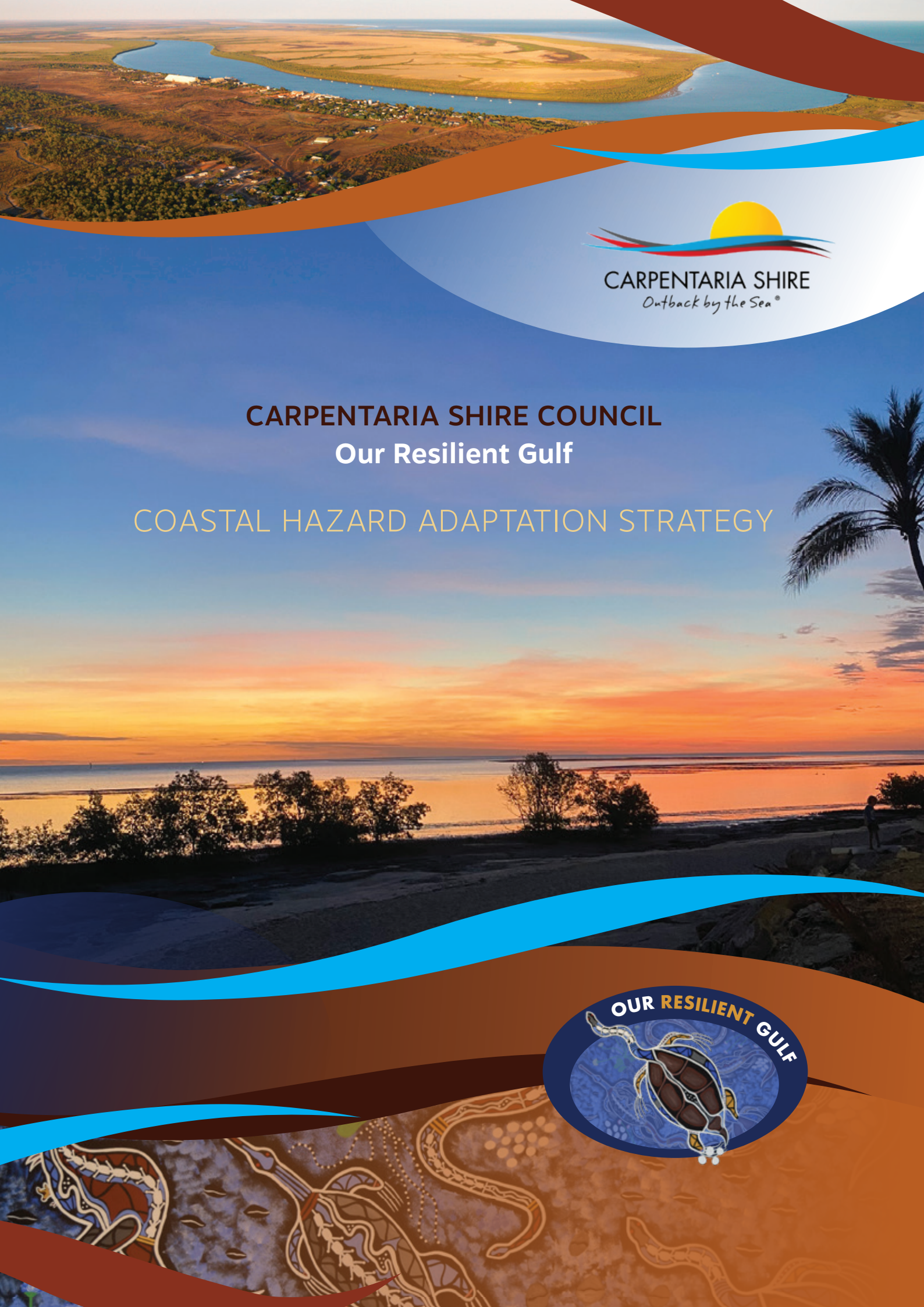


CARPENTARIA SHIRE
Outback by the Sea®

CARPENTARIA SHIRE COUNCIL
Our Resilient Gulf

COASTAL HAZARD ADAPTATION STRATEGY

OUR RESILIENT GULF

ACKNOWLEDGEMENT TO COUNTRY

We acknowledge the Traditional Owners of the Carpentaria Shire, the Gangalidda, Garawa, Gkuthaarn, Kaiadilt, Kukatj, Kurtijar, Lardil, Waanyi and Yangkaal people.

FOREWORD

The Carpentaria Shire coast is a dynamic and varied landscape. Our coastal zone encompasses some of the most iconic landscapes of the Gulf region, with pristine coastal wetlands, estuaries and inlets, marine and terrestrial wildlife and important habitats for migratory birds. The region is characterised by a diversity of cultural, economic and environmental values.

The Traditional Owners of the land, the Gangalidda, Garawa, Gkuthaarn, Kaiadilt, Kukatj, Kurtijar, Lardil, Waanyi, Yangkaal groups, have inhabited and cared for this ancient landscape for thousands of years.

The coast is highly valued by our Traditional Owners, local communities, residents of the broader Gulf Region, and visitors to the area. The coastal landscape and access to the coast underpins our economy.

Coastlines are dynamic, ever-changing with each tide and storm event. Erosion and storm tide inundation are natural processes that shape the coast over long timeframes. These processes are referred to as coastal hazards when they impact on how we use and enjoy the coast.

The Carpentaria Shire coast is prone to coastal hazard impacts, driven by cyclones and summer storm events. Coastal hazard impacts are also predicted to increase with a changing climate.

The State Government and Local Government Association of Queensland (LGAQ) provided funding to Queensland coastal Councils to develop a strategic approach to managing coastal hazards. With the funding awarded to Carpentaria Shire Council, we have been able to develop this Coastal Hazard Adaptation Strategy.

Our Coastal Hazard Adaptation Strategy enables us to be better prepared to reduce the impacts of coastal hazards on our communities, environment, cultural values, infrastructure, liveability and services, both now and into the future (to 2100).

CONTENTS

1. INTRODUCTION

1.1 Our coastline

The Shire of Carpentaria is Queensland's 4th largest Shire and covers around 65,000 km^2 of north west Queensland (Figure 1), on the south east coast of the Gulf of Carpentaria. The Shire of Carpentaria has around 370 km of coastline, largely dominated by low-lying tidal plains. Six major rivers run through the Shire: the Mitchell, Norman, Staaten, Gilbert, Flinders and Leichhardt Rivers. These rivers all drain to the Gulf of Carpentaria to the north east and account for the discharge of around 18.3% of Queensland's and 7.3% of Australia's surface water.

Figure 1. Carpentaria Shire coast

The Gulf of Carpentaria is dominated by a broad, low-gradient basin, bordered in the north by shallow sills. A broad shelf sits to the north of the coast of Carpentaria Shire. The Gulf has been repeatedly submerged and exposed by fluctuating sea levels over the late Quaternary. These sea level changes resulted in the environment changing from open ocean, isolated basins and lakes, to exposed terrestrial environments.

The diversity of our landscape features support a range of land uses, including social, cultural, environmental and economic values.

The landscape has been shaped by coastal processes over many thousands of years. Erosion and accretion of the shoreline, and inundation of coastal areas, are part of these natural processes. However these process can become coastal hazards when they have the potential to impact on infrastructure, access, services, our lifestyle and the economy.

1.2 The Coastal Hazard Adaptation Strategy

Context

The QCoast$_{2100}$ program is a state-wide initiative of the Queensland Government and Local Government Association of Queensland (LGAQ), to help coastal councils proactively plan for managing coastal hazard impacts, from present day to 2100.

Carpentaria Shire Council was awarded funding through QCoast2100 to undertake the *Our Resilient Gulf* program and develop the Coastal Hazard Adaptation Strategy (CHAS).

The Coastal Hazard Adaptation Strategy has been:

- Developed to proactively manage the impact of coastal hazards, now and into the future
- Developed in consultation with stakeholders and communities
- Tailored to include our full coastal landscape and communities.

Purpose

The purpose of The Strategy includes to:

- Inform future decisions regarding the protection and management of our coast and foreshore
- Inform future land use planning
- Guide the management of public utilities and facilities
- Guide the management of areas of environmental and cultural significance
- Foster collaboration and the shared care of our coastline.

Approach

The Coastal Hazard Adaptation Strategy has been developed through an eight-phase process (Figure 2) as outlined in the $QCoast_{2100}$ Minimum Standards and Guidelines (LGAQ and DEHP 2016).

The process has included a series of studies and activities that sought to:

- Identify coastal hazard areas
- Understand vulnerabilities and risks to assets
- Engage with the community to understand the preferred approaches to adaptation
- Determine adaptation actions, costs, priorities, and timeframes for implementation.

Figure 2. $QCoast_{2100}$ eight-phase process

1.3 Engagement

Process

The Strategy development has been informed through consultation with key stakeholder groups and our Carpentaria Shire coastal communities.

Engagement events included:

- Community pop up events in August 2020 and April 2021, at multiple venues including Carpentaria Shire Council Chambers, Karumba Recreation Centre, Karumba Town Shopping Centre and Karumba Point.
- An online community knowledge survey in mid-2020 to inform an appreciation of coastal values and adaptation opportunities.
- A community stakeholder workshop in August 2020 to help build awareness and prioritise important coastal values and assets.
- A four week public comment period in mid-2021.

Communication

During development of the Strategy, communication materials included project updates and a series of tailored fact sheets relevant to coastal hazard adaptation. The fact sheets are provided as Supplement A to this Strategic Plan. The fact sheets include:

- Terminology
- Coastal hazards
- Coastal adaptation
- Resilient housing
- Coastal economics.

Council's website and Council's social media channels were used for publicising the project, sharing information, and encouraging registration and participation.

The engagement and communication process across all phases of the Strategy development was informed by planning undertaken in Phase 1 (CSC 2019a).

Outcomes

All input and feedback assisted to shape the direction of technical investigations underpinning the Strategy, and priority adaptation actions for the Carpentaria coast.

Additional outcomes included:

- A shared understanding of needs and opportunities in the adaptation planning process for the Carpentaria coastline
- Appreciation of objectives for coastal management, and preferred approaches to adaptation.

1. INTRODUCTION (cont.)

1.4 Content of the Strategy

The Strategy includes:

- **Section 2:** An overview of landscape features, values, history, and important elements of a resilient Carpentaria coast
- **Section 3:** An overview of coastal hazards, including erosion and inundation, areas that may be exposed to coastal hazards, and the implications of exposure including potential economic costs.
- **Section 4:** Carpentaria Shire Council's approach to adaptation, including a framework for shared responsibilities, adaptation responses and options.
- **Section 5:** Priority adaptation actions across the Shire.
- **Section 6:** Locality summaries with tailored adaptation actions for different communities.
- **Section 7:** The approach to implementation, including adaptative management and change management planning.

2. CARPENTARIA SHIRE COASTAL ZONE

2.1 Coastal landscape

Values

Well known features of our Carpentaria coastline include:

- Broad, low-gradient basin, bordered in the north by shallow sills
- Vast mangrove forests and intertidal wetlands
- Complex and significant river systems supporting unique biodiversity
- Seasonal weather patterns including elevated water levels and tropical cyclone activity in the wet season.

Key environmental values include:

- **Coastal landforms** – including dune systems, tidal inlets, salt pans, and beach rock cheniers (ridges)
- **Vegetation communities and ecosystems** – including coastal saltmarsh wetlands, seagrass meadows, mangroves and native dune vegetation
- **Significant and endangered species** – including both land and marine environments (e.g. turtles, birds and fish and mammals).

Table 1 provides a summary of key values for the Carpentaria coast. The table provides a summary of the important values related with coastal areas in the region, including tourist and industry values, community and Traditional Owners.

Economy

The unique and beautiful coastal landscape of the Carpentaria coast, or Outback by the Sea®, drives a strong tourism sector that is a significant contributor to the Carpentaria coastal economy.

Throughout the Shire, managed resource protection and agriculture is the dominant land use, with large cattle stations for beef production. Other industries include fishing, prawning, mineral processing, tourism and government administration. Much of the Shire's commercial activity occurs in Karumba, with an active port exporting mining product (mainly zinc) and in previous years cattle to the Asian markets, and a substantial fishing industry. Tourist attractions in the region include the Les Wilson Barramundi Discovery Centre, Krys the Big Crocodile, the Burke and Wills Camp 119 and the Mutton Hole Wetlands, located along the Norman River.

2. CARPENTARIA SHIRE COASTAL ZONE (cont.)

Table 1. Coastal values for the Carpentaria Shire

Value	Description
'The Outback by the Sea' Tourism and destination assets	The amazing fishing, stunning sunrises sunsets over the ocean, great food and laid-back atmosphere have been attracting adventurers and those looking for a quieter life for decades. Many came for a visit and never left. In 2018/19 the total tourism and hospitality sales in Carpentaria was more than $11.5 million. The Carpentaria Shire Tourism Strategy 2020-2023 identifies the following unique destination assets and events: • Only beaches accessible by sealed roads in the Gulf • Fishing in the Gulf waters, rivers and creeks • Unique nature and wildlife • Les Wilson Barramundi Discovery Centre • Sunset experiences along the foreshores • Fishing and crab charters by boat and helicopter • Fishing Classic and other local festivals, such as Outback by the Sea • Caravan and camping facilities. The main tourist season is the dry season from April to October each year.
Connection to Country and Traditional Owners values	There are nine Traditional Language Groups in the Southern Gulf region including (in alphabetical order) – Gangalidda, Garawa, Gkuthaarn, Kaiadilt, Kukatj, Kurtijar, Lardil, Waanyi, Yangkaal. For the Traditional Owners, what we know today as the Carpentaria Region is their cultural and spiritual home. Their songlines, storylines, totems, sacred sites and cultural artefacts still exist today in this region. With the legal recognition of their rights and interests comes the opportunity to pursue a range of business and economic development opportunities for local Traditional Owners. They are a critical part of an economically sustainable and prosperous future. The waters and coastal environments are core to many of these activities including for cultural tourism, rural and industry-based enterprises, and arts. The highly regarded Normanton Land and Sea program is coordinated by the Carpentaria Land Council Aboriginal Corporation and comprises Rangers from three language groups - Kukatj, Gkuthaarn, and Kurtijar. Their activities include feral animal and weed control, turtle and dugong management, protection of cultural sites and knowledge sharing.
Fin fish, crab and prawn fisheries	Karumba is known as the 'fishing frontier', and many visitors make an annual pilgrimage to the region. Commercially, the region is best known for its barramundi and prawn fisheries with the Northern Prawn Fishery being valued at $65 million (2011-12). Both the barramundi and prawn fisheries are now carefully managed, dependent on a healthy environment, including the estuaries and seagrass meadows required for breeding. The region also has the only hatchery in the world to breed the Southern Gulf strand of Barramundi.

2. CARPENTARIA SHIRE COASTAL ZONE (cont.)

Value	Description
Pastoral industry And live cattle exports	The Carpentaria Region is home to a thriving pastoral industry, dating back to the early 1900s with a number of stations across the vast plains of the region. These include Delta Downs, owning and operating Delta Downs, Karumba Downs and Magieville Outstation, with a herd of approximately 45,000 head. The station is owned by the Kurtijar people, the Traditional Owners of the land over which the stations are located. The station is a key employer of Aboriginal workers and youth from across the region. The station is strategically located close to Karumba, where the live export terminal for the Asian markets is located. Another important station for the Carpentaria Region is Stanbroke Gulf Coast Agricultural Co.
Unique wetland ecosystems	The region comprises significant diversity of coastal ecosystems including vast saltpans and wetlands which attract thousands of migratory wader birds each year and provide breeding, feeding, moulting and drought refuge for many other residents including sarus cranes, brolgas, pelicans and jabirus. Places such as the 9,000ha Mutton Hole Wetlands have cultural significance as well as ecological.
Habitat for turtle and dugong	Their greatest threats include climate change, lack of nesting, breeding and feeding sites, as well as marine pollution. Turtle and dugong are significantly important traditional food sources for local Aboriginal peoples.
Early European history	The Gulf's European history dates back to the late 1800s evidenced today by the old remnants of wharfs and buildings. This early infrastructure highlights the region's pioneering history by European explorers Burke and Wills, its proximity to strategically important sites in both World Wars, early commercial fishing industry and 'prawn rush', and home of the Empire Flying Boats.

2. CARPENTARIA SHIRE COASTAL ZONE (cont.)

2.2 Towards a Resilient Coast

Change and resilience

The coastline is a dynamic and picturesque part of the landscape, where the land meets the sea. One of the most challenging aspects of the coastal landscape is that it experiences constant, and often rapid change.

Wind and waves continually work to move sediment and shape the shoreline, and extreme weather events can periodically result in substantial erosion and inundation of coastal land.

A resilient coast has social, economic and environmental systems in place to avoid, manage and mitigate the impact of hazardous events or disturbances (e.g. coastal hazards). Resilience also means the ability to respond or reorganise in ways that maintain the essential function, identity and values of a region, while also being able to proactively adapt to change.

For the Carpentaria region, coastal hazard adaptation options have been developed in keeping with the identity and values of our coastal communities.

During a number of discussions and engagement activities, the following elements were identified as important for a resilient Carpentaria coast:

- Tourism values
- Environmental values
- Cultural values
- Recreation values
- Place based values
- Infrastructure
- Public safety.

3. COASTAL HAZARDS

3.1 Hazards

Coastal hazards include inundation of low-lying coastal land, and / or erosion of the shoreline.

Periodic inundation and erosion are natural processes and contribute to shaping the unique landforms of our coastal zone. However, when these processes have an adverse impact on communities, infrastructure and some natural assets, they are considered coastal hazards. In the Southern Gulf, major coastal hazard impacts are typically associated with wet season monsoons and occasional Tropical Cyclones.

3.2 Storm tide inundation

Storm tide inundation is the flooding of low-lying coastal land from a locally elevated sea level (the 'storm tide'). The storm tide is a combination of the predicted tide, storm surge, and wave action (Figure 3). Storm surge is driven by the combined influence of low atmospheric pressure and high winds associated with events such as Tropical Cyclones.

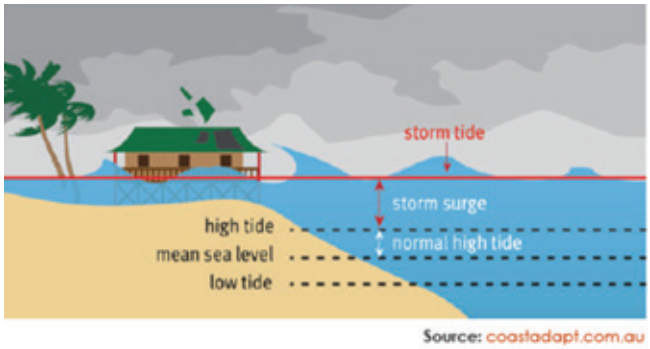


Figure 3. Components of storm tide

3.3 Coastal erosion

Coastlines naturally erode and accrete over time, driven by variations in sediment supply and climate patterns.

Short term erosion

Coastal erosion occurs when winds, waves and coastal currents act to shift sediment away from the shoreline. This can be a short-term shift, often associated with storm activity (termed storm bite), and the beach will then gradually rebuild (Figure 4).

When a beach is stable, all of the sand moved offshore during a storm eventually moves back onto the beach (over timeframes of months to years). In this case periodic beach erosion does not result in a long term landward movement of the shoreline.

Long term erosion

In other cases, due to changing sediment supply or climate conditions, the beach may not have sufficient capacity to rebuild between storm events. In the absence of intervention, long-term erosion (termed recession) may occur, which is the landward movement of the shoreline over longer timeframes (decades).

Both short term and long-term erosion processes may impact on coastal assets, depending on how close to the fore-dune assets are located.

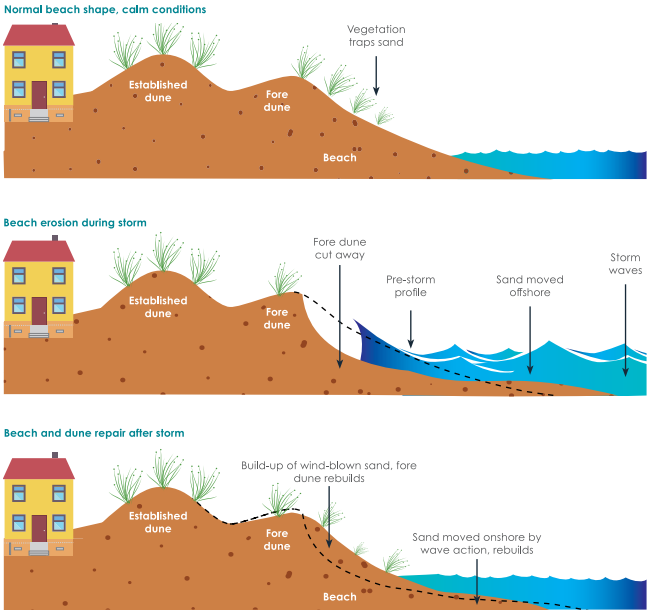


Figure 4. Natural short term erosion and dune rebuilding process

3.4 Tidal inundation due to sea level rise

Tidal inundation is regular inundation from the tidal cycle, including up to the Highest Astronomical Tide. Areas of low-lying coastal land will be prone to an increased extent of tidal inundation with sea level rise. A 0.8 m sea level rise by 2100 is currently planned for by the Queensland State Government.

3.5 Current and future exposure

Updated mapping

The Carpentaria Shire coast is prone to cyclone and storm events, and coastal hazard impacts are predicted to increase with a changing climate.

As part of the *Our Resilient Gulf* program, the existing mapping for Erosion Prone Areas and predicted storm tide inundation zones have been updated for the main coastal towns of Karumba and Normanton. These updates have been based on the best available technical data, and have included:

- Application of the State Government approach to defining Erosion Prone Areas, tailored to the Carpentaria region in consultation with State and LGAQ[1]
- Updated mapping of storm tide inundation zones based on previous study outputs[2].

Based on the state-wide approach to mapping, the Erosion Prone Area includes components of:

- Open coast erosion: the tidal area plus a horizontal buffer to account for the erosion risk.
- Tidal areas: the combined area inundated by the Highest Astronomical Tide plus a defined vertical buffer due to sea level rise.

As required by State Government, a sea level rise of 0.8 m by 2100 has been adopted for the Coastal Hazard Adaptation Strategy (with 0.3 m by 2050).

Planning horizons

Mapping for both erosion and storm tide inundation includes multiple planning horizons and event likelihoods[3] (Table 2).

Table 2. Likelihood of occurrence scenarios

Likelihood of occurrence	Hazard AEP	Planning horizons
Likely	2%	Present-day, 2050, 2100
Possible	1%	Present-day[4], 2050[4], 2100
Rare	0.5%	Present-day, 2050, 2100

Maps of the 2100 1% AEP are provided in Supplement B to the Strategy.

Erosion Prone Areas and storm tide inundation zones do not represent a predicted loss of coastal land. The maps provide an indication of areas that may be exposed to erosion or inundation processes (now or in the future), and in many cases the impacts can be avoided, mitigated or managed through adaptation planning.

Additional detail on the mapped components and the approach is provided in the Phase 3 summary report (CSC 2020a).

FUTURE IMPACTS

Projected sea level rise and an increase in cyclone intensity for the Queensland coastline is anticipated to increase the extent and impact of coastal hazards.

Coastal erosion:

- Increased water levels will accelerate coastal erosion
- Sediment transport patterns may be altered by shifts in wave direction, triggering changes to the form and location of shorelines
- Low-lying land may be permanently inundated
- Increased cyclone and storm activity will escalate the severity of coastal erosion events

Storm tide inundation:

- Sea level rise will increase the apparent severity and frequency of storm tide inundation and will cause inundation to occur further inland
- Increased cyclone and storm intensity will add to the magnitude of storm tide events and the extent of inundation.

Source: Coastal Hazard Technical Guideline (DEHP 2013)

[1] Refer Phase 3 summary report (CSC 2020a)

[2] Refer Phase 3 summary report (CSC 2020a)

[3] Default areas only for Erosion Prone Area, all AEPs for storm tide inundation

[4] Data not available for all events/planning horizons see Phase 3 report

Exposure

Land in and around Karumba will be increasingly exposed to tidal area inundation (permanent tidal area expansion due to sea level rise and buffer land adjacent). For example, regular inundation of commercially zoned land is expected to increase from 7% present day to 24% in 2100, residentially zoned land is expected to increase from 4% presently to 19% in 2100, and community infrastructure zones are expected to increase from 10% presently to 66% in 2100.

The area in and around Normanton will be increasingly exposed to tidal area inundation (permanent tidal area expansion due to sea level rise and buffer land adjacent), however to a lesser extent than Karumba. Rural zoned land is expected to be increasingly exposed from 30% presently to 43% in 2100.

A greater proportion of land is exposed to storm tide inundation. Presently, 3% of residential land in Karumba is exposed to a 2% likelihood event, however this is expected to increase to 25% in 2100. These percentages increase when rarer events are considered with extensive areas temporarily inundated with a 0.5% event in 2100.

Coastal erosion has occurred at Karumba Point with numerous privately owned properties and businesses potentially exposed to future events.

3.6 Potential impacts

Approach

Coastal hazards have the potential to have adverse impacts on Carpentaria Shire's coastal communities, services and lifestyle, in both the present day and by 2100.

As part of the *Our Resilient Gulf* program, new technical assessments have been undertaken to review coastal hazard risk for a range of assets across the region. The risk assessment has included analysis of:

- Data on infrastructure assets (drainage, sewerage, water, roads, marine, beach and foreshore)
- The Carpentaria Shire Council planning scheme land parcels
- New information collated on dwellings in Karumba (building locations, types)
- Environmental overlays.

Risk is assessed based on the likelihood of an asset being exposed to a coastal hazard, combined with the consequence of that exposure (Table 3).

Table 3. Risk matrix

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Likelihood	**Likely 10% AEP**	Low	Medium	High	Very high	Very high
	Possible 1% AEP	Low	Medium	Medium	High	Very high
	Rare 0.2% AEP	Low	Low	Medium	Medium	High

3. COASTAL HAZARDS (cont.)

A tailored approach to assessing consequence was developed, based on stakeholder and community feedback on the important elements for the coastal zone (property and infrastructure, economy and growth, public safety, environmental values, Traditional Owner values, community services and lifestyle) (Table 4).

To complete the risk assessment:

- The likelihood of exposure (likely, possible, rare) was determined for each asset / land parcel, separately for erosion and inundation
- The consequence of exposure (insignificant, minor, moderate, major, catastrophic) was determined for each asset / land parcel, separately for erosion and inundation
- Coastal hazard risk was assessed (low, medium, high, very high), based on the likelihood and consequence for each asset / land parcel, separately for erosion and inundation
- Outputs from the risk analysis were mapped for Karumba and Normanton[5], to review the distribution of assets / land at risk from coastal hazards.

[5] Refer Phase 5 Summary report (CSC 2020c)

Table 4. Consequence categories (modified from LGAQ and DEHP 2016)

	Place and planning and sustainability			Community and lifestyle		Environment
Consequence	**Property and infrastructure**	**Economy and growth**	**Public safety**	**Lifestyle**	**Traditional Owner values**	**Environmental values**
Catastrophic	Widespread major damage or loss of property or infrastructure with total value >$10 million. Full recovery/repair may take many years.	Regional economic decline, widespread business failure and impacts on state economy.	Loss of lives and/or permanent disabilities.	Widespread semi-permanent impact (~1year) to highly utilised community services, wellbeing, or culture of the community with no suitable alternatives.	Severe and widespread, permanent impact on multiple sites of indigenous significance, including loss of land, connection to land, and ability to continue traditional practices. Recovery unlikely.	Severe and widespread, permanent impact on multiple regionally or nationally significant ecosystem services and natural features of the region. Recovery unlikely.
Major	Major damage or loss of property or infrastructure with total value >$5 million. Full recovery/repair may take several years	Lasting downturn of local economy with isolated business failures and major impacts on regional economy.	Widespread serious injuries/ illnesses.	Major widespread long-term (~1 month) disruption to well-utilised services, wellbeing, or culture of the community with very few alternatives available.	Severe and widespread semi-permanent impact on one or more sites of indigenous significance, including loss of land, connection to land, and ability to continue traditional practices. Full recovery may take many years.	Severe and widespread semi-permanent impact on one or more regionally or nationally significant ecosystem services and natural features of the region. Full recovery may take many years.
Moderate	Moderate - major damage to property or infrastructure with total value >$1 million. Full recovery may take less than 1 year.	Significant impacts on local economy and minor impacts on regional economy.	Isolated serious injuries/ illnesses and/or multiple minor injuries/ illnesses.	Minor medium- to long-term (~1 week) or major short-term disruption to moderately utilised services, wellbeing, or culture of the community with limited alternatives.	Substantial impact on one or more sites of local indigenous significance. Full recovery may take several years.	Substantial impact on one or more locally significant ecosystem services and natural features of the region. Full recovery may take several years.

3. COASTAL HAZARDS (cont.)

Table 4. Consequence categories (modified after LGAQ and DEHP 2016)

	Place and planning and sustainability			Community and lifestyle		Environment
Consequence	**Property and infrastructure**	**Economy and growth**	**Public safety**	**Lifestyle**	**Traditional Owner values**	**Environmental values**
Minor	Minor damage to properties or infrastructure with total value >$200,000.	Individually significant but isolated impacts on local economy.	Minor and isolated injuries and illnesses.	Small to medium short-term disruption (~1 day) to moderately utilised services, wellbeing, finances, or culture of the community with some alternatives available, or more lengthy disruption of infrequently utilised services.	Small, contained and reversible short-term impact on sites of indigenous significance. Full recovery may take less than 1 year.	Small, contained and reversible short-term impact on isolated ecosystem services and natural features of the region. Full recovery may take less than 1 year.
Insignificant	Minimal damage to properties or infrastructure with total value >$50,000.	Minor short-term impact on local economy	Negligible injuries or illnesses.	Very small short-term disruption (~1 hour) to services, wellbeing, finances, or culture of the community with numerous alternatives available.	Little to no impact to sites of indigenous significance.	Little to no environmental impact.

Economic costs (base case)

In the absence of intervention / adaptation, there are economic costs associated with coastal hazards.

Economic analysis is important for determining the best approach to coastal hazard adaptation for different localities. Economics is used in several ways including to:

- Value assets and key industries
- Define a base case (cost of no action)
- Assess adaptation options.

After assigning values to key infrastructure and natural assets[6], the foundational step of an economic assessment in coastal hazard adaptation is to define a base case (Figure 5). This means determining the potential economic costs or losses associated with coastal hazards (and no additional adaptation/ intervention, i.e. business as usual). This becomes the baseline for a cost-benefit assessment of implementing adaptation options.

The base case for the Carpentaria Shire coast has been determined by examining the likelihood and consequence ($ damage) of coastal hazard impacts on assets, and at different timeframes (e.g. present day, 2040, 2070 and 2100).

[6] Refer to Phase 7 summary report (CSC 2021)

3. COASTAL HAZARDS (cont.)

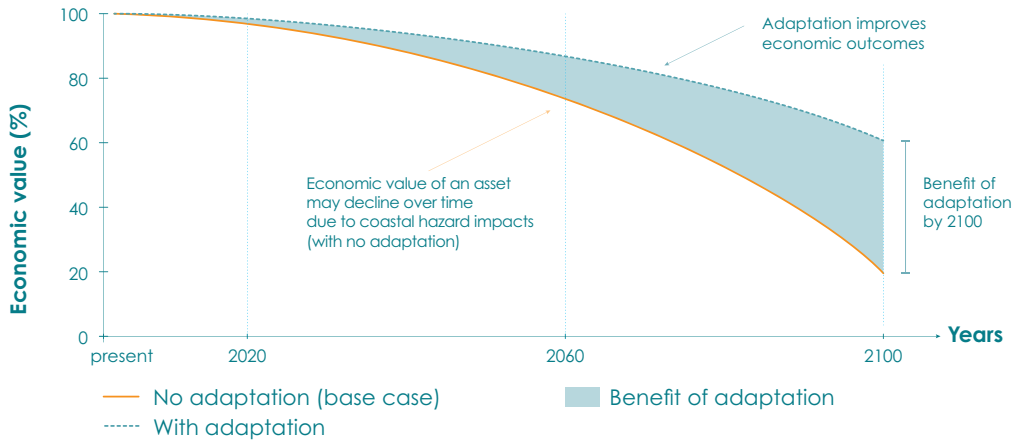


Figure 5. Economic base case and benefit of adaptation

For Carpentaria, five key components of damages / losses have been considered for the base case:

1. **Damage to buildings and facilities** – Public and private buildings, and structures such as marinas and swimming pools, among others. This is the financial cost of repairing or replacing these assets.
2. **Damage to other infrastructure and facilities** – Such as electricity, sewerage, drainage, and water supply infrastructure.
3. **Damage to transport infrastructure** – Including roads, pathways, and bridges. This is the financial cost of repairing or replacing the assets and can also trigger other economic losses where access to key sites is lost.
4. **Losses of land, environmental and cultural assets** – Such as wetlands, national parks, and habitats for threatened species. This is the lost value from a reduction of these assets.
5. **Damage to beach and foreshore assets** – Such as lifesaving towers, pontoons, jetties, playgrounds, shelters, storm tide valves, and other beachside facilities.

Average Annual Damages (AAD)

Combined potential annual damages from all coastal hazards for the Carpentaria Region ranges from around $13.6M at present day, to $21.7M by 2050, and $64.5M by 2100. This represents the potential economic value of costs that can be mitigated through adaptation / intervention.

Losses of natural assets has been considered separately to infrastructure assets. Estimating these damages/losses carries significant uncertainty, however, does provide a means of assessing potential damages associated with coastal hazard impacts on natural assets over time.

4. APPROACH TO ADAPTATION

4.1 Framework

Council's role

Carpentaria Shire Council recognise a shared responsibility for the management of coastal hazard risk; shared by Council, other land managers and private landowners. Council's primary responsibility is the maintenance and protection of Council land and assets, and to inform statutory planning.

Council's role in adaptation varies depending on the type and ownership of different assets (Table 5). Council's role includes to:

- **Inform** – Council will make available to all stakeholders (including public and private land and asset owners) the outcomes of relevant Council-led investigations on coastal hazard risk, planning and adaptation options.
- **Observe** – Council will actively observe / monitor coastal hazard risk for Council owned land and assets. For land and assets owned or managed by others, Carpentaria Shire Council may, as part of everyday activities, observe a risk from coastal hazards and will notify the relevant landowner/manager.
- **Plan** – Council will develop strategic planning measures to mitigate the risk of coastal hazard impacts on Council owned land and assets, and to inform appropriate land use planning across the region.
- **Act** – Council will implement strategic planning measures to mitigate the risk of coastal hazard impacts on Council owned land and assets, and to inform appropriate land use planning across the region.

Initiatives in the Coastal Hazard Adaptation Strategy also seek to foster and enable other stakeholders to proactively manage coastal hazard impacts on their own/land assets in accord with the Strategy and in consultation with Council.

Table 5. Council's role in coastal hazard adaptation

		Land or asset type		
		Council owned	Managed by other authorities	Privately owned
Council's role	Inform	✓	✓	✓
	Observe	✓	○	✗
	Plan	✓	✗	✗
	Act	✓	✗	✗

4. APPROACH TO ADAPTATION (cont.)

A strategic approach

Across Australia and internationally, coastal land managers are taking a strategic approach to managing the risk of coastal hazards, and enhancing the resilience of our coastal zones.

Common elements of this strategic approach include:

- Assigning a strategic adaptation response to different localities, to guide decision making with a pathways approach across present day, intermediate and 2100 planning horizons
- Assessing the range of adaptation options suitable in different locations to help avoid, mitigate, and manage the risk of coastal hazards
- Developing a strategic plan for coastal adaptation, with prioritised actions over a 5—10 year timeframe.

A tailored approach has been developed to guide decision making on adaptation response and options across the Carpentaria Shire coast.

Adaptation objectives

The purpose of clarifying adaption objectives is to help guide an appropriate adaptation response, and to screen adaptation options, across different localities.

Objectives for our Carpentaria Shire coast, as informed by consultation with stakeholders and the community, include to:

- Protect the Karumba foreshore and important assets that are drivers of the local economy
- Retain the natural beauty and landscapes of the coast
- Protect coastal habitats and ecosystems, supporting diverse wildlife including migratory birds
- Protect culturally significant Aboriginal sites and practices

Minimise potential impacts of coastal hazards on local industries, including tourism and cattle farming

These objectives provide a reference for considering the suitability of different coastal hazard adaptation options across the Shire.

Adaptation response

The tailored framework includes four adaptation responses – Avoid, Monitor, Mitigate, and Transition (Table 6).

Avoid

The general first principle is to avoid placing new development or assets in coastal hazard areas. The preference is to ensure land use in coastal hazard areas is one that is low risk for coastal hazard impacts, while also being a use that maximises economic, social, and environmental value to the region.

Any new development / infrastructure that is placed in coastal hazard areas will need to be in accord with State planning policy and approvals requirements and include necessary mitigation measures.

Monitor

In areas where the coastal hazard risk profile is low, Council will continue to monitor risk and undertake existing maintenance / asset management activities. If, over time, the risk profile is observed to increase (as indicated by local trigger levels), then the adaptation response may shift to mitigate.

Mitigate

At localities where coastal hazard risks have been identified, Council will actively manage the risk through implementing a range of adaptation options.

Mitigation will be tailored to each locality, incorporating site-specific processes, community input, and statutory planning considerations. If, over time, the risk profile is observed to increase (as indicated by local trigger levels), and mitigation becomes infeasible (due to economic or other factors), then the adaptation response may shift to transition.

Transition

In some specific areas within a locality, if the coastal hazard risk profile is very high, and/or mitigation becomes infeasible (due to economic or other factors), Council may make a strategic decision to transition to an alternative land use. Transition is likely to be a gradual process over time, where mitigating hazards for a period is part of the transition process.

4. APPROACH TO ADAPTATION (cont.)

Table 6. Adaptation response

	Coastal hazard adaptation			
	Avoid	**Monitor**	**Mitigate**	**Transition**
Adaptation response	Avoid placing new development or assets in coastal hazard areas.	Monitor the risk of coastal hazards. Monitor until local trigger levels are reached to initiate mitigation.	Actively mitigate the risk of coastal hazards through a range of adaptation options. Mitigate until local trigger levels are reached to initiate transition.	A strategic decision to transition to an alternative land-use in some areas. Mitigation may be part of the transition process.
Adaptation options	Monitoring and initiatives to enhance adaptive capacity		Full range of adaptation options (Table 7)	

4. APPROACH TO ADAPTATION (cont.)

Adaptation options

Four themes of adaptation options have been defined for the Strategy, with a range of options that relate to avoiding, mitigating and managing the risk of coastal hazards. The themes are:

1. Shire-wide initiatives to enhance adaptive capacity
2. Planning updates
3. Modifying infrastructure
4. Coastal management and engineering.

The range of common adaptation options across these themes are described in Table 7. More detailed descriptions of the options are provided in Supplement C to the Strategy, along with a preliminary screening of the relevance of options to different localities.

Table 7. Common adaptation themes and options

Theme	Adaptation options	Description	Attachment A summary sheet number
Shire-wide initiatives to enhance adaptive capacity	Community stewardship	Developing programs and partnerships to enhance stewardship of the coastline	Sheet 1
	Knowledge sharing	Facilitating knowledge sharing and education on hazards and adaptation	Sheet 2
	Monitoring	Monitoring changes in coastal hazard risk and effectiveness of adaptation	Sheet 3
Planning updates	Land use planning	Informing statutory planning and strategic plans Includes consideration of land purchase or land swap/relocation	Sheet 4
	Disaster management	Updating emergency response planning	
Modifying infrastructure	Increase infrastructure resilience	• Modifying critical infrastructure (e.g. raising floor levels) • Modifying drainage networks • Building resilient homes	Sheet 5
	Relocate infrastructure	• Relocating critical infrastructure	
Coastal management and engineering	Dune protection and maintenance	Minimising dune disturbance, maintaining vegetation	Sheet 6
	Beach nourishment	Beach scraping and / or importing additional sand to the beach	Sheet 7
	Structures to assist with sand retention	Using structures (groynes, artificial headlands or similar) to help retain sand	Sheet 8
	Structures to dissipate wave energy	Constructing offshore breakwaters or artificial reefs to dissipate wave energy (submerged or exposed)	Sheet 9
	Last line of defence structures	Constructing seawalls / revetments	Sheet 10
	Structures to minimise inundation	Constructing levees / dykes	Sheet 11

4.2 Adaptation response by locality

Adaptation response has been assigned for a series of key localities across the region. The adaptation response takes into consideration what is at risk (land and assets), and how the risk is changing over time – the emerging risk profile (present day, 2050, and 2100)[7] (Table 8).

Table 8. Adaptation responses by locality

CHAS Zone Name	2020	2050	2100	Comments
Karumba Point	Mitigate*	Mitigate	Mitigate**	Ongoing erosion and storm tide inundation exposure requires short term intervention and long term strategy for integrated, active management.
Karumba Town	Monitor	Mitigate	Mitigate**	Monitoring of coastal protection along the Norman River is a priority to identify key interventions in the future. Ongoing maintenance of seawalls and protection structures required.
Normanton	Monitor	Monitor	Monitor	Monitor the impact of future storm tides and king tides level on the township. Area is already exposed to large scale river floods.
Other areas*	Monitor	Monitor	Monitor	Monitor the impact of future storm tides and king tides level on rural areas and natural areas, in particular those pastoral areas near Karumba, privately owned.

** Mitigation already taking place*

*** Possible transition of some parts of shoreline – transition planning discussion to commence*

4.3 Determining adaptation actions

A range of adaptation actions have been defined to enable a strategic approach to coastal hazard adaptation across the Carpentaria Shire coast. A suite of priority actions across the four themes (Table 7) has been defined at:

- The regional scale (outlined in Section 5)
- The locality scale as part of the adaptation response pathway (outlined in Section 6).

The program of priority actions has been informed by the initial screening of options, as well as a detailed cost-benefit analysis for tailored coastal engineering options for Karumba Point[8].

There is not a strong economic case for engineered adaptation options in present day, however, some built options are expected to become economically viable over time. There are other drivers for considering the suitability of these options and willingness to invest. This includes broader strategic initiatives to maintain access and cultural values.

Baseline actions of dune protection and maintenance, and mangrove protection and enhancement, will be critical for enhancing resilience.

Actions across capacity building, land use planning and modifying infrastructure are the core focus for most localities, combined with some site-specific targeted investigations to inform future updates to the adaptation pathways.

Results may also change over time and should be the subject of future Strategy updates.

[7] As per technical investigations in the Phase 5 and 6 summary reports (CSC 2020c, 2020d)

[8] Refer Phase 7 summary report (CSC 2021a)

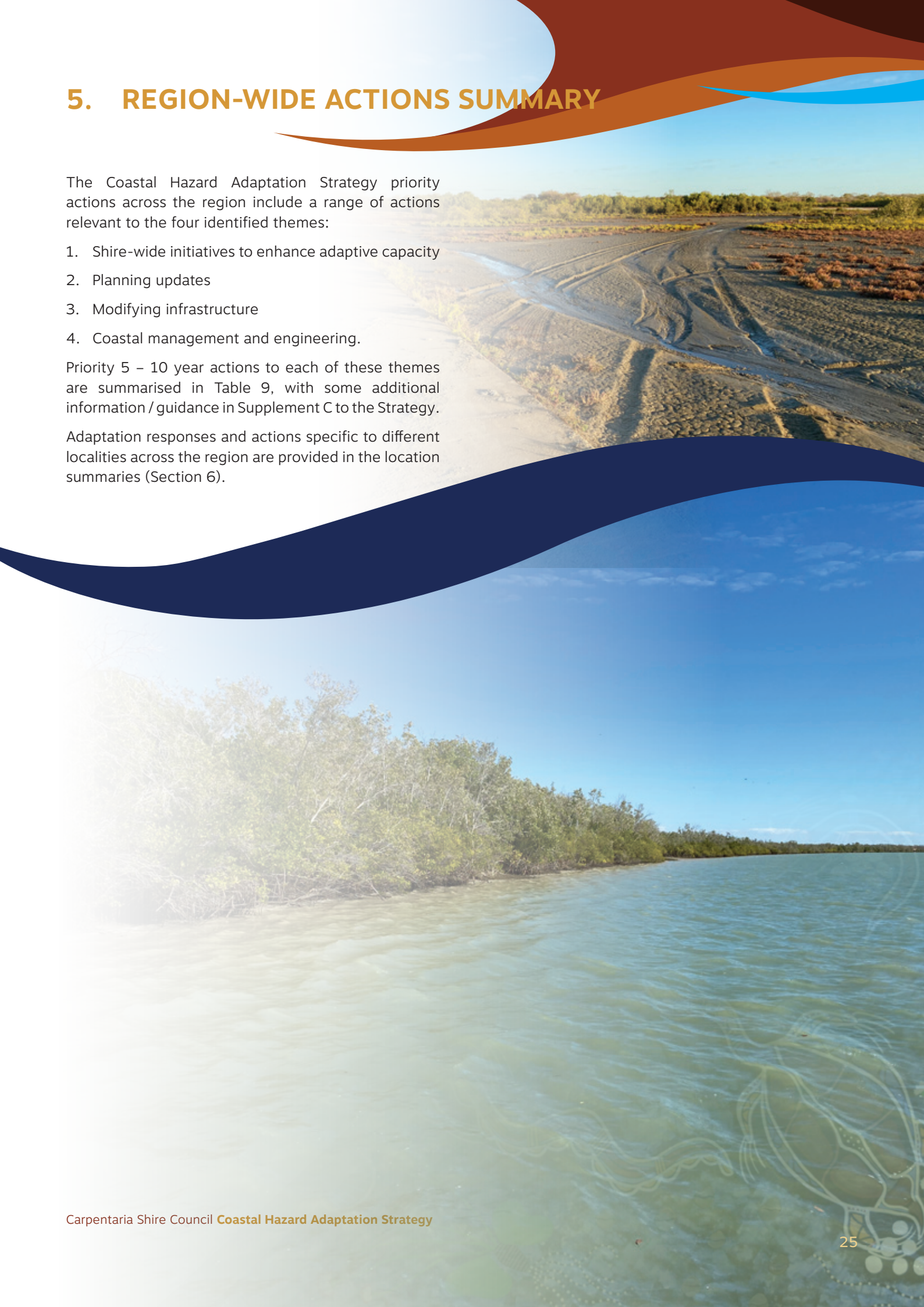
5. REGION-WIDE ACTIONS SUMMARY

The Coastal Hazard Adaptation Strategy priority actions across the region include a range of actions relevant to the four identified themes:

1. Shire-wide initiatives to enhance adaptive capacity
2. Planning updates
3. Modifying infrastructure
4. Coastal management and engineering.

Priority 5 – 10 year actions to each of these themes are summarised in Table 9, with some additional information / guidance in Supplement C to the Strategy.

Adaptation responses and actions specific to different localities across the region are provided in the location summaries (Section 6).



5. REGION-WIDE ACTIONS SUMMARY (cont.)

Table 9. Region wide actions

Theme	Strategic action no.	Description	2021 Priority strategic actions (completed within 5 – 10 years)
1. Shire wide initiatives to enhance adaptive capacity	1.1. Community stewardship	Develop programs and partnerships to enhance stewardship of the coastline.	1.1.1 Assign coastal management work program to relevant council area/staff 1.1.2 Establish a natural foreshore and dune protection and maintenance program, and mangrove protection and enhancement program utilising a mix of Council and volunteers' time 1.1.3 Seek co-funding / resources for further initiatives through grants and stakeholder partnerships for CHAS related initiatives, including LandCare grants, Queensland Reconstruction Authority grants (QRRRF) and other state and federal grants 1.1.4 Establish collaborative partnership in coastal hazard management with Carpentaria Land Council Aboriginal Corporation (CLCAC), Southern Gulf NRM and Northern Gulf NRM 1.1.5 Promote coastal hazard education in schools in collaboration with external partners and providers (e.g. CLCAC and others) 1.1.6 Establish citizen photo monitor point at selected locations
	1.2. Knowledge sharing	Facilitate knowledge sharing and education on hazards and adaptation. Knowledge sharing includes collaborative partnerships.	1.2.1 Identify networks / forums for knowledge sharing (internal and external), including opportunities to share information with Carpentaria Shire Council 1.2.2 Establish a collaborative partnership with Traditional Owners 1.2.3 Facilitate training for staff in coastal resilience management 1.2.4 Promote cross-sector partnerships and initiatives to enhance resilience and strategic adaptation for tourism 1.2.5 Support research collaborations with Universities and research organisations through partnerships (e.g. ARC Linkage, NESP funding) 1.2.6 Support research in catchment management and its impact on coastal vulnerability (e.g. impact of water quality on vegetation; land loss and erosion in the catchment related to land use)
	1.3. Monitoring	Monitor changes in coastal hazard risk and effectiveness of adaptation.	1.3.1 Establish partnership with CLCAC to monitor shorelines and the impact of erosion and inundation 1.3.2 Establish partnership with Delta Downs and CLCAC to support monitoring the risk of saltwater intrusion into pastoral land and water bodies 1.3.3 Establish a shoreline and beach condition monitoring system at Karumba Point, led by Council staff 1.3.4 Establish a foreshore and riverbank condition monitoring system in collaboration with CLCAC rangers 1.3.5 Expand and support the CLCAC shoreline monitoring program with georeferenced photo points to monitor erosion and land loss to sea inundation 1.3.6 Expand and support the CLCAC marine pollution reduction program to maintain healthy marine vegetation to reduce erosion impacts

5. REGION-WIDE ACTIONS SUMMARY (cont.)

Theme	Strategic action no.	Description	2021 Priority strategic actions (completed within 5 – 10 years)
1. Shire wide initiatives to enhance adaptive capacity (cont.)	1.4 Research	Strengthen research collaborations with Universities and research organisations in exploring coastal hazards and future adaptation.	1.4.1 Establish collaboration with key universities and research centres to progress suitable actions in the Strategy 1.4.2 Apply for collaborative government funding grants for relevant actions
2. Planning updates	2.1. Land use and strategic planning	Use the outcomes of the CHAS to inform statutory planning and other strategic plans.	2.1.1 All planning matters undertaken by Council to incorporate and have regard to the new coastal hazard information presented in the Coastal Hazard Adaptation Strategy 2.1.2 Consider implications (within Council) of the Strategy for future development approvals and conditions including: - approval conditions for lots of un-developed land with existing approvals - implications for future development approvals and conditions. 2.1.3 For the next scheduled Planning Scheme update, use the updated Erosion Prone Area and storm tide inundation extent and outcomes of the Strategy to inform decisions on development areas and strategic land use planning
	2.2. Disaster management	Update emergency response planning.	2.2.1 Use the updated Erosion Prone Area and storm tide mapping, assets exposure and risk assessment to update the Carpentaria Shire Local Disaster Management Plan
	2.3. Early warning systems	Early warning systems for erosion and storm tide inundation.	2.3.1 Investigate potential use of early warning system service using up-to-date technologies (e.g. EWN/Weatherzone) 2.3.2 Provide early warning training to the Carpentaria community using updated technologies (e.g. organise community resilience day, use social media) 2.3.3 Continue and update Storm Tide Guide and guidance for residents
3. Modifying infrastructure	3.1. Resilient infrastructure	Modifying critical infrastructure (e.g., raising levels).	3.1.1 Review at risk infrastructure (from the Strategy data outputs) and embed risks into current asset management plans. This could include 'betterment' at critical asset refurbishment/ renewals points. Linked to 3.2.1 3.1.2 Review of road renewals and upgrades (prioritisation). Linked to 3.2.1 3.1.3 Consult with utility providers on future services and upgrades and implications of coastal hazard areas. 3.1.4 Consider developing specific coastal hazard overlay code in future planning updates. Linked to action 2.1
	3.2 Resilient homes	Build homes following resilience guidelines and requirements.	3.2.1 Integrate resilient homes criteria in the planning approvals procedures 3.2.2 Promote resilient homes within the community and building sector (link in with knowledge sharing initiatives). 3.2.3 Consider developing specific coastal hazard overlay code in future planning updates. Linked to action 2.1

5. REGION-WIDE ACTIONS SUMMARY (cont.)

Theme	Strategic action no.	Description	2021 Priority strategic actions (completed within 5 – 10 years)
3. Modifying infrastructure (cont.)	3.3. Relocate infrastructure	Relocate critical infrastructure.	3.3.1 When updating asset management plans, consider the long term (2100) coastal hazard risk, and consider options for relocation if needed. Linked to 3.1.1 & 3.1.2
4. Coastal management and engineering	4.1. Nature based foreshore protection and maintenance	Minimise foreshore disturbance, maintain dunes and riparian vegetation.	4.1.1. Create pilot dune and riparian vegetation protection and maintenance programs at specific locations in collaboration with CLCAC 4.1.2 Extend the dune and riparian vegetation protection and maintenance program to all relevant locations 4.1.3 Continue and expand the rubber vine eradication program along tidal waterways and riverbanks 4.1.4 Link to 1.3 monitoring activities for marine pollution reduction and mangrove monitoring Marine Pollution Reduction and Mangrove monitoring
	4.2 Beach nourishment	Continue beach nourishment alone or in combination with coastal protection measures.	4.2.1 Investigate cost-effectiveness and environmental soundness of sources of sand for beach nourishment 4.2.2 Investigate funding sources / develop business case for alternate sand nourishment sources both onshore and offshore 4.2.3 Discuss potential offshore sand sources with State and Ports (possibly offshore sandbank near Beacon 10) 4.2.4 Identify priority areas for coastal nourishment 4.2.5 Create long term program for beach nourishment and maintenance
	4.3 Last line of defence structures	Rockwall or seawalls alone or combined with nourishment and vegetated dunes to protect the shoreline from storms and erosion.	4.3.1 Identify funding sources for the design and implementation of rockwall protection potentially as part of foreshore improvements and masterplan 4.3.2 Have discussions with State in regard to potential approval of seawall to be implemented to protect at risk infrastructure or if required after extreme weather event 4.3.3 Undertake design of seawall protection and general shoreline protection measures potentially as part of foreshore improvements and masterplan 4.3.4 Identify strategic sources of construction materials 4.3.5 Maintain existing seawalls at Karumba Township

6. LOCATION SUMMARIES

Carpentaria coast localties as defined for the Strategy are shown in Figure 6. Adaptation pathways for the three localities are summarised in the following section. The pathways include a collective pacakage and sequencing of adpation actions for managing coastal hazards at the relevant locations.

These pathways are adaptive and may be subject to change and actions will be subject to prioritisation across localies over time as part of ongoing implementation and budget considerations.

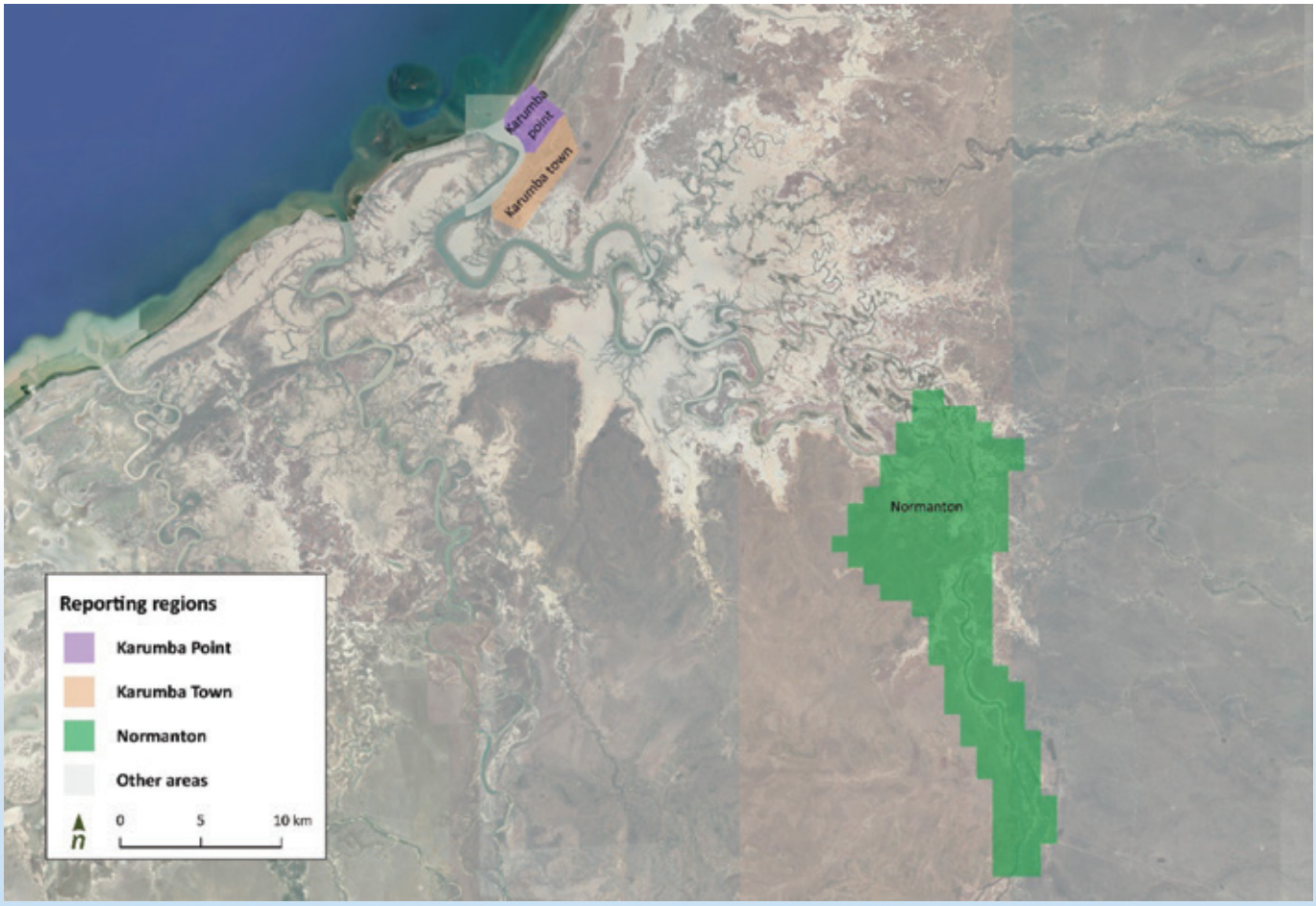


Figure 6. Carpentaria coast localities

6. LOCATION SUMMARIES (cont.)

6.1 Karumba Point

Overview

Karumba Point (Figure 7) is the tourism hub of the Outback by the Sea experience with holiday accommodation, restaurants and business premises throughout. Other key assets include the Karumba airstrip, caravan park, boat ramp and trailer parking facilities. Tourists and residents often patronise the venues at Karumba Point to catch the sunset over the Gulf.

Coastal hazards exposure and implications

The predominant concern for Karumba Point is the ongoing erosion of the river mouth in front of some of the most popular venues, and south of the boat ramp. Existing coastal protection has been installed on an ad hoc basis and consists of informal structures placed by concerned residents. These informal structures offer some protection from further erosion, however they are not of proper design and pose a potential public safety hazard.

Storm tide inundation also poses a threat to assets in Karumba Point. Sea level rise will lead to more frequent inundation events from both storm tide and regular tidal waters.

The ongoing adaptation response for Karumba Point is to mitigate the coastal hazard risk (present day through to 2100) with the potential to explore a transition response should exposure increase to unacceptable levels. Adaptation responses for Karumba are detailed in Table 10.

Figure 7. Karumba Point

6. LOCATION SUMMARIES (cont.)

Table 10. Karumba Point adaptation pathway

Karumba Point		**Present day**	**2050**	**2100**
Theme	**Strategic action no.**	**Mitigate**	**Mitigate**	**Mitigate**
1. Shire wide initiatives to enhance adaptive capacity	1.1. Community stewardship	As per shire wide actions as applicable Establish community Beachcare program to clean up and restore Karumba Point beaches and vegetation Establish a specific pilot site for vegetation and dune enhancement at the southern end of Karumba Point		
	1.2. Knowledge sharing	As per shire wide actions as applicable		
	1.3. Monitoring	Establish a community photo monitoring station at Karumba Point, with related signage about coastal hazards		
2. Planning updates	2.1. Land use planning	As per shire wide actions as applicable		
	2.2. Disaster management	As per shire wide actions as applicable		
	2.3. Early warning systems	As per shire wide actions as applicable		
3. Modifying infrastructure	3.1. Resilient infrastructure	As per shire wide actions as applicable		
	3.2. Resilient homes	As per shire wide actions as applicable		
	3.3. Relocate infrastructure	As per shire wide actions as applicable		
4. Coastal management and engineering	4.1. Foreshore protection and maintenance	As per shire wide actions as applicable Establish a Council program to maintain the natural function of native foreshore vegetation at Karumba Point Monitor all tidal foreshores at Karumba Point (connected to Shire wide action 1.3.3)	Continue Council program to maintain the natural function of native foreshore vegetation at Karumba Point Establish Council program to maintain tidal vegetated shorelines, in collaboration with CLCAC and other NRM bodies	Continue Council program to maintain the natural function of native foreshore vegetation at Karumba Point Continue Council program to maintain tidal vegetated shorelines, in collaboration with CLCAC and other NRM bodies

6. LOCATION SUMMARIES (cont.)

Karumba Point		Present day	2050	2100
Theme	**Strategic action no.**	**Mitigate**	**Mitigate**	**Mitigate**
4. Coastal management and engineering	4.2. Beach nourishment	As per shire wide actions as applicable Continue beach nourishment program south of the boat ramp Investigate sand sources for current and additional beach nourishment (linked to 4.2.1 & 4.2.3 of Shire wide actions) Prepare beach nourishment program for beach maintenance, including identification of funding sources (linked to 4.2.2 Shire wide actions)	As per shire wide actions as applicable Continue beach nourishment program at key locations at Karumba Point as per beach nourishment program Utilise identified sand sources for additional beach nourishment on the Karumba foreshore Continue implementing nourishment program for beach maintenance, including identification of funding sources as required	As per shire wide actions as applicable Continue beach nourishment program at key locations at Karumba Point as per beach nourishment program Utilise identified sand sources for additional beach nourishment on the Karumba foreshore Continue implementing nourishment program for beach maintenance, including identification of funding sources as required
	4.3. Last line of defence structures	As per shire wide actions as applicable Seek funding sources for preliminary design for seawall or combined seawall with beach nourishment for Karumba Point, potentially as part of foreshore improvements and masterplan If triggered by large event or funding is sourced through grants, accelerate implementation of actions listed for 2050.	As per shire wide actions as applicable Detailed design and approvals for seawall or combined seawall with beach nourishment for Karumba Point. If triggered by large event or funding is sourced through grants, accelerate implementation of actions listed for 2100.	As per shire wide actions as applicable Build seawall or combined seawall with beach nourishment for Karumba Point.

6.2 Karumba Town

Overview

Karumba Town is the major industrial area for Carpentaria Shire with regionally significant port activity as an important economic driver. The Les Wilson Barramundi Discovery Centre is an award winning tourist attraction that also plays an advocacy and educational role for the regional fisheries. Local goods and services such as groceries and a chemist are also present in town. The back waters of Karumba town are flood prone and regularly affected by tidal and riverine waters. (Figure 8).

Coastal hazards exposure and implications

The Karumba Town foreshore has been largely protected with formal sea walls, many of which are privately owned and managed. Only a small portion of the foreshore is managed by Council, and this area doesn't appear to be of concern at present day. In general, these seawalls prevent erosion and offer protection from elevated water levels due to storm tides and riverine flood waters. Other stretches of the foreshore are well-vegetated, also offering protection from erosion. The low lying areas in Karumba Town are presently exposed to large storm tide events with recent historical events causing widespread damage. The town has developed resilience to such events however with rising sea levels and more intense storms, exposure to storm tide is expected to increase.

The adaptation response for Karumba Town is 'Monitor' from present day and 'Mitigate' from 2050 through to 2100 (subject to 10-year review) (Table 11). This reflects the well protected foreshore, community resilience to storm tide events, and future outlook for coastal hazard characteristics.

Figure 8. Karumba Town

6. LOCATION SUMMARIES (cont.)

Table 11. Karumba Town adaptation pathway

Karumba Town		**Present day**	**2050**	**2100**
Adaptation response / Theme	**Strategic action no.**	**Monitor**	**Mitigate**	**Mitigate**
1. Shire wide initiatives to enhance adaptive capacity	1.1. Community stewardship	As per shire wide actions as applicable Establish community Beachcare program to clean up and restore Karumba township natural foreshore vegetation Update environmental and natural hazard history signage along the waterfront area		
	1.2. Knowledge sharing	As per shire wide actions as applicable		
	1.3. Monitoring	Establish a community photo monitoring station at Karumba Township, with related signage about coastal hazards		
2. Planning updates	2.1. Land use planning	As per shire wide actions as applicable		
	2.2. Disaster management	As per shire wide actions as applicable		
	2.3. Early warning systems	As per shire wide actions as applicable		
3. Modifying infrastructure	3.1. Resilient infrastructure	As per shire wide actions as applicable		
	3.2. Resilient homes	As per shire wide actions as applicable		
	3.3. Relocate infrastructure	As per shire wide actions as applicable		
4. Coastal management and engineering	4.1. Foreshore protection and maintenance	As per shire wide actions as applicable Monitor all tidal foreshores at Karumba Township (connected to Shire wide action 1.3.3)	Continue monitoring all tidal foreshores at Karumba Township (connected to Shire wide action 1.3.3)	Continue monitoring all tidal foreshores at Karumba Township (connected to Shire wide action 1.3.3)
	4.2. Beach nourishment	Not applicable		
	4.3 Last line of defence structures	As per shire wide actions as applicable Monitor conditions of existing seawalls managed by Council. Maintain existing seawall. If triggered by large event or funding is sourced through grants, accelerate implementation of actions listed for 2050.	Design and approvals for upgraded seawall along Karumba Township esplanade If large event or funding is provided, move to 2100 action. If triggered by large event or funding is sourced through grants, accelerate implementation of actions listed for 2100.	Construction of upgraded seawall along Karumba Township esplanade

6. LOCATION SUMMARIES (cont.)

6.3 Normanton

Overview

Normanton is situated approximately 80km upriver from the Norman River mouth and Karumba. It serves as the administrative hub of Carpentaria Shire (Figure 9).

Coastal hazards exposure and implications

Due to its distance from the Gulf, coastal hazard exposure to Normanton is negligible, particularly when compared with the existing river flood exposure. Coastal erosion risk is mainly associated with riverbank erosion and potential loss of land due to future sea level rise; tidal and storm tide inundation exposure at Normanton is quite low compared to other parts of the Shire, in particular Karumba.

The current adaptation response for Normanton is to Avoid/Monitor coastal hazards through to 2100 (Table 12).

Figure 9. Normanton

Table 12. Normanton adaptation pathway

Karumba Town		Present day	2050	2100
Adaptation response	**Strategic action no.**	**Monitor**	**Monitor**	**Monitor**
1. Shire wide initiatives to enhance adaptive capacity	1.1. Community stewardship	As per shire wide actions as applicable		
	1.2. Knowledge sharing	As per shire wide actions as applicable		
	1.3. Monitoring	Establish a community photo monitoring station on the Norman River bridge or other safe location to monitor riverbank changes		
2. Planning updates	2.1. Land use planning	As per shire wide actions as applicable		
	2.2. Disaster management	As per shire wide actions as applicable		
	2.3. Early warning systems	As per shire wide actions as applicable		
3. Modifying infrastructure	3.1. Resilient infrastructure	As per shire wide actions as applicable		
	3.2. Resilient homes	As per shire wide actions as applicable 3.2.1 Integrate resilient homes criteria in the planning approvals procedures for homes at risk of all forms of flooding. 3.2.2 Promote resilient homes within the community and building sector (link in with knowledge sharing initiatives). 3.2.3 Consider developing specific flooding hazard overlay code in future planning updates (for both riverine and coastal flooding). Linked to action 3.2.3 of shire wide actions		
	3.3. Relocate infrastructure	As per shire wide actions as applicable		
4. Coastal management and engineering	4.1. Foreshore protection and maintenance	As per shire wide actions as applicable Monitor all tidal foreshores at Normanton (connected to Shire wide action 1.3.3)	Continue monitoring all tidal foreshores at Normanton (connected to Shire wide action 1.3.3)	Continue monitoring all tidal foreshores at Normanton (connected to Shire wide action 1.3.3)
	4.2. Beach nourishment	Not applicable		
	4.3. Last line of defence structures	Not applicable		

7. IMPLEMENTATION

7.1 Working together

Carpentaria Shire Council recognises a shared responsibility is required for the successful management of coastal hazard risk in the region. Successful implementation will require continual collaboration and careful coordination between a large number of agencies and organisation as well as a commitment by the local community to protect and look after these fragile environments. Key organisations and their key roles and responsibilities are outlined in Table 13.

Table 13. Key roles and responsibilities in coastal hazard adaptation

Organisation	Key roles and responsibilities in relation to coastal hazard adaptation
Carpentaria Shire Council	Council will provide oversight and lead the coordination for the *Our Resilient Gulf* Strategy implementation. Council's primary responsibility is the maintenance and protection of Council land and assets, and to inform statutory land use planning. Council will implement the *Our Resilient Gulf* Strategy through a range of mechanisms including: • embedding outcomes and actions from the Strategy into existing Council process and activities; and • implementing new initiatives from the Strategy. Council's role in adapting to climate change and coastal hazards varies depending on the type and ownership of different assets. Council's role includes to: • Inform the community and all stakeholders the outcomes of relevant Council-led investigations on coastal hazard risk, planning and adaptation options. • Observe and monitor coastal hazard risk for Council-managed land and assets. For land and assets owned or managed by others, Carpentaria Shire Council may, as part of everyday activities, observe a risk from coastal hazards and will notify the relevant landowner/manager. • Proactively plan and implement strategic planning measures to reduce the risk of coastal hazard impacts on Council managed land and assets, inform appropriate land use and master planning across the region and work together with other agencies and organisations to manage their own risks • Act by implementing strategic planning measures and actions to reduce the risk of coastal hazard impacts on Council managed land and assets, and to inform appropriate land use planning across the region.
Traditional Owner groups and existing and future Native Title areas	Gkuthaarn and Kukatj's holds Native Title over parts of the coastal area west of the Norman River. Other Native Title determinations may emerge in the future, such as the Kurtijar People claim.

Organisation	Key roles and responsibilities in relation to coastal hazard adaptation
Local Disaster Management Group	LDMGs are established by local governments to support and coordinate disaster management activities for their respective LGAs. In additional to a large number of legislated responsibilities, the LDMG regularly reviews different risks to the community including those associated with coastal hazards. The information in the *Our Resilient Gulf* Strategy and associated technical reports should be used to update and inform future risk assessments, planning and response initiatives.
State agencies	DATSIP – Department for Aboriginal and Torres Strait Islander Partnerships DES – Department of Environment and Science DAF – Department of Agriculture and Fisheries TMR – Department of Transport and Main Roads QRA – Queensland Reconstruction Authority Queensland Tourism
Local business and private asset owners	Fact Sheet 3 'Resilient homes' provides some basic information on how buildings can adapt to coastal hazards and become more resilient.

7.2 Monitoring, evaluation, reporting and improvement

The *Our Resilient Gulf* Strategy will be reviewed every 10 years as a minimum. The next scheduled review of the Plan will be in 2030. The review should include consideration of:

- The degree to which the adaptation actions (planned or unplanned) have been implemented.
- Success of implementation of any adaption actions to date, considering:
    - Integration into Council and stakeholder plans and processes
    - Delivery of on-ground activities
    - Community perspectives
    - Reduction in coastal hazard risk.

Other triggers to update the Strategic Plan including consideration of:

- Any changes in the policy environment (e.g. sea level risk predictions, approach to defining coastal hazard areas).
- Updated technical information or data that may become available.
- Any new development and landscape changes in the region.

REFERENCES

CSC (2019a). Coastal Hazard Adaptation Strategy Phase 1 Summary Report. Report by BMT to Carpentaria Shire Council.

CSC (2019b). Coastal Hazard Adaptation Strategy Phase 2 Summary Report. Report by BMT to Carpentaria Shire Council.

CSC (2020a). Carpentaria Shire Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 3 Summary Report. Report by Alluvium, NCE and JBP to Carpentaria Shire Council

CSC (2020b) Carpentaria Shire Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 4 Summary Report. Report by Alluvium, NCE and JBP to Carpentaria Shire Council

CSC (2020c) Carpentaria Shire Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 5 Summary Report. Report by Alluvium, NCE and JBP to Carpentaria Shire Council

CSC (2020d) Carpentaria Shire Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 6 Summary Report. Report by Alluvium, NCE and JBP to Carpentaria Shire Council

CSC (2021a) Carpentaria Shire Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 7 Summary Report. Report by Alluvium, NCE and JBP to Carpentaria Shire Council

CSC (2021b) Carpentaria Shire Council: Coastal Hazard Adaptation Strategy (CHAS) Phase 8 Summary Report. Report by Alluvium, NCE and JBP to Carpentaria Shire Council

DEHP and LGAQ (2016). Developing a Coastal Hazard Adaptation Strategy. Minimum Standard and Guidelines for Queensland Local Governments. Queensland Government.

SUPPLEMENT A

Fact Sheets

SUPPLEMENT B

Coastal hazard mapping

SUPPLEMENT C

Adaptation actions – summary sheets