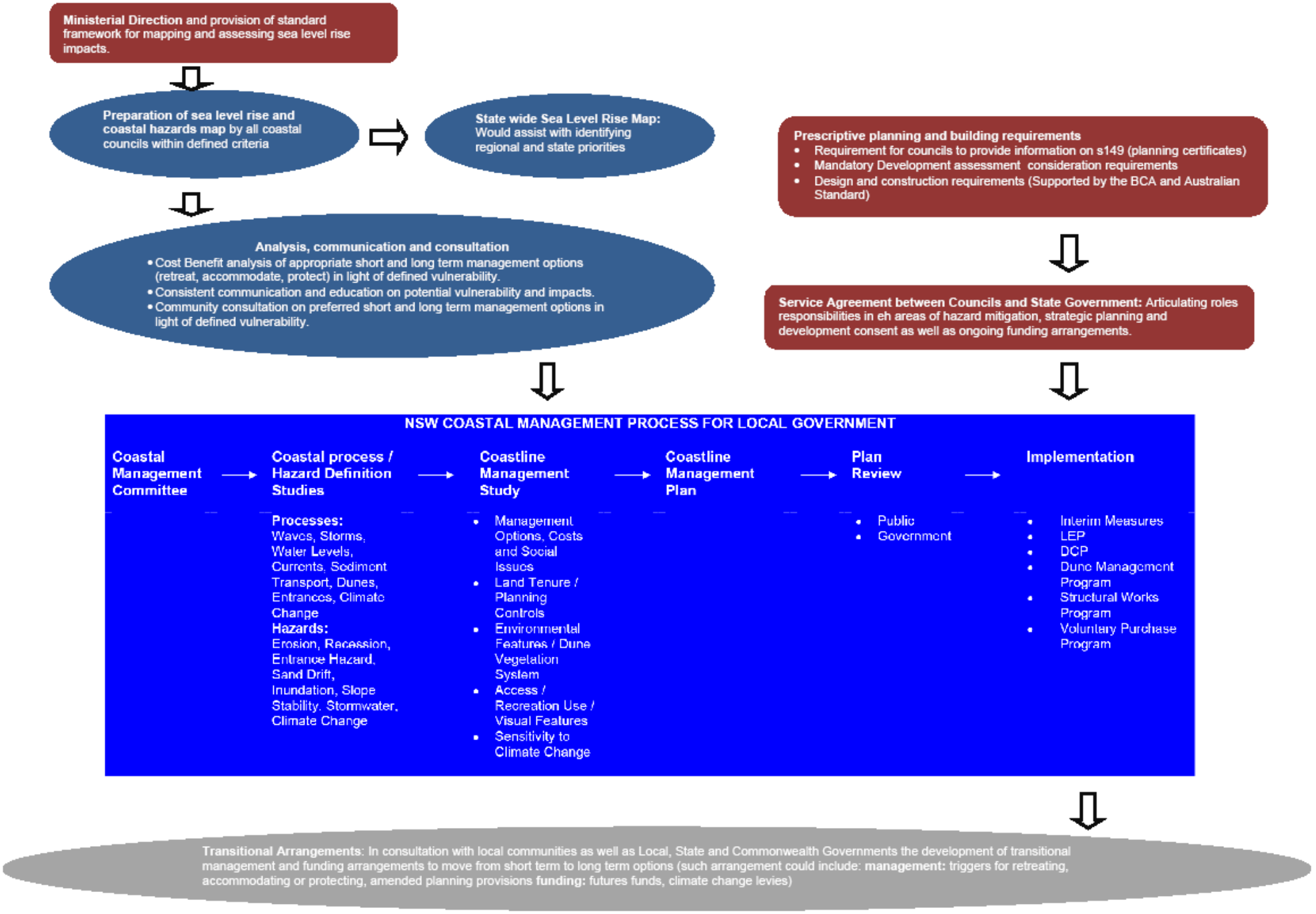

Figure 1: A Framework for integrating sea level rise in the NSW Coastal Management Process

3. Possible Management Options (Retreat, Accommodate, Protect)

Once the level of risk and potential impacts of sea level rise have been identified, there are a number of traditional coastal management responses that can be applied singularly or collectively in response. Engineers Australia (2004) identifies three possible strategies, retreat, accommodate, protect for which most options can be categorised into. Tables 2, 3 and 4 provide a summary of the mechanisms for achieving each of these.

This section of the paper does not aim to provide all potential actions that fit into the categories of retreat, accommodate or protect. However, it does aim to identify some of the information needs, decision making tools and communication strategies councils require in selecting and applying each strategy within their risk management, strategic planning, development assessment and communication activities. The implementation of each of these strategies singularly or in combination with one or two of the others will have a number of short and long costs and benefits that must be understood and considered prior to a strategy being selected.

Retreat
Recognising that sea level rise over the next century and beyond is inevitable, application of the precautionary principle suggest that planned retreat offers a long term adaptation response to the inevitable impacts of shoreline recession and inundation (Engineers Australia 2004). Table 2 summarises some of the costs and benefits of implementing a retreat strategy in response to climate change.

Accommodate
The strategy of accommodating climate change impacts and sea level rise is another strategy available to policy makers where planned retreat is not practical or desired the local community. In accommodation the emphasis is on maintenance of natural processes with the continued occupancy and use of vulnerable area (Engineers Australia 2004). Table 3 summarises some of the costs and benefits of implementing an accommodate strategy in response to climate change. In must be recognised that in many locations accommodating sea level rise will only be a short to medium term strategy as rising sea levels prevent safe access or the provision of essential services.

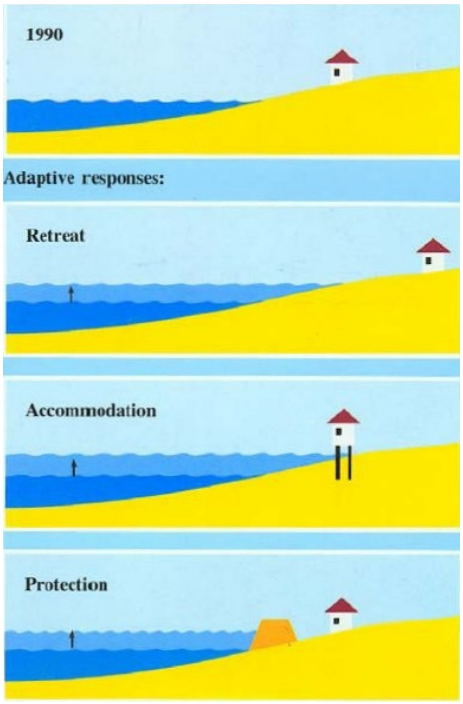

Figure 2: Traditional coastal management responses to erosion and inundation.

Protect
Where retreating or accommodating in response to the impacts of climate change are not considered appropriate due to the cost or practicalities of relocation and a desire for protection of valuable coastal assets a strategy for protection is required (Engineers Australia 2004). Table 4 summarises some of the costs and benefits of implementing a protection strategy in response to climate change.
In relation to the impacts of climate change including sea level rise the financial costs and limited availability of building resources, including sand, will play a significant role in the determination of protection as a long term option.

Retreat **Aim:** Instigate measures to minimise the costs of changing land-use once threatened by coastal hazards and climate change impacts.			
Emphasis:	**Implementation Mechanisms:**	**Costs**	**Benefits**
Relocation or abandonment of land and structures in highly vulnerable areas and resettlement of residents	• building structures that are capable of relocation or may be acceptably sacrificed, • prevention of further 'fixed' development, • leaving land and resources unprotected, • applying easements or planning zones to allow for rolling change of land-use as it becomes affected by coastal hazards and climate change impacts, • prohibiting 'high value' developments and infrastructure in vulnerable areas in • favour of low cost activities (such as recreation) • locating major roads and key community infrastructure away from the coast with sacrificial connecting roads to vulnerable areas, • retaining public coastal land in public ownership, • preventing high value development in vulnerable areas, • requirement for disclosure of hazards in real estate transactions and property titles.	• the lost value of land, resources, social, economic and environmental values, • the opportunity costs of development that may have occurred under another option, • potential compensation claims for loss of land, infrastructure and access to resources.	• maximises options for future management and planning in the coastal zone, • allows for some short to medium term utility of vulnerable areas, • prevention of costly adaption measures in the future should the vulnerability of an area increase. • maintenance of coastal processes and retention of coastal amenity and public access.

Table 2: Implementation mechanisms, costs and benefits of retreat strategies (Adapted from Engineers Australia 2004)

Acoomodate **Aim:** Formulate measures that allow continued or extended use of vulnerable land and resources.			
Emphasis:	**Implementation Mechanisms:**	**Costs**	**Benefits**
On maintenance of natural processes with the continued occupancy and use of vulnerable area.	• preparation of emergency evacuation plans to reduce the human consequences of major storms and inundations, • raised buildings and infrastructure in areas prone to inundation and flooding, • requirement for disclosure of hazards in real estate transactions and property titles, • creation of government flood and hazard insurance, • creation of land use and development setbacks.	• additional construction costs, • cost of loss or damage which does occur, • opportunity costs of development which may otherwise have occurred, • costs of establishing and administering insurance policies or compensation funds to be shared across the community.	• allows for short to medium term use of land and resources in areas that are vulnerable to some/infrequent climate change impacts, • attempts to accommodate natural processes whilst also facilitating some development and resource use, • able to focus safety and prevention on priority areas without involving the same costs as full protection measures.

Table 3: Implementation mechanisms, costs and benefits of accommodate strategies (Adapted from Engineers Australia 2004)

Protect **Aim:** Shield areas from relevant climate change impacts & identified hazards.			
Emphasis:	**Implementation Mechanisms:**	**Costs**	**Benefits**
On defence of vulnerable areas, population centres and infrastructure	• Hard structural options, such as: dykes, levess, flood barriers, sea walls (both rock and sand bag), revetments, groynes; and saltwater intrusion barriers. • Soft Structural options, such as: beach nourishment; dune restoration; wetland creation; littoral drift make-up and afforestation.	• construction costs & commitment to ongoing maintenance, • permanent loss of aesthetic and natural values, • loss of marine and coastal habitats, • impact on areas where materials (such as sand for beach nourishment) are extracted, • impact on adjacent environs, which would have received sand, had it not been artificially constrained elsewhere, • potential loss of access to intertidal areas.	• facilitates the continuation of important industry and resource use, • enables 'high value' developments and properties to remain in the short and medium terms, • enables areas of high social, cultural, indigenous and heritage values landward of defenses to be preserved, • allows for the preservation of high value biodiversity, habitats and ecosystem functions landward of the protective structure • facilitates continuous recreation and public access of popular areas.

Table 4: Implementation mechanisms, costs and benefits of protect strategies (Adapted from Engineers Australia 2004)

The choice of strategy will depend on the circumstances of the threat, vulnerability and capacity of those affected to respond, community attitudes and willingness to pay must also be taken into account. Effective response will significantly reduce the total economic, social and environmental cost to communities. Each of the strategies has a number of costs and benefits when considering their implementation in the contexts of zoning and land uses (where can I build), planning and approvals (what can I build), and building approvals (how can I build it).

Before a decision can be made on which of these is the most appropriate the authors believe following information is required:

- A clear vision for the desired characteristics and intended land uses of local and regional coastal areas beyond 2100;
- An understanding of community attitudes and support in relation to selected adaptation responses;
- The scenario for which potential risk is being assessed against;
- The expected regional and LGA specific impacts of sea level rise and associated coastal process issues;
- Information on existing and future land uses within an LGA;
- The capacity of existing infrastructure to manage the impacts of climate change;
- A cost benefit analysis and comparison of the possible strategies;
- Funding strategies and timeframes for the implementation of the selected management options.

Once this information is presented to coastal communities for their consideration and consultation on their chosen management response the appropriate short and long term governance structures can be put in place to build climate change resilience. Ultimately coastal communities must be responsible for selecting their preferred management response within a consistent risk identification and communication framework that engenders an understanding of short, mid and long term management responses, their costs and outcomes.

4. Discussion and Recommendations

Councils can't afford and communities won't accept climate change adaptation to be done in an ad-hoc fashion (Morrison *et al* 2008). Additionally climate change adaptation will not be achieved efficiently of effectively if considered on a site by site basis. Although there is considerable concern amongst local councils about their responsibilities and liability for climate change, the current coastal zone management framework in NSW provides limited guidance on how to consistently conduct adaptation activities to protect their communities from coastal impacts, and to minimise their legal liability (Ghanem *et al* 2008, Morrison *et al* 2008). Therefore the statutory framework must be amended to clarify the responsibilities of councils and to provide more guidance to councils as to how potential climate change impacts should be addressed.

There is a clear need for specific Federal and State Government guidance to assist councils in setting benchmarks for strategic planning in relation to coastal hazards, and in providing guidance on when and how to conduct adaptive activities that address climate change risks in the coastal zone. The authors of this paper believe that the following issues must be addressed:

1. The lack of a clear framework for integrating sea level rise into planning and decision making.
2. The need for ongoing technical and policy support in selecting, implementing and maintaining the most appropriate adaptation response underpinned by consistent mechanisms for the disclosure of risk.

4.1 The development of a prescriptive framework for integrating sea level rise in planning and decision making

A number of publications including Lipman and Stokes (2003), Buckley (2007) as well as McDonald and England (2007) draw the conclusion that councils across Australia require greater statutory and regulatory guidance from their State Government partners in relation to climate change impacts including sea level rise. The Pittwater Council Flood Mitigation and NSW Planning for Bushfire Protection case studies discussed in this paper highlight two important points:

1. It will be easier for councils to consider and plan for the impacts of climate change including sea level rise utilising existing risk management frameworks such as the NSW Coastal and Estuary or Flood Prone Land Management process. These processes already allow for a degree of uncertainty in their identification of risk and designation of management strategies. Additionally, the consideration of climate change impacts within these frameworks facilitates consideration of its impact on existing natural hazards.

2. A prescriptive policy process that results in uniform assessment of risk and communication of management activities would assist in consistent implementation and broad stakeholder acceptance. Further, an endorsed risk assessment and management process would offer councils the guidance and legal protection they desire.

The authors believe that the framework articulated in Figure 1, if implemented would offer each of these things.

Another arrangement articulated in Planning for Bushfire Protection that could be replicated in NSW Coastal Management processes is the development of service agreements between individual councils and most appropriate NSW Government Agencies articulating the services and assistance to be provided to councils and funding arrangements. This would clearly articulate the roles, responsibilities and levels of financial and technical support necessary to implement a consistent and effective coastal management response to the impacts of climate change including sea level rise.

4.2 Technical and policy support in selecting, implementing and maintaining the most appropriate adaptation response underpinned by consistent mechanisms for the disclosure of risk.

Increasing the resilience of coastal communities to climate change will be a costly process that will inevitably involve the loss of some natural and built assets in the coastal zone. It is too early in this debate to be nominating specific long term responses within the traditional coastal management triage of retreating, accommodating or protecting. Before the appropriate level of public consultation and consideration of management responses can be made additional information including but not limited to potential impacts, a cost benefit analysis and comparison of the possible strategies and an understanding of community attitudes and support in relation to priority sites and selected adaptation responses is required.

The availability of this information needs to be underpinned by consistent education and communication strategies. This information will allow local communities to define their vision and preferred management options within a regional context and state wide framework.

It is likely that local adaptation actions will have environmental and economic impacts that are felt regionally or even state-wide. Therefore councils must be supported in this process through the provision of technical support and guidance. The authors believe the simplest mechanism for achieving this would be increasing the funding to the NSW Coastline, Estuary and Floodplain management programs. This would result in enhanced personnel and associated expertise

within the NSW Government and ensure the necessary technical and engineering advice is provided to all councils and other coastal land managers in NSW.

4.3 Recommendations

The authors of this paper believe that the following actions would assist in providing coastal councils in NSW the necessary guidance:

- The development of specific statewide guidance for the identification and mapping of climate change impacts including sea level rise for coastal, estuarine and flood prone lands.
- Considering sea level rise impacts in environmental planning must become mandatory and underpinned by a prescriptive framework.
- Standard tools for the communication of climate change impacts and disclosure of specific risks must be developed.

The development of specific statewide guidance for the identification and mapping of climate change impacts including sea level rise for coastal, estuarine and flood prone lands. Once this guidance is complete councils in partnership with the State Government would be instructed to undertake the necessary assessment mapping, within an specified timeline, with technical and policy guidance from the appropriate State Government agencies. This action would result in the development of consistent coastal hazard and sea level rise risk map that extents the length of the NSW coastline from the Queensland to Victorian borders. Allowing for the identification or regional and statewide hotspots and priorities.

Such guidelines would result in endorsed hazards maps that are consistent and assist in setting local, regional and statewide adaptation responses. The development of consistent sea level rise risk maps throughout NSW to specified criteria would ensure decisions based on these maps are defensible and able to be communicated to residents consistently and transparently. Ultimately such maps are required to provide the desired certainty for future development and investment at the industrial, commercial and residential scales.

Considering sea level rise impacts in environmental planning must become mandatory and underpinned by a prescriptive framework.

At present councils in NSW are given considerable scope in the manner and degree to which they consider the impacts of climate change and sea level rise in their strategic planning and development assessment activities (Ghanem *et al* 2008, Morrison *et al* 2008). As sea level rise is inevitable all levels of government will be forced to demonstrate a duty of care in reducing its impacts on communities (McDonald and England 2007).

The most efficient and appropriate process for achieving this would be adapting the process and lessons learnt in the development of Planning for Bush Fire Protection. The framework articulated in Planning for Bush Fire Protection that clearly defines the roles of both the NSW Government and councils in identifying and mitigating bushfire risk provides a good model. In response to the impacts of climate change including sea level rise the following aspects of Planning for Bush Fire Protection must be applied to the NSW coastline, estuary and floodplain management processes.

The development and implementation of such activities would provide councils with a defensible process for managing and communicating potential risk to affected residents. It would also assist in the consistent assessment of development applications potentially effected by sea level rise.

The NSW Government should demonstrate leadership in providing the required statutory framework for the mandatory consideration of climate change impacts including sea level rise in

environmental planning. If this action is not undertaken, councils and communities will be forced to bear the cost of a range of negative outcomes including:

- Potential litigation;
- Increasing emergency response costs;
- Remediation of the natural environment;
- Increasing cost or loss of social services;
- Loss of community support and trust for the decision making frameworks; and
- Loss of coastal amenity and access.

Standard tools for the communication of climate change impacts and disclosure of specific risks must be developed

Local communities will need to support and take ownership of local adaptation responses. To assist this, councils require consistent messages and communication tools for engaging residents about coastal sustainability and climate change vulnerabilities. The development of tools and strategies for a wide range of audiences would ensure this is done consistently and appropriately. The development of centrally available risk disclosure education tools and engagement strategies for a wide range of audiences by the Commonwealth Government would achieve this. Such tools could be used by all coastal managers to raise public awareness of the impacts and management strategies associated with climate change and sea level rise.

Conclusion

In closing, the impacts and public policy implications of climate change and sea level rise will extend beyond boundaries, jurisdictions and responsibilities. Therefore adaptation responses will need to occur within a framework that allows for local solutions as well as the consistent identification, communication and mitigation of risks. At present such guidance is not provided to councils managing coastal, estuarine or flood prone lands in NSW.

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