ACCARNSI DISCUSSION PAPER – NODE 1 COASTAL SETTLEMENTS

The Economic Value of Natural and Built Coastal Assets

Part 2: Built Coastal Assets

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This paper was motivated by the Australian Federal Government climate change adaptation initiatives. The authors are members of the Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI), one of eight networks within the National Climate Change Adaptation Research Facility (NCCARF)

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THE ECONOMIC VALUE OF NATURAL AND BUILT COASTAL ASSETS.

Both natural and built coastal assets are under increasing pressure from a growing population and also from the projected impacts of climate change. There is a need to better understand how much these assets are worth to the society and also how these assets might be at risk from diverse and dynamic pressures, both current and future. This paper is a review of the existing available literature and research around the issue of economic valuation of built assets in our coastal zones. The paper builds on a previous publication on economic evaluation of natural assets (Part I). Part I provided a brief overview of environment economic valuation techniques and a discussion of several economic assessments covering a range of coastal ecosystems and uses: coastal and marine ecosystems, marine parks, beaches (including visitation – residential and tourism, and surfing), coral reefs, coastal lakes and the intertidal zone (wetlands, salt marshes, mangroves, estuaries and seagrass).

The current paper (Part II) reviews recent reports and assessments that provide valuation of a range of built coastal assets (infrastructure) which in many cases is linked to the risks of climate change. The assets discussed in this paper include:

- value of industry, transport, commercial property and residential property
- surf life saving clubs
- services such as water infrastructure and electricity
- coastal assets managed by local government
- coastal protection measure such as beach nourishment as an indication of value of the infrastructure protected
- marine industry
- ports

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PART II: BUILT ASSETS

1.0 INTRODUCTION

Over 85% of the Australian population currently live within the coastal zone[1] (ABS, 2002). This number is projected to increase with rapid population growth and movement (seachange) occurring in many of our coastal cities and towns. Population growth and the increase in the need for infrastructure and services go hand in hand and will continue to place immense pressure on the coastal zone. There are also high social expectations of the services provided and for the government to continue to provide these services at the rate of demand. There is also the current coastal industry to support and maintain and the extensive natural coastal environment to consider and protect. Finding a balance is of considerable difficulty and understanding the values of both the natural environment and the built environment will assist in the sustainable management of our coastline. Sustainable management will include supporting population growth, maintaining core industries and protecting the natural environment. Techniques to value the natural coastal environment and examples of previous studies have been explored in Part I of this review; this paper (Part II) will focus on the value of the built coastal environment and associated studies and reports that detail values associated with these assets.

Much of the climate change related discussion has highlighted the extensive level of development within our coastal zone, a legacy of past settlement and the reliance on rivers, estuaries and waterways for transport and transfer of goods. The current discussion also highlights the vulnerability of many of our coastal settlements to storms, cyclones and sea level rise and the need to prepare for an uncertain future. There are also issues regarding whether infrastructure assets are situated on public land or in close proximity of private land, which have a significant bearing on how and what management options can be put in place.

The built coastal environment is extensive with diverse ownership. It encompasses a wide range of assets managed by both State and Local Government in additional to commercial enterprise and private property. These assets include for example:

- residential and commercial buildings
- ship terminals, ports and harbours
- service infrastructure related to water, wastewater, stormwater
- service infrastructure related to electricity supply and telecommunications
- bridges
- jetties and fishing pontoons/piers
- boat access points
- navigational channels
- beach protection works such as groynes and seawalls
- sand by-passing and beach nourishment
- surf lifesaving clubs
- public amenities including beach showers
- parks, pathways, board walks and viewing platforms
- beach access ways and fencing

[1] up to 50 km from the coastline

Fletcher and Lord (2011) point out that in many cases it is the public assets that are at the greatest risk as they are commonly situated seaward of the private and commercial development, for example wastewater infrastructure, amenities, car parks, roads and bridges. In many cases, local authorities have responsibility for extensive coastal assets that will be at risk from climate change associated impacts (namely sea level rise and storm tide inundation), which places increasing pressure on resources and funding. Many small local governments manage long lengths of coastline with numerous assets that are highly valued by the community and may not always have the capacity to provide adequate maintenance and protection.

There is also a range of infrastructure that provides essential services that are found within the coastal zone and in some cases on low lying land. These include hospitals, roads, buildings, airports, ports, and schools. In these cases it is not only the infrastructure at risk but the critical services that they provide.

The built coastal environment is highly vulnerable to weather events such as storms and cyclones and in particular when events are combined (for example, intense rainfall and storm surge combined with seal level rise) (ATSE, 2008). With projections of climate change related impacts, e.g. sea level rise and intensification of storms, there are heightened levels of vulnerability that need to be considered in the long term management of current infrastructure and when planning for future developments. In many cases, this may lead to changes in the maintenance schedules and life span of coastal infrastructure and the way in which they have been traditionally managed, in addition to changing costs. The level of vulnerability and risk needs to be linked to the value (both dollar and social values) of the assets and incorporated into the management strategy, whether it is to protect, retrofit or retreat. In terms of protecting coastal assets, the benefits from the avoided damage must outweigh the costs of protection and take into consideration the eventual loss of the intertidal environment (Frankhauser, 1995).

These options therefore require careful consideration of the environment and potential impacts or losses therein. The 'coastal squeeze' is a very likely outcome for heavily armoured coastlines, where the response of the natural environment to climate change (i.e. landward migration) results in the loss of this environment due to hard structures in place (Schlacher et al., 2007; DCC, 2009). Therefore, maintaining current infrastructure may result in a loss of the surrounding environment and such a loss will have further economic, social and lifestyle impacts. As the impacts of climate change become more evident in the future, the management of our coastline should resemble a series of tradeoffs, which consider both the infrastructure and the environment. In the case of severe impacts from natural events, there may be an opportunity to change the current land use rather than to rebuild in a vulnerable position.

There have been several recent studies describing the vulnerability of the coastline and coastal assets to climate change. The key documents in this discussion have been *Climate Change Risks to Australia's Coast: A First Pass National Assessment* by the Department of Climate Change in 2008 and the supplement document *Climate Change Risks to Coastal Buildings and Infrastructure* released in 2011, these studies will be discussed in further detail in Section 2.1.

Many local government and service providers have also initiated research and assessment of their coastal assets, although due to the sensitivity of the information these are not often publically available. Sydney Water has undertaken extensive assessment of their water infrastructure and services and the potential impacts of climate change, as in many cases their assets are within low lying areas (Allen et al., n.d). The Victorian Government has also initiated a program called The Future Coasts Program which will include an assessment of Victoria's vulnerability to climate change (specifically in terms of coastal erosion and flooding) and the development of a strategy for industry to respond and adapt (State Government of Victoria, 2011).

Depending on the type of asset in question, there are a range of methods used to determine the value of at least some aspects of the asset and the services provided. In many cases it is difficult to quantify the entire extent of the social values provided by these assets.

Some examples of valuation methods include the present value (usually discounted), replacement cost, damages avoided and output value. In the case of a new development, a cost-benefit analysis is usually undertaken to assist in weighing the positive benefits and the negative outcomes of a project. It is commonplace for the asset custodian (such as the local Council) to maintain an asset register that includes the construction cost, replacement cost, maintenance and service schedules and costs. These provide an indication of the value of the asset.

In a changing climate, understanding the vulnerability of coastal assets is paramount for long term planning. The values also provide a better indication of possible insurance costs and how these might change in the future if risks increase for a particular asset under a changed climate. Understanding the value of the built coastal environment can support management and assist in future planning and decision making, particularly as the vulnerability of assets increases because of climate change impacts among other factors.

2.0 Value of built assets

The following section provides a summary the reports and assessments of the value of a range of built coastal assets. This list is not exhaustive and provides examples of the level of information publically available. The types of assets vary and their value can be related to the replacement costs, for example a protective seawall or a beach side park, or the direct economic output value of the industry associated with the infrastructure, such as a coastal port. Furthermore, the value of an asset may be linked closely to the local environment such as the added value of a view to a coastal property or the added protection of intervention within the environment, such as a seawall or beach nourishment. In addition to the dollar value, there are a range of other values including the social, health and lifestyle values offered through the provision of coastal infrastructure. These values are inherently difficult to quantify and therefore the information available is fairly limited.

A number of reports incorporate the risks of climate change to asset value assessments in order to better understand the potential costs associated with increased risks of beach erosion, flooding and storm inundation. For example, Yohe (1989) reported on the measure of economic vulnerability across the US to sea level rise, which included the value of threatened structures, value of threatened property and value of threatened social value.

2.1 Value of transport, industry, commercial and residential infrastructure

The value of transport, industry, commercial and residential infrastructure that is exposed to the risks of climate change has been well documented in a series of reports by the Department of Climate Change and Energy Efficiency (DCC, 2009 and DCCEE, 2011). The reports are based on NEXIS data (Geoscience Australia's National Exposure Information System) and a 'bucket-fill' modelling approach utilising elevation data and erosion and inundation risks associated with climate change: 1.1 m sea level rise in combination with a 1 in 100 year event (Tasmania, Victoria and New South Wales) or high water level (Queensland, South Australia and Western Australia) (DCC, 2009; DCCEE, 2011).

The findings provide a highly useful estimation of the value of coastal infrastructure within the coastal zone that may be exposed to hazards associated with climate change. While this does not provide an exhaustive figure of the full value of all coastal assets, it can be used as a useful indication. Additionally, the figures provided do not include the full extent of the flow-on impacts associated with the loss of these services.

The following includes a summary of the results presented in these reports in addition to general information.

2.1.1 Transport infrastructure

Australia has approximately 810,000 km of roads (including both sealed and dirt roads) (COAG, 2007). Many major roads are found within the coastal zone, both urban arterial links and extensive highways that are integral for connecting Australian communities.

The Department of Climate Change and Energy Efficiency report concluded that coastal roadways within Australia exposed to climate change associated hazards, i.e. on land within 1.1 m of the current sea level, have a 2008 replacement value of $46 - $60 billion (DCCEE, 2011). Western Australia has the greatest length of coastal roadway at risk with a replacement value of $8.7 - $11.3 billion. The value of Queensland's coastal roadway at risk is $9.7 - $12.9 billion with South Australia, Victoria, New South Wales having a replacement value of $7 billion (DCCEE, 2011).

These figures illustrate the value of the extensive road networks within the coastal zone that are vulnerable to climate change. In addition to these specific roads, there are many more within the coastal zone that provide key transport networks for the community and industry.

2.1.2 Rail and Tramways

Australia has 41,000 km of railway track with a range of uses from urban passenger trains, privately owned tracks for sugar cane transport, long distance freight and transport of bulk commodities (cited in COAG, 2007). Those at risk from climate change impacts provide a representation of the rail infrastructure within the coastal zone that will be exposed to sea level rise and associated hazards. They have an overall replacement value of $4.9 - $6.4 billion ($2008) (DCCEE, 2011) and on a state basis:

Queensland	$1.7 - $2.3 billion
New South Wales	$0.6 - $1.3 billion
South Australia	$0.6 - $1.3 billion

Tasmania	$0.6 - $1.3 billion
Victoria	$0.1 - $0.5 billion
Western Australia	$0.1 - $0.5 billion
Northern Territory	$0.1 - $0.5 billion

* 2008 dollars
(DCCEE, 2011)

These figures provide an example of the value, in terms of the replacement value, of the rail infrastructure within the coastal zone and vulnerable to climate change. These figures do not include the flow-on impacts that would occur if the networks were unable to function as a result of extreme events and sea level rise.

2.1.3 Light industrial buildings

A light industrial building is defined as "…one primarily used for warehousing, manufacturing, assemble activities, services…" (DCCEE, 2011 p.6). The light industrial buildings exposed to climate change risks have a 2008 replacement value $4.2 - $6.7 billion nationally (DCCEE, 2011). On a state basis:

Queensland	$1.3 - $2 billion
South Australia	$0.6 - $1.2 billion
New South Wales	$0.8 - $1.1 billion
Western Australia	$0.7 - $1.1 billion
Victoria	$0.5 - $0.8 billion

* 2008 dollars
(DCCEE, 2011)

2.1.4 Commercial buildings

There are an extensive number of commercial buildings within our coastal cities and towns. A look at any major city on a satellite mapping image will show many of the buildings that form a large part of the commercial industry. A commercial building is defined as "… one primarily occupied by businesses engaged in commercial trade, including wholesale, retail, office and transport activities…" (DCCEE, 2011 p.5). The figures below illustrate just a small number of the commercial buildings within the coastal zone, specifically those exposed to the hazards associated with rising sea levels (erosion and storm inundation). At a National scale these buildings have a total replacement value of $58 - $81 billion ($2008) (DCCEE, 2011) and on a state basis:

South Australia	$22 - $27 billion
Western Australia	$12 - $17 billion
Queensland	$10 - $15 billion
Victoria	$8 - $12 billion
New South Wales	$5 - $9 billion

* 2008 dollars
(DCCEE, 2011)

2.1.5 Residential

Residential property forms a significant part of the built environment within the coastal zone and given the current rate of population growth, it will continue to grow. A residential building is defined "…as a fixed structure consisting of one or more residences primarily for housing people…" (DCCEE, 2011 p.9). Again, looking at a satellite mapping image of Australian will highlight the major coastal cities and the many small coastal towns and communities that are spread along the entire Australian coastline.

The value of residential properties is highly dependent on the characteristics of the region and city or town, in addition to the characteristics of each specific property. The value of properties can also be influenced through prices determined through the housing market. Given the extensive residential development of the coastline and the variation between values and prices, it is difficult to quantify the full value to society.

Residential buildings exposed to both inundation and shoreline recession associated with sea level rise have a national replacement value of $51 - $72 billion ($2008) (DCCEE, 2011) and from inundation alone, $41 - $63 billion accounting for 187,000 to 274,000 (DCC, 2009) and 157,000 to 247,600 (DCCEE, 2011) buildings at risk, respectively. Buildings exposed on a state basis have a replacement value of the following (Table 1):

Table 1. Replacement value of residential buildings at risk from climate change impacts (Source: DCCEE, 2011)

State	Replacement Value*	Buildings at risk
Queensland	$15 - $20 billion	44,000 - 68,000
New South Wales	$14 - $20 billion	44,000 - 68,000
Victoria	$8 - $11 billion	31,000 - 48,000
South Australia	$5 - $8 billion	31,000 - 48,000
Western Australia	$5 -$8 billion	20,000 - 30,000
Tasmania	$4 billion	12,000 - 15,000

* 2008 dollars

A study undertaken by Kinrade and Preston (2008) provides further details for property at risk within the Western Port Region of Victoria. Under the worst case scenario of a 1 in 100 year event in 2070, over 1000 properties would be at risk with an improved land value of $780 million.

Another example provided in a socioeconomic assessment of the foreshores at Clarence, south west Tasmania, states that the capital value of residential and commercial properties at risk to climate change within Clarence Council region have an estimated value of $175 million (SGS Economic and Planning, 2007).

These figures provide an indication of the high values associated with residential property within the coastal zone that are vulnerable to climate change.

2.1.6 Sea Level Rise Mapping

A series of sea level rise maps, released by Geoscience Australia, visually highlight the areas of potential inundation under sea level rise scenarios of 0.5 m, 0.8 m and 1.1 m projected between 2030 and 2100. These scenarios are based on the low scenario (B1), medium scenario (A1FI) and high-end scenario developed by CSIRO (Geoscience Australia, 2011). The maps have been developed for all the capital cities of each state including the Gold Coast and illustrate an event that may occur annually or more frequently (Geoscience Australia, 2011). The maps were developed using a bucket-fill modelling approach which considers a static rise and does not include local factors. Despite this, the maps illustrate the extent of the low lying coastal land and the infrastructure within.

The examples below of the Gold Coast and Adelaide (Figures 1 to 6) provide the projected sea level rise inundation maps for the 0.5 m, 0.8 m and 1.1 m sea level rise scenarios. The Gold Coast maps (Figures 1 to 3) represent the northern area of the Broadwater where extensive natural waterways and canal systems occur. These maps highlight that it is not only beaches that are at risk but the extensive waterways, and with the Gold Coast having some 600 km of waterways there are many areas that will potentially be at risk. Additionally, approximately 350,000 people live within 10 m of AHD[2] on the Gold Coast (GCCC, 2010b) and many of these low lying areas will become increasingly vulnerable in the future. Australia, being an island nation, has an extensive coastline and when estuaries, inlets and islands are included it is estimated at over 120,000 km (Thom and Short, 2006 cited in Harvey and Woodroffe, 2008).

Figures 4 to 6 provide the sea level rise maps for Adelaide under a 0.5 m, 0.8 m and a 1.1 m scenario, note the extent of both the commercial and light industrial and residential areas with high vulnerability.

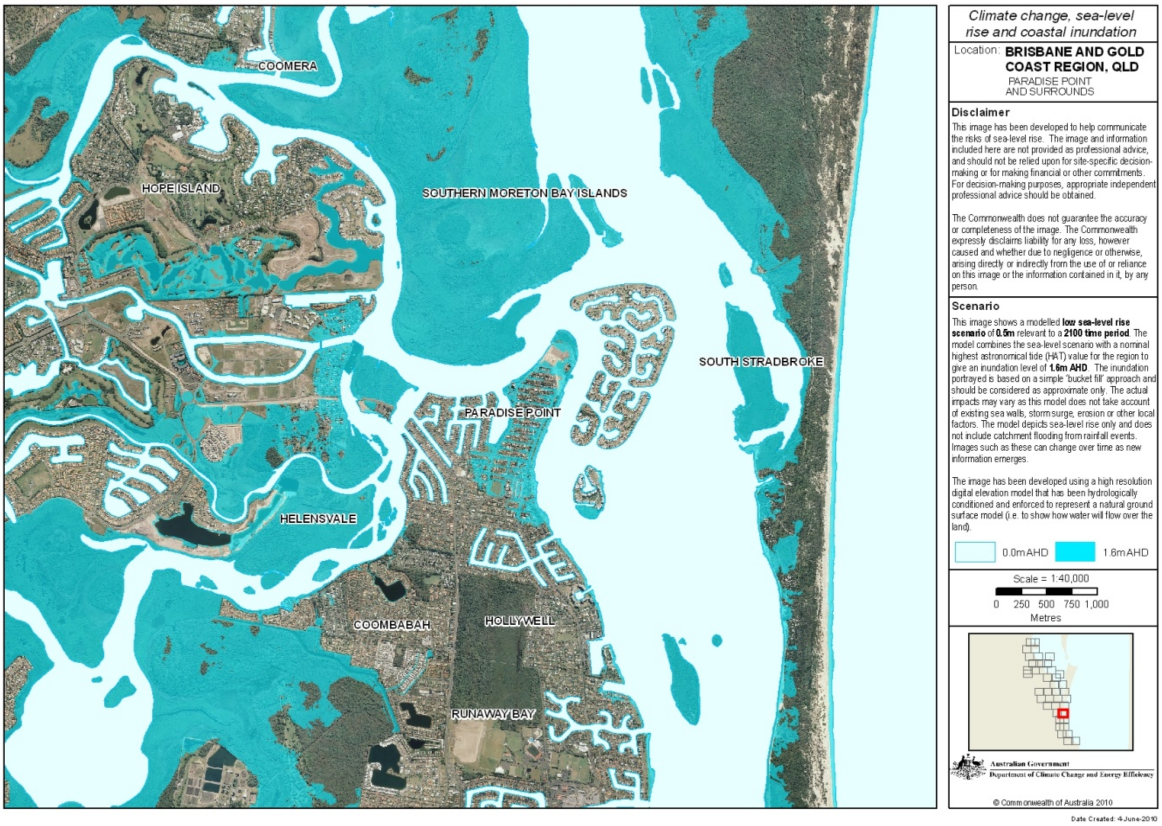

Figure1. Sea level rise inundation within the northern waterways of the Gold Coast for a 0.5 m scenario (low scenario in 2100) (Source: GeoScience Australia).

[2] AHD – Australian Height Datum (See Geoscience Australia: http://www.ga.gov.au/earth-monitoring/geodesy/geodetic-datums/australian-height-datum-ahd.html)

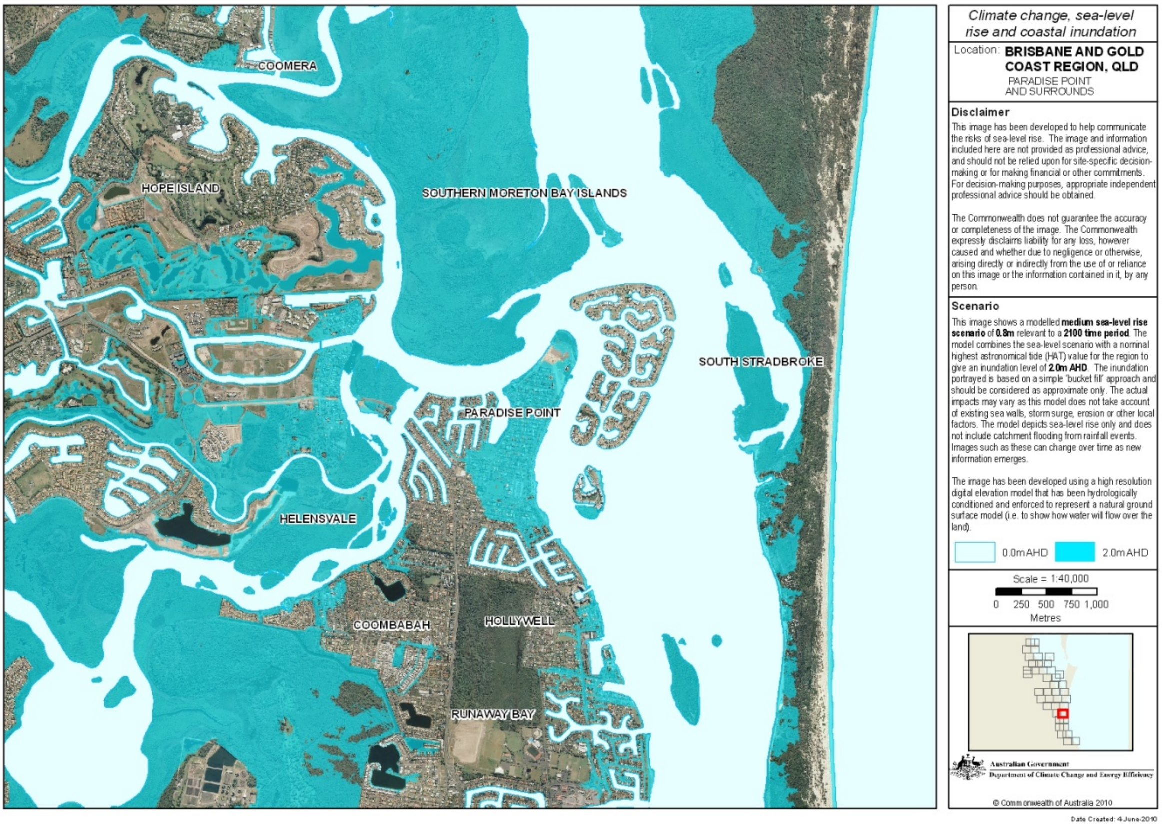

Figure 2. Sea level rise inundation within the northern waterways of the Gold Coast for a 0.8 m scenario (medium scenario in 2100) (Source: GeoScience Australia).

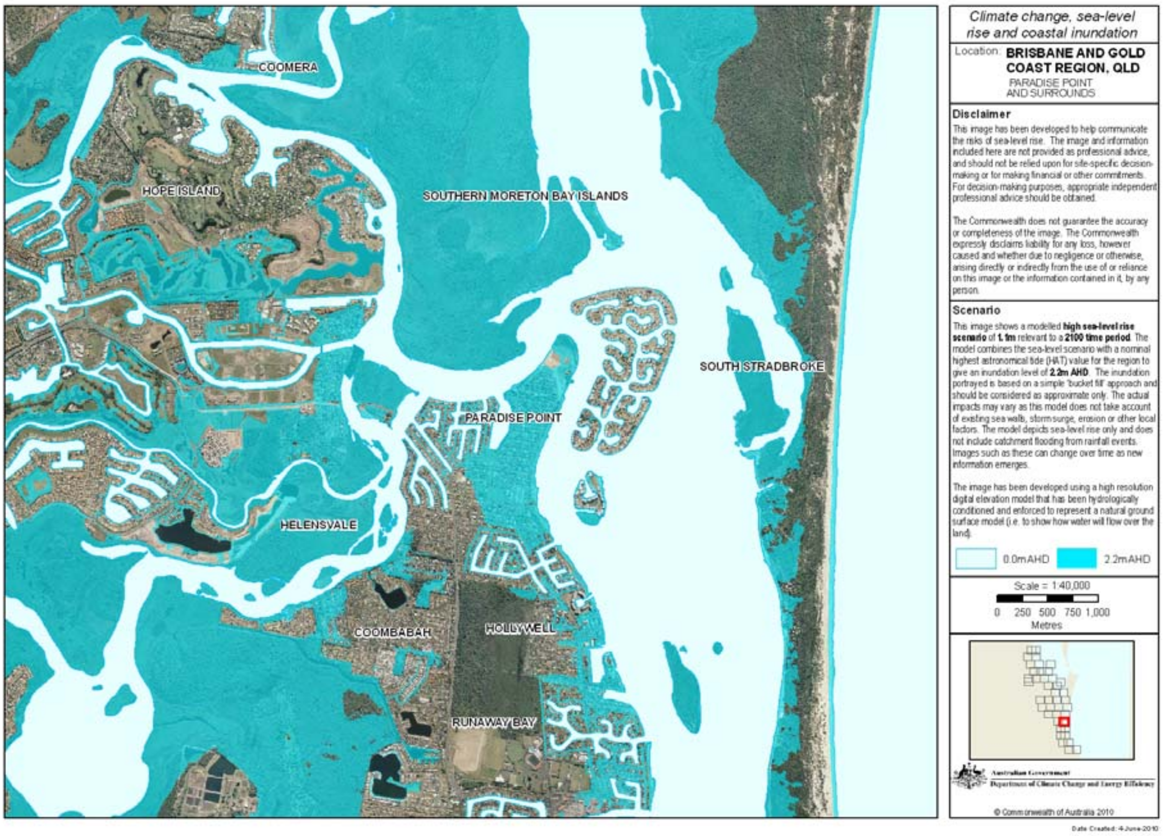

Figure 3. Sea level rise inundation within the northern waterways of the Gold Coast for a 1.1 m scenario (high-end scenario in 2100) (Source: GeoScience Australia).

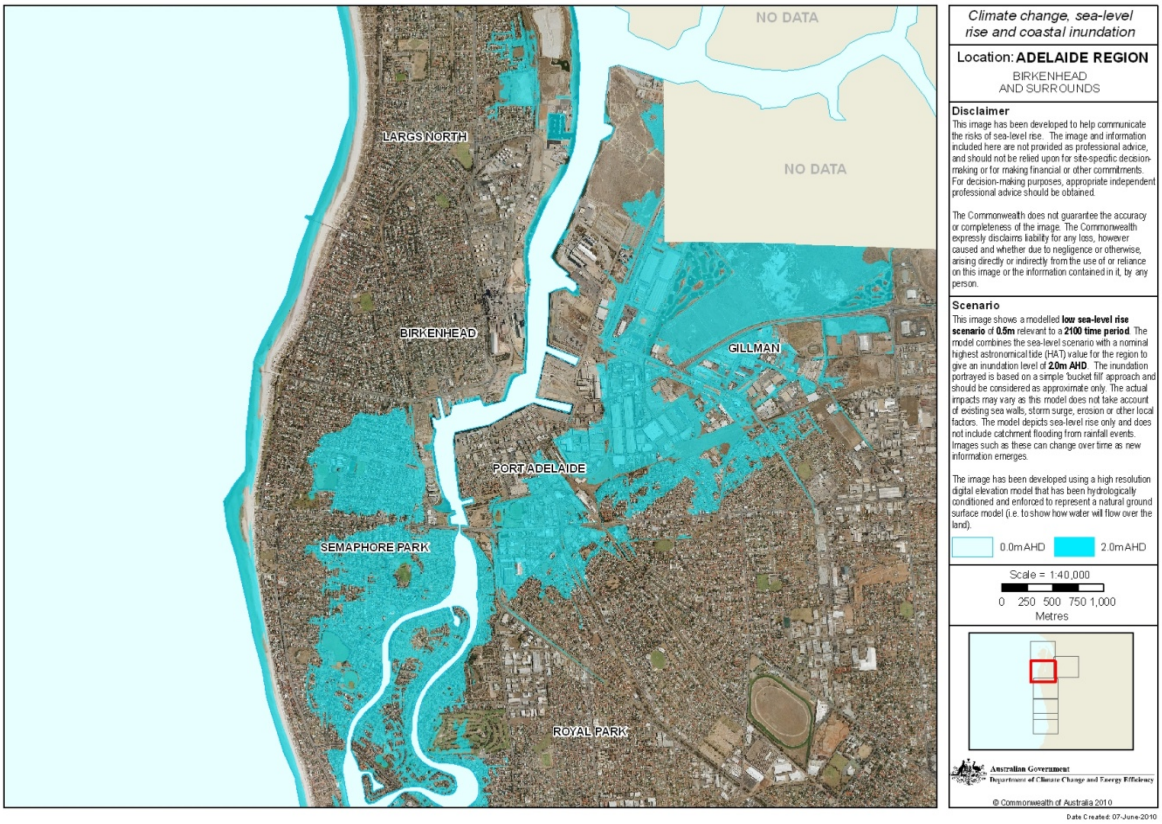

Figure 4. Sea level rise inundation at Port Adelaide for a 0.5 m scenario (low scenario in 2100) (Source: GeoScience Australia).

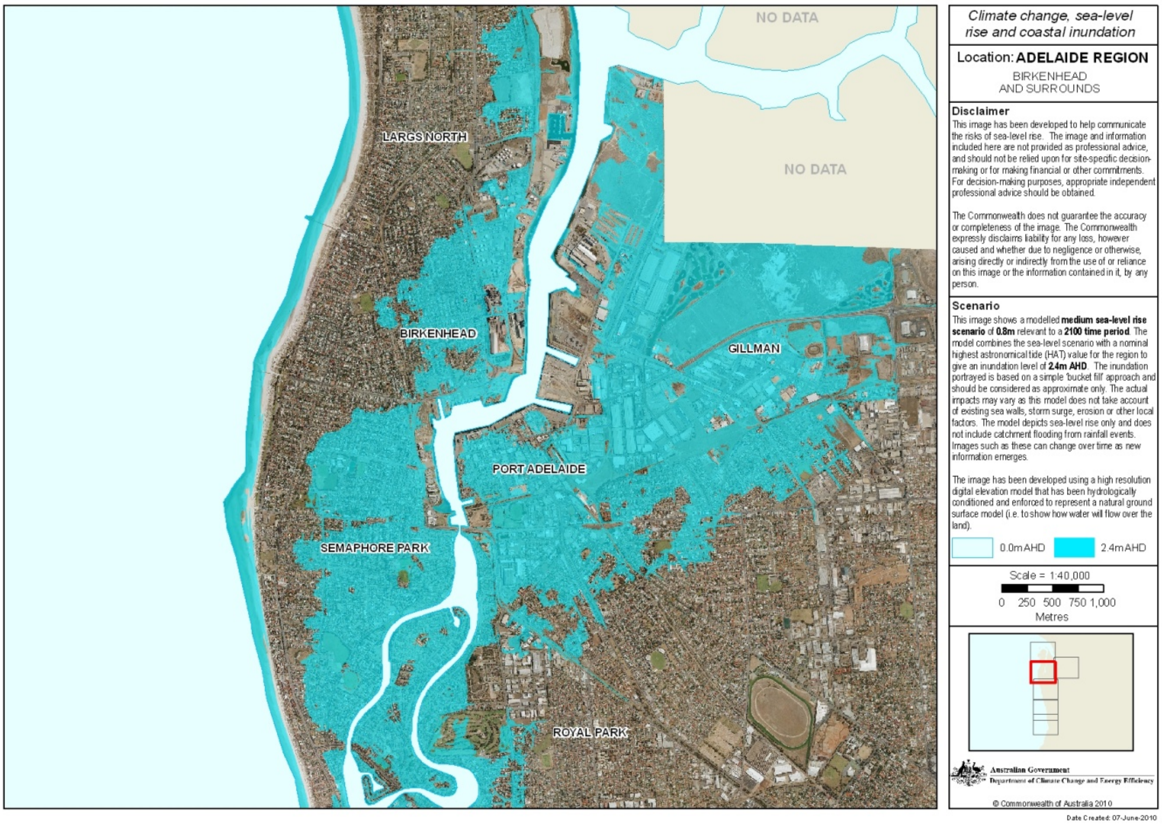

Figure 5. Sea level rise inundation at Port Adelaide for a 0.8 m scenario (medium scenario in 2100) (Source: GeoScience Australia).

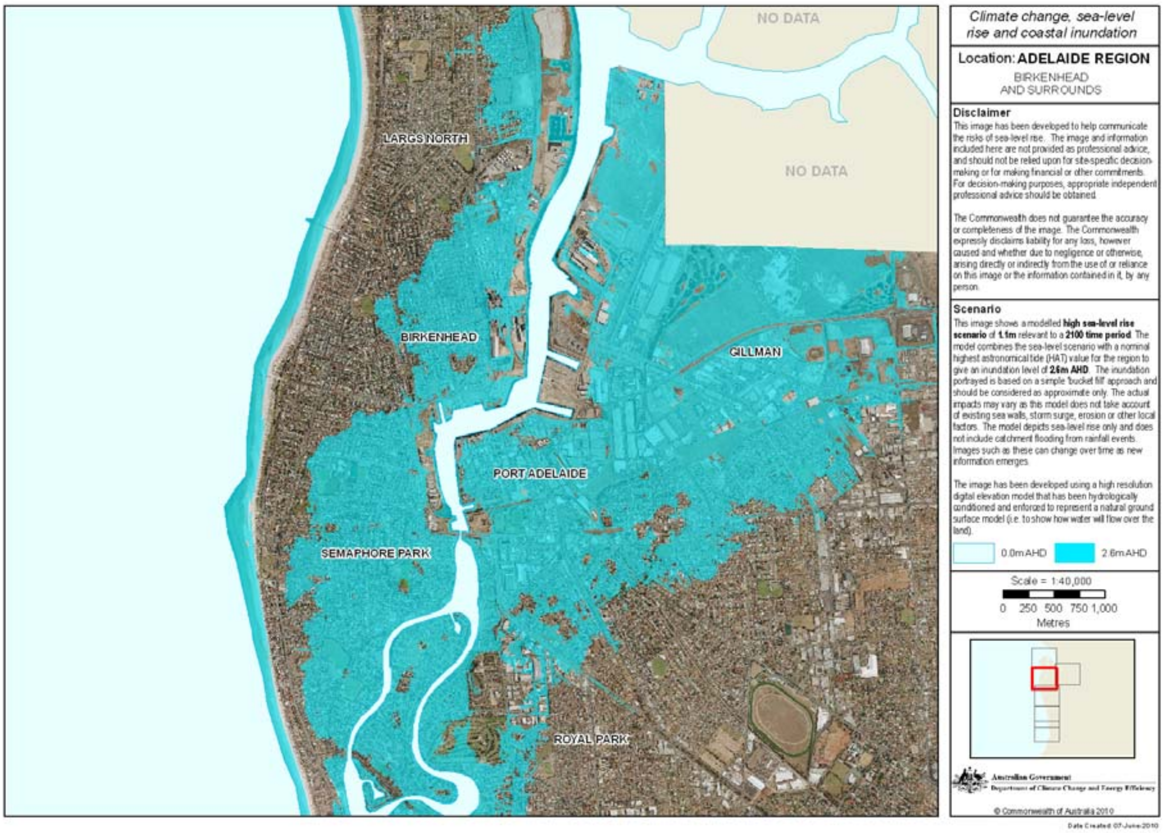

Figure 6. Sea level rise inundation at Port Adelaide for a 1.1 m scenario (high-end scenario in 2100) (Source: GeoScience Australia).

2.2 Coastal residential property

The high values of coastal properties, and beachfront properties in particular, relate to the characteristics of and proximity to the beach, access and associated amenities. These properties have been generally highly valued, even when faced with a risk of coastal erosion. For example, a property on Hedges Avenue on the Gold Coast sold for over $13 million at the peak of the property boom in 2009 and had an unimproved land[3] of $8.5 million around the time of the transaction. This property currently maintains an unimproved land value of $4.9 million after the recent property market decline. At these high values it may be questioned as to whether the risks of coastal erosion are reflected in the value of the land.

A valuation of Byron Bay coastline in 2000 also draws attention to the high values of beach front property in particular those with ocean views. The land at Wategos Beach was valued at $800,000 to $2.1 million (prior to the recent property market increase) and a beach block at Suffolk Park with a value of $392,000 - $550,000 (Byron Shire Council, 2000). In Victoria the average price of a coastal house is $14,500 higher than a non-coastal house (Spillar Gibbins Swan, 2000 cited in Victorian Coastal Council, 2002). Currently coastal land is much more highly valued than other development sites and represents a cultural value in the appreciation of such characteristics as ocean views and beach access.

[3] Unimproved land value refers to the value of the land without any buildings and is therefore an indication of the lands worth. The value is calculated by the State Government (Queensland) and local Council rates are usually calculated based on this value.

Local government also benefits from highly valued beach front properties through rates revenue. Beachfront home owners generally pay much higher rates than other residents and it has been implied that high rate payers have higher expectations for coastal protection. The value of properties within the market can be influenced by the state and characteristics of the beach (Gopalakrishnan et al., 2010). Under a future of sea level rise combined with higher intensity storms, there is a risk of property value loss and lack of available insurance in high risk areas. There is also the question of whether to protect or retreat and Phillip and Jones (2005) argue that it is unlikely that areas of high real estate values will not be protected through hard engineering solutions, unless there is strong political will and clear monetary benefits to do otherwise.

2.2.1 Hedonic Pricing Method

A common way of assessing the value that an environmental characteristic adds to a property is determined through the hedonic pricing method (see Part I: Economic Value of Natural Coastal Assets, p.7). This method is based on the idea that a property is valued in terms of a range of characteristics such as land size, access, house attributes, age and neighbourhood among other factors and that there is an implicit value for each set of characteristics. Based on market prices, these implicit values can be determined, for example properties closer to the beach fetch a higher value than similar properties situated further inland. This is reflected in what people are willing to pay for each property, i.e. the market price. The interpretation of results can also be complicated by the home owner's attitude towards the risks of beach erosion and also by their expectation of future beach management (Landry et al., 2003).

In Australia, the hedonic pricing method is more commonly used for studies of the impact of noise, e.g. airplane and road noise, on residential developments than for coastal amenities (see ENVALUE[4] for a list of studies). However, there are a number of studies from the US that investigate the value of properties in relation to the beach width, proximity to the beach, loss of beach front property and the beach protection in place (e.g. Parsons and Powell, 2001; Gopalakrishnan et al., 2010; Pompe and Rhinehart 1994, 1995 and 1999) . The benefit of a wide beach can be seen within the property market value generally due to the protection from storms and improved amenity (Pompe and Rhinehart, 1995). Understanding this value can be used to financially justify erosion protection measures such as seawalls and beach nourishment.

2.2.2 Beach Erosion and Risk

Landry et al. (2003) based a study of alternative erosion control measures on the property values of a small island on the US East Coast. The data collected included the property sale prices as a function of structural characteristics (such as size and age) and physical characteristics (such as beach width, distance from the beach, erosion risk and protective structure in place) with a constant erosion rate. Beach width was determined to be highly significant with an increase in one metre implying an increase of USD $233 in property value. Beach front properties also had an additional value of USD $34,068 and those adjacent to the waterway had an additional value of USD $87,620 (Landry et al., 2003). Additionally, the study included an erosion risk dummy property that had an implied reduced value of USD $9,269 due to the perceived erosion risks (Landry et al., 2003).

[4] ENVALUE is a Australian valuation study database available at www.environment.nsw.gov.au/envaleapp/

In a US case study of two beaches in South Carolina, Pompe and Rhinehart (1995) found that beach front property values increased by $558 for one foot of additional beach width[5]. Additionally it was found that properties 800 m behind the beach also benefited from a wide beach with increased values of $254 per foot of beach width. Pompe and Rhinehart (1994) also provided an earlier study with the following table (Table 2):

Table 2. The value of a wider beach for average house values (in USD$1983) (Source: adapted from Pompe and Rhinehart, 1994).

Distance from the beach (m)	Increased width 21-24 m	Increased width 21-30 m	Increased width 21-38 m
80 m	$6,408	$19,223	$35,243
805 m	$2,916	$8,749	$16,040
1.19 km	$2,154	$6,462	$11,847

This data suggests that the value of a wider beach varies depending on the proximity of the property to the beach and that property over one kilometre away will still benefit from a wider beach, although to a lesser degree.

In a recent study of Sydney Beaches, the hedonic pricing method was applied to properties adjacent to Collaroy-Narrabeen Beach to better understand the value of beach front properties at a beach with a history of beach erosion that has required extensive management and government investment (Anning et al., 2009). While the results of this study have not yet been published, preliminary figures were provided by the author at the *Economics, Management and the Coastal Zone Forum* hosted by the Sydney Coastal Councils Group in Sydney on the 24th February, 2011. The study included analysis of 1200 properties, with the average land value of a beach front property estimated at $1.99 million (Anning, 2011). Along this stretch of coast, the total land value of properties within the first block from the beach was $246 million, and approximately half are located in the "zone of wave impact" and had a total land value of $88.7million (Anning, 2011).

Translating the value of a beach front property into the overall value lost in the event of sea level rise or severe erosion (resulting in abandonment of the property) is not straight forward. For example, if the beach front properties are lost, the second row then becomes beachfront and maintains some of the value lost by the initial row of properties (Yohe, 1989). As this value passes on to each row of properties progressively further from the beach there is a final loss of value in properties at the point that the beach does not influence their value (Yohe, 1989). Therefore the overall value lost will be less than the value of the loss of the beach front properties. Ultimately, it will be a small group of people that undergo a financial loss in this situation and the overall value of the properties (e.g. to local governments in rates revenue) will not be as great.

The level of risk associated with beach erosion may also be reflected in the value of the properties. Anning's (2011) further analysis of property data at Collaroy-Narrabeen revealed that the properties along the central section of this beach had a lower land value than those to the northern and southern end which coincides with the central section of the beach being in a zone of higher erosion

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[5] This value was specifically from 79 to 90 feet in width; there were diminishing returns for beach width where the value increased at a lower rate once a certain increased width had been reached (Pompe and Rhinehart, 1995).

risk. The results imply that the erosion status of the beach is reflected in the land value of the properties adjacent to the beach.

2.2.3 Coastal Views

In a study based on coastal views, Fraser and Spencer (1998) used the sale price of an undeveloped residential subdivision in a coastal area of Western Australia to determine the value of a coastal view. A modified hedonic pricing method was used which was in part based on a scoring system of three characteristics - degree of panorama, potential loss of view and elevation. The results demonstrated that the best ocean view (score of 10) was valued at $19,460 or 25% of the actual sale price.

Pearson et al. (2002) completed a study of views based on the view of a coastal National Park at Noosa. Noosa National Park is on a headland overlooking Noosa beach and Sunshine beach and surrounded by urban development. The study was based on unimproved land values and property, neighbourhood, access and environmental variables - which included the view of the ocean, the view of Noosa National Park and the view of the hinterland (Pearson et al., 2002). The results showed that having an ocean view was expressed as having a significantly higher value only when a full ocean view occurred and partial view was not worth more than no view at all (Pearson et al., 2002). In contrast, any view of the Noose National Park seemed to have some value above those with no view and presence of the National Park increased land values of 6-7% (Pearson, et al., 2002).

2.3 Surf Lifesaving Clubs

Surf Lifesaving Clubs (SLSC) are key coastal assets that are consistently found in close proximity to our shoreline and therefore highly vulnerable to climate change, sea level rise and subsequent increased levels of beach erosion. A recent study highlighted that over 63% of Australia's SLSC are within areas of potential instability (Elrick et al., 2011). Of this figure, 60 clubs in New South Wales, 48 in Victoria and 40 in Queensland are considered at risk (Elrick et al., 2011). In several cases SLSC are already battling with the sea, for example Currumbin Beach Vikings SLSC (Gold Coast), Cudgen Headland SLSC (Kingscliff, northern NSW), and in cases such as Seaspray SLSC (VIC) and Moore Park Beach SLSC (Bundaberg) relocation of the buildings has been proposed and/or undertaken in response to ongoing beach erosion (Elrick, et al., 2011).

From a built environment perspective, the value of the building and associated amenities are of great importance to the community. Additionally SLSC provide integral social infrastructure. There are 306 SLSC in Australia and with 150,000 members Surf Life Saving Australia is one of the largest volunteer organisations (PWC, 2011). Volunteering is also a key component of the surf lifesaving culture and a total of 1.3 million hours were volunteers in 2009/10 in Australia (PWC, 2011) (this is in addition to those regions that have paid lifeguards, for example the Gold Coast, where full time lifeguards are employed by the local Council to provide services in addition to the SLSC).

From an economic perspective the building itself can be valued in terms of replacement value, for example the Surf Lifesaving Clubs in Newcastle had an estimated replacement value of:

- $1.13 million Nobby SLSC
- $5.67 million Newcastle SLSC
- $450,000 Cooks Hill SLSC
- $2.65 million Dixon Park SLSC, and
- $1.51 million Merewether SLSC (also see Section 2.5)

(Umwelt, 2003)

On the Gold Coast there are 19 Surf Lifesaving Clubs that reside on Council managed land. The replacement value of these buildings ranges from $700,000 to $5.5 million with a total replacement value of $49.5 million (GCCC, 2012).

- $1.88 million Bilinga SLSC
- $2.25 million Broadbeach SLSC
- $2.51million Burleigh Heads SLSC
- $3.6 million Coolangatta SLSC
- $1 million Currumbin Juniors (combined with Vikings)
- $2.39million Kirra North SLSC
- $4.83 million Kirra SLSC
- $3.36 million Mermaid Beach SLSC
- $2.46 million Miami Beach SLSC
- $700,000 Neptunes Royal Club (Palm Beach)
- $2.8 million Nobby Beach SLSC
- $4.55million Northcliffe SLSC
- $ 310,000 Point Danger SLSC
- $2.85 million Rainbow Bay SLSC
- $1.39 million Main Beach SLSC (Southport)
- $ 830,000 Main Beach SLSC Heritage Building
- $3.7 million Main Beach SLSC (new section)
- $2.67 million Surfers Paradise SLSC
- $5.5 million Tugun SLSC

(GCCC, 2012)

Gold Coast City Council also maintains 38 life guard towers all of which are situated in close proximity to the ocean. The use of the life guard towers further assists Council in providing an essential service that supports community and tourism safety. The towers have a total replacement value of $2.1 million (GCCC, 2012).

In addition to the infrastructure, there is also economic activity within the club itself on a day to day basis through the restaurant services that are commonly available. And furthermore, there is a range of values associated with the economic activities of hosting major surf lifesaving events. For example, based on Tourism Australia Statistics, hosting the NSW Surf Life Saving Championships is said to have an estimated value of $18 million through visitor spending (SLSA, 2011). The buildings are also a storage place for lifesaving equipment, a benefit of being in close proximity to the beach, and a necessity for surf lifesaving services.

There are a range of values associated with SLSC beyond the infrastructure itself. The benefit of surf lifesaving in protecting swimmers is immeasurable, without which there would be many drownings each year, for example Surf Life Saving performed 12,000 rescues during 2009/10 (PWC, 2011). The SLSC also provide a hub for training from the very young (Nippers) to the older (Active) and hold a piece of history in Australian hearts. In a social context, SLSC provide immense social well-being through recreational opportunities, health and fitness, inter-generational relationships, camaraderie and lifestyle choices. Allen Consulting (2005) describes the direct and indirect benefits of surf lifesaving as flow-on impacts for individuals and social spillovers. Flow-on impacts for individuals include improved personal health, social participation, education and personal satisfaction and social spillovers include increased valuable social networks, decreased mortality, increased economic performance, decreased crime, safe natural environment and increased tourism (Allen Consulting, 2005 p. 24-25).

Surf Life Saving Australia has previously commissioned a number of studies to estimate the economic and social value of surf lifesaving to Australia. A study was completed by Allen Consulting in 2005 and this was followed by an updated study by PWC in 2011.

Both studies estimated the net benefits of surf lifesaving based on two approaches: an input based approach and an output based approach. The input based approach estimated the total value in terms of expenditure which includes the volunteer patrol hours (if the volunteers were paid), expenditure by volunteers on personal related expenses and the expenditure of the SLSC and governing body (Allen Consulting, 2005; PWC, 2011). The results are provided in Table 3 below.

Table 3. Net benefit of surf lifesaving based on an input approach (Source: Allen Consulting, 2005 and PWC, 2011).

	2003-04	2009-10
Patrol hours (if paid)	$50.1 million	$42.2 million
Expenditure	$84.7 million	116.6million
Travel expenditure		$4.6million
TOTAL VALUE	$134.8 million	$163.6 million

The output based approach was undertaken to reflect the value of the services provided by surf lifesaving activities through estimating the value of the lives saved and the injuries avoided. This included drowning, permanent incapacitation and minor first aid (Table 4).

Table 4. Net benefit of surf lifesaving based on an output approach (Source: Allen Consulting, 2005 and PWC, 2011).

	2003-04	2009-10
Drownings	$831.7 million	$2.2 billion*
Permanent incapacitations	$568.3 million	$1.2 billion
Minor injuries and first aid	$500,000	$90,000
TOTAL VALUE	$1.4 billion	$3.4 billion

* in the 2011 study a statistical life was valued more highly that the 2005 study at $3.7 million compared with $2.1 million leading to some variation in the results

A further cost benefit analysis was undertaken to determine the value of each dollar spent on surf lifesaving. The results, if volunteers were paid, were 10.4 and 21.7 in 2005 and 2011, respectively and if volunteers were unpaid 16.5 and 29.3, respectively (Allen Consulting, 2005; PWC, 2011). Given this ratio is a positive result, it illustrates the value associated with the services provided through surf lifesaving.

A further relevant study, undertaken by Blackwell and Tisdell in 2010, considered whether the level of services provided by surf lifesaving met the needs of the beach community. Using the contingent valuation method (see Part I: The Economic Value of the Natural Coastal Environment p.7) the study assessed respondents' willingness to pay for additional services, i.e. presence of an additional lifesaver/lifeguard to patrol outside the flags which are the usual limits of the service. The study site included the Sunshine Coast, Queensland, namely Mooloolaba Beach and surrounds (Kawana, Alex and Maroochydore) and surveys were carried out between 1999 and 2000. The results illustrated that respondents would be willing to pay $2.12 per person per visit for additional lifesaving services with a total marginal benefit[6] of $1.09 million and a net value of $955,000 (Blackwell and Tisdell, 2010).

These studies highlight the positive values that are placed on surf lifesaving and without the benefit of infrastructure and associated services many of these values and benefits would cease to exist. In the case of sea level rise, severe erosion and the loss of the public land may end in an uncertain future for many clubs, particularly those that are adjacent to private land and may have no options for retreating or relocating. The level of funding required to adapt and respond to potential impacts of climate change will be high and this raises the question of how these clubs will fund such needs.

2.4 Services

In addition to the value of buildings and property infrastructure, there are also a range of services that rely on infrastructure, some of which are in the close proximity to the coastline. These services make a place liveable and include the provision of sewage and water supply networks as well as electricity and phone connections. The infrastructure associated with these services is often built on public coastal land and in many cases are within high risk areas due to the very nature of the infrastructure. For example, sewage pumping stations are often located at the lowest point within the catchment (i.e. close to the ocean) and stormwater and drainage infrastructure is inherently linked to the ocean (Fletcher and Lord, 2011). Usually the public land on which the infrastructure is built, is adjacent to and abutting private property, which creates a problematic situation: if the shoreline erodes pressure may amount for relocation due to the unavailability of the adjacent private land.

2.4.1 Water services

In 2008-2009 Sydney Water undertook a number of studies including an assessment and review of their assets and the relevant risks under climate change (Allen et al., 2008). A summary of the studies by Allen et al. (2008) highlighted that critical infrastructure and water service disruption were the key risks of climate change and more specifically the frequency and intensity of events such as storms and floods, sea level rise and associated inundation, higher temperatures and lower flows and drier soils were potential impacts from climate change.

While many water authorities across Australia have or will initiate studies to assess the vulnerability of their water infrastructure and assets to climate change, little data is publically available. During an audit of Tasmania's coastal assets at risk from flooding and sea level rise it was also noted that

[6] Marginal benefit: the additional benefit from an increase in activity

consistent data sets of water infrastructure (including sewage and stormwater infrastructure) were not readily available and thus not included within this desktop study (DPIW, 2008).

Water related services are critical to the healthy functioning of our society and with much of the infrastructure in close proximity to our ocean and waterways and vulnerable to climate change, long term planning to adapt to changes in the climate are paramount. Whether these adaptation options include utilising new and innovative technology, retrofitting, relocation or removal/withdrawal long term planning and integrated management are the key to the ongoing provision of these services (Fletcher and Lord, 2011).

2.4.2 Power services

The supply of electricity is another critical service that requires extensive infrastructure and will potentially be impacted by climate change. The key impacts include changing demand and supply patterns and difficulties meeting the peak demands, for example increased temperature and the subsequent increase in use of air conditioning units. Within coastal areas, there is also the risk of saline water inundation due to sea level rise and storm surge and the consequent corrosion to electricity networks that may occur as a result (DCC, 2009).

The Department of Climate Change report provides some discussion on the potential impacts to electricity supply within the coastal zone (DCC, 2009), however no further figures regarding the value of the infrastructure appear to be publically available. DPIW (2008) also found limitations within the data available of services such as the supply of electricity and telecommunications.

2.5 Assets management by local Council: Coastal asset registers

Many coastal assets are managed by local governments in Australia. These may include the following:

- beach amenities (showers, taps, toilets)
- pathways and boardwalks
- lifeguard towers
- stormwater drains
- dune fencing
- beach access paths
- car parking
- jetties, boat ramps, pontoons and piers
- children’s play equipment and exercise equipment
- swimming enclosures and ocean pools/baths
- coastal protection (seawalls, groynes)

In general, each Council will hold an asset register of these items in which a value is placed for each asset. This register may include the construction cost, replacement cost, maintenance and service schedules and costs providing an indicative value of the asset. In many cases these assets are highly vulnerable to climate change and sea level rise due to their proximity to the beach front.

There are also many services provided by these assets that support social well-being such as health and the lifestyle that so many choose to have by living near the coastline. Without these assets accessing the beach to support these lifestyle choices would be difficult. Additionally, these assets provide a service to support tourism and to generate economic activity in even the smallest coastal towns where tourism is a valuable economic driver.

The value of such services is reflected in the amount of investment from local Councils to construct and maintain public foreshore and beach front assets. The asset's value can range from relatively high in terms of coastal protection (see Section 2.6.1) to individual assets that can be of a relatively low cost for example, $5,000 to $20,000 (Shaolhaven City Council, 2009). From a large scale perspective, the foreshore at Townsville, The Strand, was redeveloped in 1998 after extensive erosion from Tropical Cyclone Sid. The project included the construction of three artificial headlands, extensive beach nourishment and a foreshore redevelopment with amenities with a cost of over $30 million for 2.5 km of foreshore (Muller et al., 2006). Another example of extensive foreshore redevelopment was the development of the Cairns Foreshore Promenade and Regional Playground in 2003 with an associated cost of $5.9 million. This included a wide concrete pathway, board walk, children's playground and wet play area, swimming lagoon, public amenities, a memorial garden and a series of interpretative nodes (CRC, 2011). In June 2011, an announcement by the State Government confirmed the investment of a further $23.3 million into additional foreshore development in Cairns. Amongst the proposed infrastructure is an additional 1.6 km of promenade, an interactive children's playground, kiosk, additional amenities and the renovation of the heritage listed Wharf Shed No. 2 (Strudwick, 2011).

The Gold Coast City Council has invested in an ocean front pathway, the OceanWay, that is proposed to extend the length of the Gold Coast's 36km of beach front. This pathway includes a wide concrete or grass path, seating, beach access, beach showers and drinking water fountains and lighting and has been a key investment into the built coastal environment. The project aims to support Gold Coast City Council's notion of an "active and healthy lifestyle" and to provide the community with the opportunity for active travel and to open up the coastal environment in an equitable manner (GCCC, 2009). The project also includes extensive foreshore redevelopment of key tourism areas within the city. Since 1999 34 sections of the OceanWay have been either completed or are currently proposed with an investment of over $47 million (GCCC, 2010a), thereby supporting the community in gaining access to one of Queensland's most well known natural assets. However, the council has come into conflict with the beachfront home owners who do not necessarily want a pathway to run in front of their properties. This is an example of a value conflict where the built coastal environment is shared among multiple stakeholders and where different values are placed on different aspects.

Gold Coast City Council also owns a number of other buildings within close proximity to the ocean, in particular public toilets, kiosks, a café and community buildings. An example of these is described below in Table 5 as a representative of the range of assets and their replacement values. Additionally, at many key access points to the beach the Council provides beach showers, viewing platforms, seating, lighting and public toilets. Being a linear city with a 36 km coastline, there is a large number of such facilities.

Table 5. Replacement cost values of several coastal assets owned by Gold Coast City Council (GCCC, 2012).

Asset Description	Present Day Replacement Value (2011)
Toilet Block – Palm Beach	$120,000
Kiosk and dressing shed – Main Beach	$740,000
Café – Palm Beach	$242,000
Community Centre – Palm Beach	$225,000
Lifeguard Centre – Burleigh Heads	$640,000

As concern of the vulnerability of coastal assets to climate change increases, many local council bodies have initiated assessments and reporting on coastal assets potentially at risk from sea level rise and tidal inundation, some of which are publically available. Based on this available information, the following list is an example of the extent and value of coastal assets managed by a range of coastal councils.

Newcastle - south of the Hunter River

The estimated value of a number of coastal assets for the region south of the Hunter River were provided by Newcastle City Council and reported in the Newcastle Coastline Management Study in 2003 (Umwelt, 2003). The present day replacement costs were provided with a total value of over $16 million for those assets adjacent to the coastline and a further $19.5 million for infrastructure that rely on coastal protection (Umwelt, 2003). The following tables (Table 6 and 7) were adapted from this study and illustrate both the range and value of infrastructure managed by this local council.

Table 6. Replacement cost values of a range of coastal assets managed by Newcastle City Council (Source: adapted from Umwelt, 2003).

Asset Description	Present day replacement costs (2003) (7% discount)
Nobbys Beach/Shortland esplanade seawall	670,000
Newcastle ocean baths	5,900,000
Newcastle beach seawall	730,000
South Newcastle beach seawall	218,000
Bogey Hole baths (access)	3,400
Bar Beach seawall	90,000
Merewether/Dixon Park rock seawall	4,000,000
North of Merewether Beach seawall	321,000
Ladies baths seawall	5,000
Merewether baths	4,100,000
TOTAL	***16,037,400***

Table 7. Replacement costs of infrastructure managed by Newcastle City Council that are reliant on coastal protection (such as seawalls) (Source: adapted from Umwelt, 2003).

Facilities Reliant on Coastal Protection	Present day replacement costs (2003) (7% discount)
Nobby Surf Club	1,125,000
Nobby Surf Club equipment shed	130,000
Nobby Surf Club northern car park	57,022
Nobby shade structure	46,800
Nobby shade structure car park	30,547

Facilities Reliant on Coastal Protection	Present day replacement costs (2003) (7% discount)
Shortland Esplanade (Nobbys to ocean baths)	305,475
Newcastle Surf Life Saving Club	41,040
Shortland Esplanade (South Newcastle Beach)	5,670,000
Bar beach pavilion	213,832
Bar Beach south car park	2,805,000
Cooks Hill Surf Life Saving Club	30,547
Memorial Drive (Bar Beach)	50,912
Dixon Park Surf Life Saving Club	450,000
Dixon Park Kiosk	277,380
Dixon Park shade structure	2,647,500
Dixon Park car park	73,440
John Parade	71,200
Merewether Surf Life Saving Club	199,577
Merewether surf house	183,285
Merewether Beach shade structure	1,512,000
Merewether baths car park	81,460
TOTAL	***19,503,017***

Holdfast Bay – Adelaide

Replacement costs, June 2007

Foreshore hard landscaping	$1.52 million
Sea-wall 3km (~20% of costs)	$1.81million
Remaining foreshores and ramps	$1.18million
Jetty 215m	$2.75 million
TOTAL	*$9.52 million*

Patawalonga rock revetment valued at $400 /linear metre

(City of Holdfast Bay, 2008)

Port Beach, Freemantle WA

Replacement costs, 2004

Café	$500,000
SLSC building	$ 65,000
Amenities (change rooms)	$300,000
Car park	$200,000
TOTAL	*$ 1.2 million*

(DPI, 2004)

Cassowary Coast, North Queensland

Replacement costs, 2011

Marine facilities	$6.06 million
Boat ramps	$293,000
Wharves	$2.24 million
Seawalls	$3.22 million
Harbours	$310,000
TOTAL	*$12.1 million*

(Cassowary Coast Regional Council, 2011)

These figures highlight the immense value of coastal infrastructure that may be vulnerable and exposed to sea level rise and risks from climate change. Long term planning, including adaptation is going to be required to maintain the services provided. Additionally, these estimates are likely to increase in the future with future population growth within our coastal regions (DCC, 2009). These costs are replacement costs for the infrastructure only and do not incorporate the flow on effects if the assets were damaged or lost.

There are a number of strategies commonly undertaken to reduce the impact of erosion events and storm inundation. These measures include seawalls and beach nourishment and there is an ongoing conversation regarding retreating development. The costs associated with these measures are a reflection of the value of the infrastructure and services that are protected and in the end reflect the broader societal values associated to certain aspects of the coastal environment.

2.6 Value in the protection of coastal property

In many cases coastal land, property and infrastructure is protected from the impacts of coastal processes and extreme events (storms and cyclones). The level of protection could be seen as a proxy for the value placed on what is at risk. The value of the land/infrastructure at risk will be reflected in the investment into the protection and the benefits such as the avoided damages (Frankhauser, 1995). The direct threat to infrastructure along the beach or waterway is often a trigger for the approval of protective measures. Bearing in mind, in many cases tradeoffs occurs between the infrastructure to be protected and the intertidal or wetland environment. For example, in the case of sea level rise, protection using a hard structure halts the migration of the intertidal zone (Frankhauser, 1995) which is often referred to as the coastal squeeze (Schlacher et al., 2007).

2.6.1 Seawalls

Seawalls are a commonly used hard engineering structure for protecting the coastline. The value of the seawall may be described in the investment towards the construction and maintenance of the seawall, in additional to the value of the property that is being protected. It is not only the property but also the services that make that property and community liveable and access to the area that are also protected.

As an example, a majority of the Gold Coast is protected by a seawall, and private property owners are currently responsible for the construction and maintenance of the seawall if they redevelop a coastal property (GCCC, 2011). In 2012, the estimated costs for a seawall on the Gold Coast was $2,000 per linear metre and with properties on average 30-40 m in length, a newly constructed seawall has a cost of approximately $60,000 to $80,000 (GCCC, 2012). BMT WBM (2011) estimates the cost of seawalls for Wollongong, NSW at $5,000 to $10,000 per metre length. In another example, the City of Holdfast Bay in Adelaide valued their contribution to a 3km seawall at $1.81 million (equivalent to approximately $603 per linear metre) (City of Holdfast Bay, 2008). This was likely in conjunction with a State subsidy, which can be up to 80% of the cost of protection works. Therefore the cost of the seawall may be approximately $3,000 per linear metre (Townsend, pers comm. 2012).

These values would reflect the replacement costs, which are in addition to the value of the land and infrastructure that is protected. To capture the full value of such a protective measure, an understanding of the property value, the services and the protective structure in terms of present value or replacement cost would be required. In addition to this, there are the social and lifestyle values that society places on living close to and having access to the beach (see Part 1: The Economic Value of Natural Coastal Assets).

2.6.2 Beach Nourishment

Beach nourishment (the placement of sand onto the beach) is commonly used as a soft option for coastal protection. It is seen as an alternative to hard structures such as seawalls and in comparison has an overall lower environmental impact (although direct ecological impacts are not well understood (GCCM, 2008)). Beach nourishment can also be a more palatable option to the community (for example residents of Collaroy-Narrabeen protesting against a proposed seawall (SMH, 2002)).

Beach nourishment can be a costly exercise and the results are not usually sustainable as eventually the sand will move on under the prevailing coastal processes. In terms of costs, beach nourishment is given a general figure of \$10 per m^3; however, this is highly dependent on the sand source and the transport distance. For example, on the Gold Coast beach nourishment costs ranged from approximately \$6.15 per m^3 when sourced from offshore and \$4.75 per m^3 when sourced from an estuary and placed on a local beach (i.e. minimum transport distance). Therefore, a large offshore beach nourishment campaign of 500,000 m^3 may cost in excess of \$3 million (GCCC, 2006). The South Australian Department of Environment and Heritage estimated the costs for beach nourishment along Adelaide's beaches between \$6.50 and \$11.00 per m^3 depending on the dredge size and distance (DEH, 2005). The total cost of beach nourishment in Adelaide between 1973 and 2004 was \$36 million (\$ 2004) and included both dredging and trucking (DEH, 2005). A recent study of Sydney's beaches recommended a major beach nourishment campaign of 12 million m^3 of sand (sourced from offshore) at \$300 million to maintain Sydney's beaches with a future sea level rise of 0.1 m per 10 year interval. Additional campaigns, required at 10 year intervals, would cost an additional \$120 million per campaign (AECOM, 2010). Given these relatively high and on-going costs, beach nourishment may not be an affordable option for coastal protection for many local councils, particularly with the projected impacts of climate change.

Beach nourishment activities are generally funded at a local government level, occasionally by the State (Western Australia and Adelaide (Walsh, 2004) and in some cases subsidised by the State. For example, in 1989 the Queensland State Government subsidised 75% of a large beach nourishment campaign along the southern Gold Coast, with Gold Coast City Council funding the remainder (Boak et al., 2001). There is some debate regarding beach nourishment and the additional benefit it provides to the beach front home owners when funding is from a public source (NOAA, n.d.; Walsh, 2004). Parsons and Noailly (2004) further discuss this question of equity in a study in Delaware, USA, where a levy is placed on guests visiting hotels within the region and a component of the revenue spent on beach management. In this case, many of the hotels are not situated near the beach with guests unlikely to receive direct benefits of the levy. Parsons and Noailly (2004) also propose the use of property value and proximity to the beach to calculate a property tax for beach nourishment, this method addresses some issues of equity as those that benefit more pay a higher rate of tax[7].

Lindsay et al. (1992) (USA) and Anning (2011) (Australia) explored people's willingness to pay for measures of beach protection using the contingent valuation method based on a hypothetical fund for beach protection (see Part I: Economic Value of Natural Coastal Assets p.7). Both studies found that in principle people are willing to pay for coastal protection and this is dependent on availability of information, proximity of beach to their home, income level and attitude towards taxation (Lindsay et al. 1992; Anning, 2011).

Arguably beach protection, such as beach nourishment, provides for a wider beach that has additional benefits and positive flow-on through the benefit to the tourism industry, recreational opportunities, additional public open space, increased property value and in some cases improved access (NOAA, n.d.; Houston, 2002 cited in Phillips and Jones, 2006). Input into the local economy is also evident where visitors and residents spend money when visiting a particular area instead of spending that money elsewhere (see Part I: Economic Value of Natural Coastal Assets, p.14).

Beach nourishment has been undertaken extensively within Australia, highlighted in a quote by Andrew Short "…sand nourishment is coming to a beach near you" (Coastalwatch, 2009). Table 8 provides an example of several of the larger scale beach nourishment campaigns in Australia and highlights the immense volumes of sand that have been moved since the 1970's.

Table 8. Major beach nourishment campaigns in Australia

Site	Volume	Dates		Reference
Gold Coast	9 million m^3	1974 - 2006		GCCM, 2008; Boak et al., 2001; GCCC
Currumbin Creek*	1.75 million m^3	1974-2007		
Tallebudgeera Creek*	1.47 million m^3	1975-2007		GCCC
Kirra Beach	200,000 m^3	2009-2010		GCCC
Tweed River Sand Bypassing System	4.6 million m^3	1995-2006	Dredged from Tweed River	GCCM, 2008
Sand is placed on/near Gold Coast beaches	4.7 million m^3	2001-2008	Via sand bypass	
Noosa	997,000 m^3	1982-2001		Chamberlain & Tomlinson, 2006
	TBC m^3	2002-2010		SCRC
Port Stephens	344,000 m^3	1984-1996		Watson, 1997
Townsville	100,000 m^3	1998		Riedel, 1999
			+ renourishment in following years	Muller et al., 2006
Bate Bay/ Cronulla	420,000 m^3	1977-2007		PBP, 2006 cited in AECOM, 2010
Port Phillip Bay	30 projects	1975-2010	Further proposed	Bird, 2011
Adelaide	4,128,000 m^3	1973-2004	Dredged and trucked	DEH, 2005
	160,000 m^3 annually	Current		

*sand is sourced through annually dredging of the creeks for water quality and flood mitigation purposes

[7] To some extent similar to rates schedules in Australia that are based on the unimproved land values of property.

There are recent studies in Australia that have assessed the benefits and costs associated with beach nourishment and the protection provided (AECOM, 2010; Raybould and Mules, 1998). This recent study by AECOM (2010) investigated the economic benefit of beach nourishment to protect Sydney's beaches from the impacts of sea level rise and provides a business case to justify the costs of beach nourishment to protect beaches and coastal property.

A high level cost-benefit analysis was carried out for three of Sydney beaches: Collaroy-Narrabeen, Manly Ocean Beach and Bate Bay. The cost benefit analysis included:

- expenditure by beach visitors
- an approximation of the non-market values (e.g. consumer surplus – see Part I Economic Value of Natural Coastal Assets, p. 6)
- loss of property and rates revenue
- value associated with proximity of property to the beach (AECOM, 2010)

The result of the cost-benefit analysis was a net present value of $42 million for nourishment at Collaroy-Narrabeen, $48 million at Many Ocean Beach and $13 million for Bate Bay (Table 9). Sensitivity testing showed that the proposed beach nourishment would have medium value for money for Collaroy-Narrabeen, high value for money at Manly Ocean Beach and low value for money at Bate Bay (AECOM, 2010). The lower value for money at Bate Bay was related to different property values and beach visitation/expenditure rates in comparison to the other case sites (AECOM, 2010).

Table 9. Cost- benefit analysis results for three case sites in Sydney (Source: AECOM, 2010)

Case site	Present Value Cost	Present Value Benefit	Net Present Value	Return for every dollar spent
Collaroy-Narrabeen	$71 million	$113 million	$42 million	$1.60
Manly Ocean Beach	$35 million	$83 million	$48 million	$2.35
Bate Bay	$86 million	$99 million	$13 million	$1.15

The study highlighted that there is immense benefits in maintaining a wider beach for recreational amenity. With the loss of beach amenity there are further flow-on effects that can affect the wider community such as loss of rates revenue, reduction in property values, less visitation and expenditure and impacts to lifestyle. When considering additional services and infrastructure within the coastline vulnerable to sea level rise, there are likely to be even greater benefits in protecting the urbanised shoreline and avoiding potential damages.

2.6.3 Other

Another method of coastal protection is an artificial reef (or multi-purpose reef). Although often associated with surfing, artificial reefs have also been used for coastal protection. As a management strategy, artificial reefs are not widely used in Australia and for example there is one in place on the Gold Coast at Narrowneck (north of Surfers Paradise). An economic valuation was undertaken for the overall project, of which a major component was extensive beach nourishment, and related this to tourism visitation and reduced damage to public goods (see Section 2.5 coastal assets above) (Raybould and Mules, 1998).

2.7 The Marine Industry

The marine industry relies heavily on built infrastructure within the coastal zone to service their transport, storage, extraction and exporting needs. In a report to the National Oceans Office *The Economic Contribution of Australia's Marine Industry*, the total value added[8] of Australia's marine industry was worth $26.7 billion in 2002-03 to Australia's economy (3.6% of the total industry in Australia) (Allen Consulting, 2004). There is also a high tax revenue of $2.5 billion (2002-03) received by the Commonwealth and a further $1.6 billion received by the States and Territories (Allen Consulting, 2004). The taxes include company tax, petroleum resource rent tax, GST, royalties and payroll tax (see Allen Consulting, 2004, p.10 for more detailed information).

A grouping of the marine industry is provided by Allen Consulting (2004) and a discussion paper by AIMS (2008) and the direct value added for each specific industry is as follows (Table 10).

Table 10. Value of the marine industry in DATE (Source: Allen Consulting, 2004)

Industry	Value added - direct
Offshore oil and gas	$11.6 billion
Marine tourism	$11.3 billion
Port based activities	$1.7 billion
Fisheries and seafood	$1.2 billion
Ship and boat building	$0.7 billion
Shipping	$0.5 billion

There are a number of risks that the marine industry may face in a changing climate. For example, impacts to marine tourism and the seafood industry due to changes in species composition and biodiversity, habitat loss, and impacts to the shipping, boating and port industry due to increased storm intensity.

2.7.1 Port Based Industry

Ports are described as the gateways of the country (Infrastructure Australia, 2010) and the growing number of ports are relying on increased coastal infrastructure. Additional infrastructure places further pressure on the coastal environment. Ports have high value in economic terms for export and commercial industry. The output value of the entire port industry in Victoria was estimated at $1.6 billion with Port of Melbourne the largest contributor (URS, 2005). Values for the Port of Melbourne are reported by Pricewaterhouse Coopers (2007) with a total value added of $596 million (direct effects for 2004-05). The report also states that the main economic impact is through land-based activities and storage, both of which rely directly on the built environment, in addition to loading/unloading, ship operations and cargo service (Pricewaterhouse Coopers, 2007).

[8] Value added: the total output from port related organisations less the costs associated with brought in materials, services and components (Pricewaterhouse Coopers, 2007).

Pricewaterhouse Coopers (2007) also reported on the value of a number of other Australian ports where previous studies have been undertaken. Table 11 provides a summary of their discussion:

Table 11. Summary of the value of Australian ports (Source: Pricewaterhouse Coopers, 2007)

	Value added - direct	Value added - total effects (direct + indirect)	Year
Port of Sydney	$640.8 million	$1,379 million	2001-02
Port of Townsville	$215.6 million	$618.1 million	1998-99
Port of Melbourne	$596 million	$1,140 million	2004-05
Port of Brisbane	n/a	$773,600	2002-03
Port of Freemantle	$215,000	$440,000	1998-99
Port of Geelong	n/a	$176,900	2004-05

Maunsell Australia (2008) sourced data from the Department of Transport and Regional Economics and the Bureau of Transport and Regional Economics on the value of key ports in Australia to base an assessment of climate change impacts on port infrastructure (Table 12). The following throughput[9] values were provided based on 2004/05 data (Maunsell Australia, 2008).

Table 12. Total value of throughput for key ports within Australia (Source: adapted from Maunsell Australia, 2008).

State	Port	Total value of throughput
Victoria	Melbourne	$ 53,605,106
	Geelong	$ 3,291,872
New South Wales	Sydney	$ 45,773,666
	Newcastle	$ 6,593,981
Western Australia	Fremantle	$ 18,112,430
	Dampier	$ 12,565,709
	Bunbury	$ 2,768,597
	Port Headland	$ 3,936,918
Tasmania	Launceston	$ 1,367,147
Northern Territory	Darwin	$ 1,982,453
Queensland	Brisbane	$ 24,500,572
	Townsville	$ 3,841,598
South Australia	Adelaide	$ 7,012,163

3.0 Conclusion

This review has considered a range of valuation tools used in assigning asset values for the built coastal environment. The economic value of the built coastal environment is however currently difficult to quantify in its entirety. This difficulty is due to a range of factors. Firstly, the needed information is often not publicly available on asset values, and there is a lack of consistency in the use of the existing valuation tools. Secondly, the social infrastructure and social benefits from built assets are difficult to quantify and valuate. And thirdly, the projected impacts of climate change and the extent and types of risks these could impose to our coastal infrastructure are not yet measurable in real time.

[9] Throughput = exports + imports, including bulk and non-bulk (Maunsell Australia, 2007)

The built coastal environment is strongly linked to the risks proposed by climate change projections as the infrastructure is frequently in close proximity to the coastline and coastal waterways. Key infrastructure at risk includes commercial and residential buildings, surf lifesaving clubs, industry, transport networks, essential services (such as hospitals, airports) and water, electricity and telecommunication networks. However, more studies and reports are currently produced and commissioned that provide a range of information regarding these values. Additionally, continued research is underway by all levels of Government with jurisdiction over the coastal zone and authorities that manage essential services such as electricity, water and telecommunications.

Given Australia's extensive coastline and the many coastal cities and towns, there are a vast number of coastal assets managed by local government including, for example, beach pathways, amenities, car parks and so on. These assets provide a sense of liveability to the community and also strongly encourage tourism. They also require a financial commitment for both the construction and maintenance and many assets will become vulnerable to sea level rise and the intensification of storms and associated shoreline erosion. In some cases, this is likely to place immense pressure financially on local authorities to continue to provide such assets. Depending on the location, there may be opportunity to retreat or relocate such infrastructure, however in many cases the infrastructure hinges on private property and there may be no room to move. If a hard protective option is undertaken, this can lead to an increased risk of the loss of the intertidal zone and the habitat it supports. Consideration of the value of the environment at risk is also paramount to sustainable management of the coastline.

There is wide-spread residential development along Australia's coastline, which is concentrated in our coastal cities. Beachfront and waterway properties are generally highly valued within the property market and in most cases these values do not yet necessarily appear to reflect the potential vulnerability to climate change. Coastal property can also be valued based on the characteristics of the region (such as proximity to the ocean) and the coastal protective measures in place (such as seawalls and the provision of beach nourishment).

The built coastal environment is fundamentally linked to our lifestyles and with a projected growth in population in the coastal zone, it will continue facing increased demands in the future. A better understanding of the values of this infrastructure will assist in enhanced future management and long term planning, which is essential considering both the current climate variability and future projections of a changing climate. Supporting liveable communities and lifestyles under dynamic and multiple pressures is an inherently demanding and complex task but one which can be undertaken through consistent long-term planning. This requires understanding both the economic asset values of the built environment but also the social benefits they provide for the Australian society.

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