Assessing the efficacy of Coastal Adaptation Plans in South Australia

Jessica Priess

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Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: 

Date: 17.10.2022

Abstract

Coastal adaptation planning provides coastal communities with solutions to address local climate change impacts. As coastal climate hazards and impacts increase, the risks to coastal communities, infrastructure, and ecosystems also increase. Without effective adaptation planning and preparing for the impacts of climate change, communities may experience damage to infrastructure and development from coastal erosion, inundation, and extreme weather events. Coastal adaptation plans are increasingly being developed to address climate impacts locally. However, there are a number of commonly reported barriers to the implementation of adaptation plans. Many of these barriers are related to the content of plans, rather the exclusion of important details for effective implementation. There are 34 coastal councils in South Australia, at the time of writing, nine had a published coastal adaptation plan. The assessments of plans were conducted as a desk-top study based on the written content of the published South Australian coastal adaptation plans. All nine plans were assessed qualitatively, then quantitatively, against a predefined coding framework, created from international literature of best practice. This study assesses the efficacy of the nine published South Australian coastal adaptation plans for implementation using a range of evaluation criteria. Results show there was some variation in how well the South Australian coastal adaptation plans aligned with the evaluation criteria, ranging from 31 – 56% of criteria met. Many of the South Australian coastal adaptation plans effectively contained a number of important details for plan implementation, including prioritised and timebound actions, and the associated costs of adaptation actions. However, results also suggest that the nine South Australian coastal adaptation plans lacked many important details required for effective implementation of actions. Adaptation plan aspects, both lacking from South Australian coastal adaptation plans and important for implementation were firstly, identifying funding sources and clearly assigning roles and responsibilities for actions. Both aspects are important for outlining who is responsible for what actions, and where funds may come from. Secondly, outlining the requirements for ongoing monitoring and evaluation of adaptation plans post implementation, which is critical for assessing plan progress and encouraging an iterative process, were also lacking from most plans. South Australian coastal adaptation plans which met the highest percentage of criteria, were produced by councils already experiencing coastal hazards. The results demonstrate that the implementation of coastal adaptation plans in South Australia may not meet their intended aims, and may inhibit actions towards coastal hazards and risks. If plans are unable to be implemented effectively, likely

implications include, losses and damage to natural coastal environments and the built environment such as infrastructure and assets, changes to social and cultural norms, and economic implications for residents and stakeholders. This study provides a baseline of the strengths and weaknesses of coastal adaptation plans published in South Australia at the time of writing, and identifies how future coastal adaptation plans can be improved.

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Chapter 1: Problem Statement

Coastal climate change is a global issue, impacting and already perceptible in many parts of the world (Toimil, Camus, et al., 2020). Coastal settlements, especially those of low-lying regions, are exceedingly vulnerable to coastal climate change. In Australia, coastal settlements are increasingly experiencing the impacts of climate change. As a result of climate change, sea level rise poses the greatest risk to coastal communities and environments (Niven & Bardsley, 2012). As sea level rises, coastlines are more prone to the impacts from coastal hazards such as intense storm activity, coastal flooding and inundation, and coastal erosion (DCC, 2009; Pearce, Rodríguez, Fawcett, & Ford, 2018; White et al., 2014). Sea levels are predicted to continue rising beyond the year 2100, demonstrating that the risks of coastal hazards will also continue to impact coastal settlements for many years to come (Hooijer & Vernimmen, 2021; IPCC, 2022).

In Australia, the coastline holds great social, economic, cultural, and environmental importance (DAWE, 2015; DOCCAE, 2010). As more than 85% of Australia's population resides within 50 km of the coastline, the impacts from rising sea levels and coastal hazards will affect many communities (Bradley, van Putten, & Sheaves, 2015; Niven & Bardsley, 2012; Ramm, White, Chan, & Watson, 2017). Most capital cities are located along the coast. As coastal hazards intensify the exposure and vulnerability to coastal communities is increasing. Many at risk coastal communities and residences are densely populated and of high-value (Toimil, Losada, Nicholls, Dalrymple, & Stive, 2020). However, regional communities with lower population densities are also at risk, and they too are witnessing the impacts of coastal climate change. As climate change continues, the need for effective coastal adaptation plans and actions is escalating.

Adaptation allows for communities to change aspects of the coastline or their way of living to adapt to coastal hazards (Baills, Garcin, & Bulteau, 2020; Thomsen et al., 2012). The adaptation process, when effective, holds many benefits for communities including the preservation of societal lifestyle and cultural values, economic benefits for stakeholders, and it may also benefit the environment. Adaptation is typically the responsibility of local governments (Spalding et al., 2014).

Many local governments in Australia have commenced planning for coastal climate change and have produced adaptation plans that set out options to manage it. Generally, adaptation

plans address current and predicted future risks for a place or region, and provide planning related solutions or actions to help reduce community risk to climate hazards (DCC, 2009; Rangel-Buitrago, Neal, Bonetti, Anfuso, & de Jonge, 2020). However, the literature suggests that globally coastal adaptation plans are often not implemented. This implementation gap is a result of inadequate detail within adaptation plans (Lioubimtseva & da Cunha, 2020; Measham et al., 2011; Preston, Westaway, & Yuen, 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016).

Adaptation planning has the potential to be very valuable as climate impacts increase. Studies have evaluated plan content to identify the strengths and weaknesses of adaptation plans based off established criteria. Adaptation plan quality is important as high-quality plans are likely to better advance community goals than lower ones. Findings suggest many adaptation plans lack important details and fail to prioritise actions required for successful implementation, highlighting the concern of whether adaptation plans will translate into actions (Measham et al., 2011; Woodruff & Stults, 2016).

Over 58 studies have identified factors inhibiting the implementation of adaptation plans (Baker, Peterson, Brown, & McAlpine, 2012; Lioubimtseva & da Cunha, 2020; Measham et al., 2011; Olazabal & Ruiz De Gopegui, 2021; Stults & Woodruff, 2016; R. Wang, 2012; Woodruff & Stults, 2016; Yalçın & Lefèvre, 2012). Of these studies, nine evaluated the content of adaptation plans (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, Ford, Sainz De Murieta, & Lesnikowski, 2019; Olazabal & Ruiz De Gopegui, 2021; Olazabal, Ruiz de Gopegui, Tompkins, Venner, & Smith, 2019; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016). Other studies focused on identifying barriers to implementation beyond the adaptation plan content. Consistent findings outlined the complexity and uncertainty surrounding climate change and it impacts, how adaptation actions can be affected by stakeholders and public perception, and also the political barriers (Bedsworth & Hanak, 2010; Measham et al., 2011). Another major barrier is a community's adaptive capacity, or alternatively, the ability to anticipate or respond to change (Cinner et al., 2018).

In South Australia, there are 34 coastal councils, of these councils, 12 have published coastal adaptation documents. Coastal adaptation plans have been published from the year 2013 – 2021. The majority of these documents are regional and in coastal settlements where coastal hazards are already having an impact.

Study Aim

The aim of this study is to determine the efficacy of South Australian coastal adaptation plans.

Study Objectives

In order to achieve the aim, the following objectives will be addressed:

1. To conduct a review of studies evaluating the adaptation 'implementation gap'
2. To create a set of criteria by which to assess South Australia's coastal adaptation plans
3. To apply the criteria to South Australia's coastal adaptation plans

Chapter 2: Literature Review

Coastal climate change

Coastal climate change is impacting coastlines and human settlements globally. Settlements in low-lying densely populated coastal regions are likely to be threatened by climate change in the near future (He & Silliman, 2019; Toimil, Camus, et al., 2020). Approximately 40% of the world's population lives within 100 km of the coastline and 10% percent live in places of low coastal elevation (less than 10 m above sea level) (IPCC, 2022; Peter Sheng, Paramygin, Yang, & Rivera-Nieves, 2022; Spalding et al., 2014). Coastal climate change poses significant risks to communities, economies, and natural coastal environments (DAWE, 2015; DEW, 2007).

Many coastal communities are already witnessing the effects of climate change (Bongarts Lebbe et al., 2021; DCC, 2009; Spalding et al., 2014). In recent decades, there is evidence of an increase in sea surface temperature, sea level rise, and extreme weather events (Bradley et al., 2015; Cooper & Lemckert, 2012; DCC, 2009; He & Silliman, 2019; Lu et al., 2018; Ramm et al., 2017). As a result of increasing ocean temperatures and melting ice caps, the sea level is rising (DCC, 2009; DOCCAE, 2010; IPCC, 2022; Lu et al., 2018; Toimil, Camus, et al., 2020).

All coastlines will likely be affected by coastal climate change in the future, posing significant impacts to coastal communities. The impacts of climate change will manifest in many ways due to complex interactions in the coastal zone (DCC, 2009; Toimil, Losada, et al., 2020). Rising sea levels and the increase in frequency of extreme weather events will influence numerous coastal processes. Coastal hazards associated with changing climate include sea level rise, increased storm activity, coastal flooding and inundation, and coastal erosion (IPCC, 2022; Morris, Konlechner, Ghisalberti, & Swearer, 2018; Toimil, Camus, et al., 2020).

Impacts of sea level rise

Sea level rise is often considered to pose the greatest risk to coastal environments and communities. The Sixth Assessment Report of the International Panel for Climate Change (IPCC) states that global mean sea level (GMSL) is rising and accelerating (IPCC, 2022). The

dominant source of GMSL is now combined glacier and ice sheet contributions (Figure 1). Future rise of GMSL caused by ice contributions and thermal expansion is projected to 2100 and likely to range between 0.61 – 1.10 m (Figure 2). However, sea level will continue to rise beyond 2100 (Hooijer & Vernimmen, 2021; IPCC, 2022; Ramm et al., 2017; Stephens, Bell, & Lawrence, 2017).

Rising sea levels are estimated to affect 88 million to 1.4 billion people globally by 2050 (Hauer et al., 2021; IPCC, 2022; Neumann, Vafeidis, Zimmermann, & Nicholls, 2015). Sea level rise not only impacts coastlines directly, it is also the main driver for other coastal hazards; indirectly enabling an increase in their frequency and severity (Toimil, Camus, et al., 2020). Sea level rise is associated with greater community exposure to storm surges, coastal flooding, and inundation (Bongarts Lebbe et al., 2021; IPCC, 2022). As a result, there is great potential for landward migration of coastal settlements and losses of sedimentary coasts (Jackson, Costas, González-Villanueva, & Cooper, 2019; Mills et al., 2016).

Figure 1: Contributors to global sea level rise (1993-2018)

The observed sea level from 1993 to 2018 (black line), plus estimates of the different contributions to sea level rise: thermal expansion (red line) and added water, mostly due to glacier melt (blue line). Combined (purple line), the estimates of contributions match the global sea level closely. (Source: NOAA Climate.gov)

Figure 2: Observed sea level from 2000-2018, with future sea level through 2100 for six future pathways. The pathways differ based on future rates of greenhouse gas emissions and global warming and differences in the rates of glacier and ice sheet loss. (Source: NOAA Climate.gov)

Increased storm activity

Storm activity is predicted to increase in both frequency and intensity as a result of climate change. The occurrence of related extreme weather events is likely to be affected, including greater frequency and intensity of tropical cyclones, storm surges, rainfall distribution, and wave and wind energy (DOCCAE, 2010). The potential cause of greatest immediate threat to coastal communities are the impacts of storm surges (Niven & Bardsley, 2012). Storm surges are defined by temporary increases in coastal sea levels caused by falling atmospheric pressure and severe winds during storms. The magnitude of a storm surge is controlled by the pressure fall, wind speed, and the geomorphology of the coast (DCC, 2009).

Adverse impacts are expected, including damages to infrastructure and the built environment (DCC, 2009; Niven & Bardsley, 2012). Storm activity occurs concurrently with sea level rise, influencing the overall intensity towards the coastline and magnifying spatial exposure (DCC, 2009). By 2030, it is possible that 1 in 100 year storm tide events will become 1 in 20 year events, and annual occurrences by 2070 (DOCCAE, 2010). Storm activity alters coastal geomorphology and function, as it directly increases the rate of coastal erosion, and flooding and inundation of land (both temporarily and permanently) (Niven & Bardsley, 2012; Peter Sheng et al., 2022).

Flooding & Inundation of land

As human settlements expand along the coast, flood vulnerability for low-lying coastlines has increased (Peter Sheng et al., 2022; Warrick, Vos, East, & Vitousek, 2022). The relationship between sea level rise and storm activity will result in flooding of coastal communities in varying degrees, altering coastal flooding regimes (Ramm et al., 2017). Flooding regimes will range from short term or temporary flooding (e.g., nuisance flooding) post storm activity, to permanent inundation of land. It is predicted that flooding events which historically occurred once per century are exceedingly likely to occur more frequently (e.g. annually, monthly, and daily) (Hooijer & Vernimmen, 2021; IPCC, 2022).

Consequently, societal impacts, losses in natural environments, and infrastructure will occur (Hauer et al., 2021; Tribbia & Moser, 2008). Regular daily to annual tidal flooding is likely to be most disruptive to communities and will occur before permanent inundation. It is estimated that the most vulnerable areas (e.g., the Low Elevation Coastal Zone) for permanent inundation will be housing more than 1 billion people by 2060 (Hauer et al., 2021; IPCC, 2022).

Erosion of coastlines

Erosion is exacerbated and interconnected to other coastal hazards (Stephens et al., 2017; Toimil, Camus, et al., 2020). For example, rising sea levels, combined with extreme weather events are causing soft shorelines to recede at an accelerated rate (Niven & Bardsley, 2012). Coastal erosion is influenced by changes in sediment supply, and wave energy and direction (DCC, 2009; DOCCAE, 2010; Morris et al., 2018; Stephens et al., 2017; Warrick et al., 2022). Waves provide the majority of the energy that shapes the coastline, with large wave events associated with chronic coastal erosion (DCC, 2009).

The most vulnerable coastlines consist of soft sediments such as beaches, dunes, and sand cliffs on the open coast. The impact on hard coasts, however, is dependent upon their exposure to wave action and geological structure, but overall are less likely to erode at the same rate as soft coasts (DCC, 2009). Erosion, therefore, is highly dependent on coastal geomorphology (Toimil, Camus, et al., 2020).

Risk & Vulnerability

Human settlements are increasingly at risk from coastal climate hazards associated with climate change (Mills et al., 2016). Risk is defined as "the potential for adverse consequences from interactions between coastal hazards, the exposure, and vulnerability of affected human and ecological systems" (IPCC, 2022, p.7). Figure 3 represents the three intersecting components to risk: the presence of coastal hazards; exposure of communities or infrastructure to coastal hazards; and vulnerability (the susceptibility to damage, and or capacity to cope with the impacts of coastal hazards).

Permanent or temporary inundation, disruption to ecosystem and societal functioning, and destruction of coastal ecosystems and infrastructure are all at risk to climate change impacts (Bongarts Lebbe et al., 2021; DCCEE, 2011; Niven & Bardsley, 2012). Coastal cities with high concentrations of population and large economic, political, and societal processes are at greater risk. Highly developed coasts are limited in the extent to which they might naturally recover from damage caused by hazard events, and are increasingly at risk to coastal hazards as the climate changes (Birkmann, Garschagen, Kraas, & Quang, 2010; Rangel-Buitrago et al., 2020).

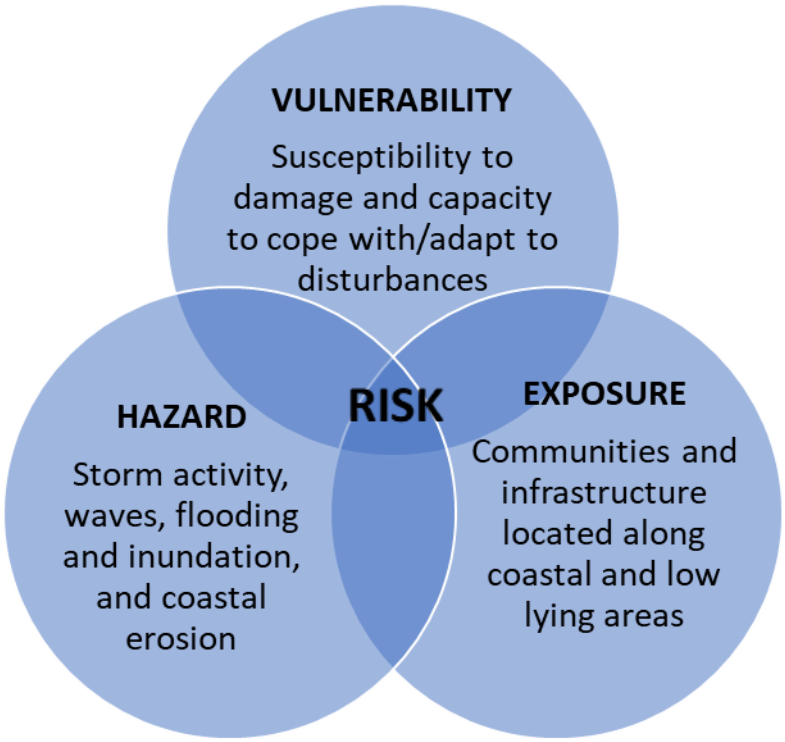

Figure 3: Venn diagram demonstrating coastal risk as the relationship between coastal hazards and the vulnerability and exposure of a coastal settlement (de Brito, Evers, & Höllermann, 2017).

Vulnerability (in a coastal context) is commonly defined as a community's ability to cope with the consequences of escalated coastal hazards or impacts (e.g., sea level rise) associated with climate change (IPCC, 2022; Rangel-Buitrago et al., 2020). Vulnerability encompasses sensitivity, susceptibility, and exposure to harm, as well as, the capacity to cope and adapt (IPCC, 2022; Rangel-Buitrago et al., 2020). The vulnerability of a community refers to the impacts from coastal hazards on socio-economic and ecological systems, which is often the main driver of risk (Nick Harvey, Clouston, & Carvalho, 1999). As coastal hazards increase, so does the vulnerability of coastal communities, thus increasing levels of risk (Bradley et al., 2015; Morris et al., 2018; Toimil, Losada, et al., 2020).

Exposure is determined by the presence of people, ecosystems, and infrastructure that could be adversely affected by impacts of climate change hazards (IPCC, 2022; Toimil, Losada, et al., 2020). Coastal settlements are more exposed to coastal hazards due to their proximity to hazardous environments. For example, residing within the low elevation coastal zone increases the probability of being adversely impacted by storm surges or coastal flooding (Hauer et al., 2021).

Exposure and vulnerability to coastal hazards is dynamic, and changes both spatially and temporally (Toimil, Losada, et al., 2020; Tribbia & Moser, 2008). Reducing exposure can often reduce vulnerability (Toimil, Losada, et al., 2020). Continuing demographic shifts associated with urban expansion and population growth in coastal regions, despite the risk of coastal hazards, is increasing coastal exposure and vulnerability (DCCEE, 2011; Gibbs, 2016; Koerth, Vafeidis, & Hinkel, 2017; Morris et al., 2018; Neumann et al., 2015; Niven & Bardsley, 2012).

Risks to coastal communities will differ due to varying rates, magnitude, and timing of changing climatic conditions and impacts of hazards (Kettle & Dow, 2014). Climate hazard impacts will vary within and between communities as a result of varying vulnerabilities and coping capabilities (Kettle & Dow, 2014). Therefore, effective determination of risks and vulnerabilities is required to manage and reduce them (Niven & Bardsley, 2012). Managing risks, however, is complex due to an array of stakeholders with disparate interests (Mills et al., 2016; Niven & Bardsley, 2012; Toimil, Losada, et al., 2020).

Assessing risk and vulnerability

A popular mechanism used to assess climate risk is a risk assessment. Risk assessments are used to make decisions to reduce or manage potential risks (Lawrence et al., 2013; Stephens et al., 2017; Wainwright et al., 2014). Ideally, a risk assessment should be one of the first steps towards adaptation planning (Rangel-Buitrago et al., 2020).

Risk assessments identify the possibility of climate hazards and their potential impacts to communities in the future. It is a process used to identify hazards and levels of risk that have the potential to cause adverse impacts to a region (Kelly & Adger, 2000; Stephens et al., 2017). To avoid partial understanding of risks, risk assessments typically target each aspect of risk (vulnerability, exposure, and coastal hazards) (Toimil, Losada, et al., 2020; Tonmoy, Wainwright, Verdon-Kidd, & Rissik, 2018). There are many types of risk assessment tools which involve a diverse range of methods and approaches (Rangel-Buitrago et al., 2020). Some types of risk assessment tools include coastal hazard mapping, coastal vulnerability assessments, and impact assessments (Tonmoy et al., 2018).

Risk assessments should consider multiple factors specific to a region, such as the change in climate, likelihood and type of coastal hazards occurring, characteristics of the natural environment, including important ecosystems; and society, including demography, economy, social, and cultural values (Toimil, Losada, et al., 2020). Identifying hazards, vulnerability, and risks as part of risk assessments also requires dynamic and multidisciplinary approaches to wholly understand risks and respond appropriately (Rangel-Buitrago et al., 2020). An important inclusion for all risk assessments is accounting for levels of uncertainty surrounding the magnitude and timing of coastal hazard impacts (Mills et al., 2016; Stephens et al., 2017; Toimil, Losada, et al., 2020; Wainwright et al., 2014).

Coastal hazard mapping or hazard assessments identify the spatial extent and degree of exposure to potential hazards. As sea level rise increases the frequency and severity of coastal hazards, assessments must quantify the likelihood of occurrence and types of hazards (e.g., storm activity, flooding/inundation, erosion) (Stephens et al., 2017). Coastal hazard assessments determine areas which are likely to be vulnerable to erosion from rising sea levels. Three components are commonly considered for coastal hazard assessments: episodic recession (due to storm activity), long-term recession (sediment transport over time), and recession as a consequence of sea level rise (Wainwright et al., 2014).

Vulnerability assessments evaluate the potential impacts on socio-economic, ecological, and physical systems (Nick Harvey et al., 1999; Rangel-Buitrago et al., 2020). Considering multiple socio-economic outcomes allows for an understanding of how sensitive decisions may be to multiple different futures and reduces uncertainty (Toimil, Losada, et al., 2020).

There are a number of limitations to risk assessments and their application. Risk assessment outcomes are dependent on geographic scale, types of models used, knowledge of physical processes, and availability of data (Toimil, Losada, et al., 2020; Wainwright et al., 2014). Limiting factors will also arise when socio-economic aspects are not recognised; uncertainty of future scenarios is not considered; and, when the perception of risk differs to the actual level of risk (Kettle & Dow, 2014; Tonmoy et al., 2018).

Coastal Adaptation

With increasing risks and vulnerabilities along the coast there is a greater need for communities to adapt. Adaptative planning has the potential to reduce the exposure of communities to hazards, and future development decisions should avoid increasing risks (DCCEE, 2011; Rangel-Buitrago et al., 2020; Wainwright et al., 2014).

What is adaptation?

Adaptation plays a key role in limiting the negative impacts of climate change on communities, by reducing vulnerability and/or building resilience (ability to bounce back after change) (Baills et al., 2020; Bedsworth & Hanak, 2010; IPCC, 2022; Wise et al., 2014). Adaptation is defined in a number of ways. The IPCC defines adaptation as “the process of adjustment to actual or expected climate and its effects” (IPCC, 2012, 2022). More simply, it is considered to be the actions taken to ensure co-existence with the changing climate (Barnett et al., 2014; Cooper & Lemckert, 2012; Thomsen et al., 2012), or as “being ready to manage the risks and impacts of changes over time” (City of Fremantle, 2017, p. 8).

Adaptation is a process involving a number of steps. Figure 4 demonstrates the common steps within the adaptation process. Typically, the process is made up of six main steps. The first step is to identify challenges, which involves identifying a regions baseline by scoping and framing the planning process. The second step involves assessing for risk and vulnerability, review current practises, and identify any barriers to adaptation action. After completing a risk assessment, the third step is determining the options for adaptation, this often involves

stakeholder and community engagement. The fourth step involves evaluating the options, which should include identifying an acceptable level of risk, assessing the options, and the timing for actions, to then develop and include into an adaptation plan. Steps five and six are beyond this study scope, however, each are the actions taken after an adaptation plan has been implemented. Step five is ‘take action’ and then step six is ‘monitor and evaluate’ to determine progress. Steps five and six are beyond the study scope because the study solely focuses on the content of the plans, rather than the progress of the plan beyond implementation. Figure 4 also shows that the adaptation process is an iterative process, meaning it should be continual, and different steps should refer to other steps over time.

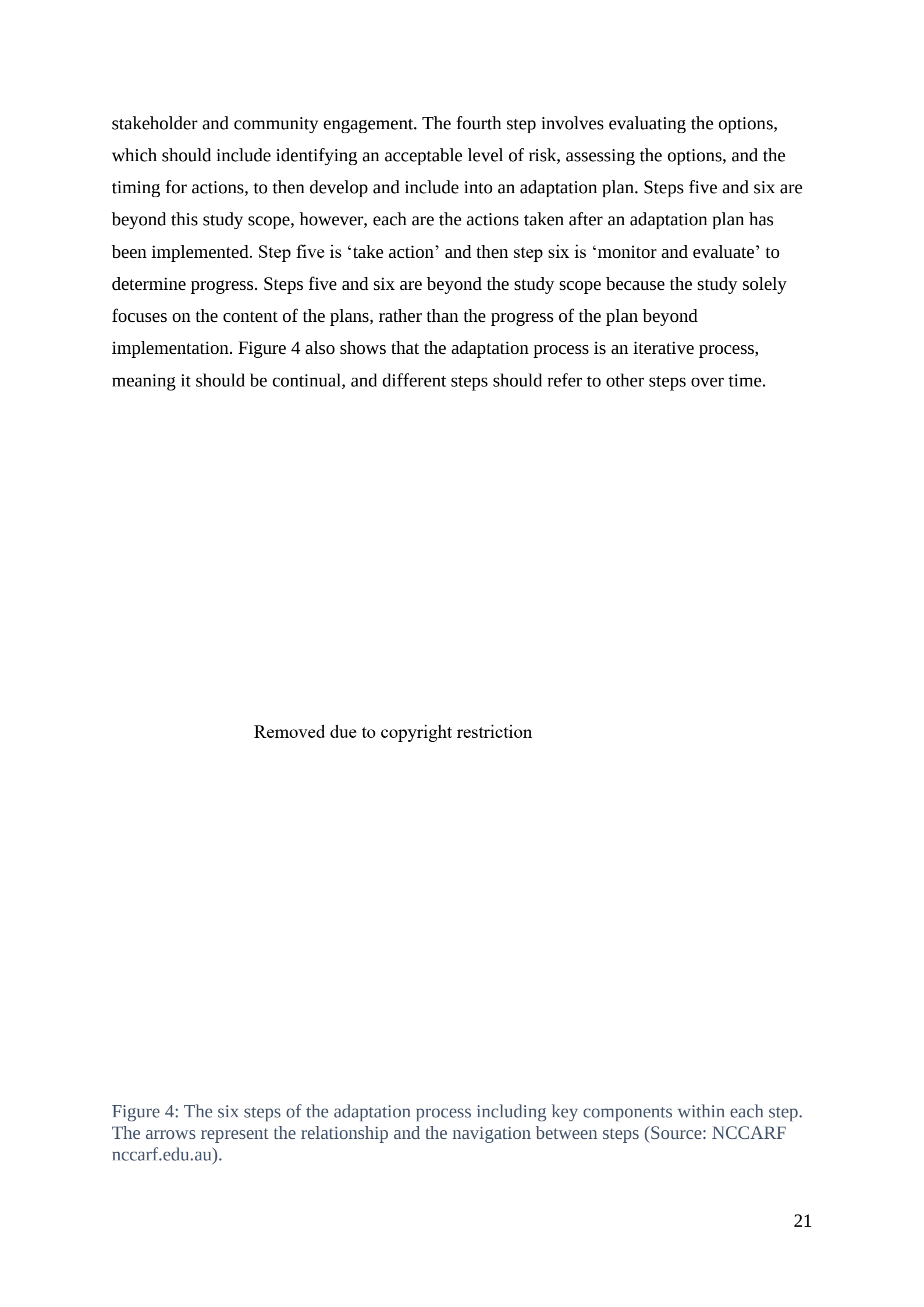

Figure 4: The six steps of the adaptation process including key components within each step. The arrows represent the relationship and the navigation between steps (Source: NCCARF nccarf.edu.au).

The focus of coastal adaptation is to mitigate risks and adapt to sea level rise and coastal hazards, present and future (Spalding et al., 2014). Coastal adaptation is uniquely complex, requiring responses to be cross-jurisdictional, socially robust, long-term, and flexible to change (DOCCAE, 2010).

Strategies to manage coastal hazard risk are important to inform adaptation responses and coastal planning, as they can help determine short- and long-term options based on risk assessments (Lawrence, Bell, Blackett, Stephens, & Allan, 2018). Decisions based on future development should avoid increasing risk and involve planning to reduce exposure (DCCEE, 2011; Rangel-Buitrago et al., 2020; Wainwright et al., 2014). Adaptation processes should continuously evolve, be innovative, and allow for changes in impacts and conditions (Bongarts Lebbe et al., 2021; Thomsen et al., 2012). Such strategies and decisions to manage risks to communities involve determining appropriate coastal adaptation options.

Coastal adaptation options

Adaptation options are actions to respond to climate hazard impacts and potential risk. Options can be in the form of planning, engineering, environmental management, and community awareness and education. Each adaptation option should be aligned with broader goals. Although there are various forms of adaptation options, they often fall under three main categories.

The main adaptation option categories include, protect, accommodate, and retreat (Azevedo de Almeida & Mostafavi, 2016; Bongarts Lebbe et al., 2021; DCC, 2009; DOCCAE, 2010; Gibbs, 2016, 2019; Niven & Bardsley, 2012; Thomsen et al., 2012). Each adaptation option category is intended for different purposes and outcomes. As demonstrated in Table 1, each adaptation option involves varying costs and benefits, such as monetary expenses, length of protection, the level of maintenance, and the changes to the coastline. Protect options involve physical protection measures such as sea walls to protect infrastructure from impacts, whereas accommodate options involve ‘non-defensive’ measures to accommodate the changes. Finally, retreat options involve relocation of infrastructure and/or changes to the land use of areas at risk.

The choice of adaptation options will be dependent on local conditions and community needs. Each option requires a complex assessment and understanding of the local social, environmental, and economic costs and benefits for effective investment and risk

management (DOCCAE, 2010). Figure 5 illustrates what is required to be considered in the decision-making process to determine the most suitable adaptation option, this includes the type of adaptation option (or a combination), the cost of the response, the cost of avoided impacts, the use and value of land and/or assets, and the length of protection.

Table 1: Description of each adaptation option with the costs and benefits

Adaptation Option	Description	Benefits	Costs
Protect	• Alters the land and existing developments to withstand coastal hazards. • Involves physical protection measures, including hard (e.g., seawalls) or soft (e.g., beach nourishment) measures	• Hard protection mostly benefits dense and heavily populated regions (e.g., coastal cities) • Maintains coastal assets in their current location • Soft protection is less intensive and involves lower costs	• Hard protection can exacerbate other coastal problems and alter coastal processes, both at the source and down the coast • Ongoing maintenance and high costs (installation and ongoing)
Accommodate	• Reduce risk with 'non-defensive' measures (e.g., building modifications) • Mainly used for episodic events to minimise impacts	• Maintains continual use of existing infrastructure • Cost effective for transitional strategies	• Often require continual improvements • Not as feasible long-term
Retreat	• Involve relocation existing infrastructure and change in land use of vulnerable locations • Methods include abandonment, relocation, setback from the coast, and avoidance of future development	• In the long-term, this option is cost effective • Reduces the need for adaptation options and lowers ongoing maintenance of other options	• Can be difficult and costly due to social and economic implications • Changes community structure

Figure 5: Adaptation options (Source: NCCARF nccarf.edu.au)

The common adaptation options used for adaptation for sea level rise, as well as, the important factors to consider when deciding the most appropriate option (costs, land use, length of protection needed, and the value of land and assets at risk)

Decision making that addresses climate change comes with a level of uncertainty and complexity, emphasising the need for flexible approaches (Abunnasr, Hamin, & Brabec, 2013; Kettle & Dow, 2014; Nursey-Bray, Harvey, & Smith, 2015; Stephens et al., 2017; Toimil, Camus, et al., 2020). Deciding which of the adaptation options is the most suitable in a given location requires planning and a scoping study to determine the nature of the coastal threat, the local environment, community values and priorities, and capacity for implementation (DCC, 2009; DEW, 2007; Gibbs, 2016). To identify the appropriate adaptation response, assessment of the region and its risks is required, and often a combination of strategies is introduced to suit each unique socio-ecological situation (Cooper & Lemckert, 2012; DEW, 2007; Thomsen et al., 2012).

Managing coastal hazards and the need for adaptation

While all coastlines are affected by a changing climate, the impacts from coastal hazards are highly dependent on regional conditions and often have broad spatial and temporal heterogeneity (Spalding et al., 2014). Differences are due to location specific circumstances, including relative sea level rise, wave and storm activity, type and placement of infrastructure, type of landscape, and the interactions between these variables (Bradley et al., 2015; Warrick et al., 2022).

The risks to coastal communities and their built environments are not only a result of impacts from climate hazards (e.g., sea level rise), but is also linked to the extent to which a community can anticipate, prepare, and respond (DCC, 2009; Gibbs, 2016; Toimil, Losada, et al., 2020). Whereas, adaptation in fact, enables the ability for communities to prepare and respond, to reduce risk. Outcomes of risk are also contingent on the estimates of the potential changes in climate and chosen adaptive responses, demonstrating that adaptation actions are strongly influenced by how assessments are scoped and conducted (Kelly & Adger, 2000; Tonmoy et al., 2018).

Adaptation helps communities manage the impacts of climate change (Baker et al., 2012; DAWE, 2015). As climate change impacts increase, people and communities are more exposed to greater levels of risk. Adaptation helps to protect people from impacts already occurring and those predicted for the future by changing the way people operate in the places they live (DEW, 2007).

While adaptation at all scales (local, national, and global) is needed, climate hazard impacts are more distinct at the local level (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Stults & Woodruff, 2016). The need for a localised approach to adapt to coastal hazards is becoming more apparent (Baker et al., 2012; Hooijer & Vernimmen, 2021). Adaptation at the local level is important as local communities can offer diverse approaches to the adaptation process, as impacts are experienced locally (Stults & Woodruff, 2016).

Adaptation Plans

The identification of adaptation options to manage risks guides the planning, preparing, and decision-making processes of coastal adaptation. This is often in the form of an adaptation plan and is the main objective of step four of the adaptation process (Figure 4) (Rangel-Buitrago et al., 2020). An adaptation plan is a tool which should provide a roadmap based on projected climate impacts, and the actions taken to appropriately prepare and act in response to the impacts. Ideally, these adaptation plans are designed to ensure a community is adequately prepared to respond to current and future coastal hazard risks.

Adaptation plans should identify the location and extent of risks, propose the most suitable adaptation options to address each risk, and outline the steps needed to meet intended objectives (DCC, 2009; Rangel-Buitrago et al., 2020). Effective adaptation plans should be integrated with other policies or plans, be informed by a diverse range of knowledge types and sources, and flexible to changing circumstances (Thomsen et al., 2012). It is also important to consider the assessment of societal goals and include the cooperation of stakeholders (Rangel-Buitrago et al., 2020).

Adaptation plans are important for outlining the intended actions to manage coastal risks and to enable the ability to track the progress of adaptation for a local area. However, there are a number of challenges, both external to and within plans, limiting the implementation of adaptation plans. Barriers to coastal adaptation that are outside of the adaptation plans themselves involve inherent challenges that impact adaptation plans indirectly. Whereas, adaptation plans also involve challenges for implementation that have to do with the plan themselves. For the purpose of this study, only the challenges related to adaptation plans directly will be investigated, however, it is important to outline the potential indirect challenges adaptation planning and plans involve.

External barriers to coastal adaptation

A review of the literature shows that while adaptation planning, and plans are key to helping communities respond to climate change locally, many adaptation plans have been ineffective because they have not been implemented. Table 2 presents a summary of commonly reported barriers to the successful implementation of adaptation plans (Baker et al., 2012; DOCCAE, 2010; Mills et al., 2016; Olazabal, Galarraga, et al., 2019; Stein et al., 2013; Verschuuren & McDonald, 2012; X. Wang, Xu, Cui, & Wang, 2020). These barriers specifically are those which surround adaptation and adaptation planning as a whole, and are not a direct result of poor plan production. Barriers include uncertainty and complexity which are inherent issues when trying to understand changing and dynamic systems, especially when relating to climate change. Other barriers surround the adaptive capacity of communities, which includes but is not limited to the jurisdictional and political barriers towards adaptation, the stakeholder and community involvement and perception, as well as, the overall understanding and consensus of what adaptation is and involves.

Table 2: Descriptions of adaptation barriers as reported in several studies

Barrier to Adaptation	*References*
Uncertainty • Uncertainty surrounding climate and sea level rise projections and coastal modelling • Coastal adaptation involves decision making with ongoing changes (timing and severity is unknown)	(Abunnasr et al., 2013; Bedsworth & Hanak, 2010; Kettle & Dow, 2014; Measham et al., 2011; Toimil, Losada, et al., 2020; Valente & Veloso-Gomes, 2020)
Complexity • Influences within and between social and ecological coastal systems are complex • Causes difficulty when evaluating the causation of processes due to the connection between physical, biological and human systems. • Decision making also involves complexity due to unknown consequences • Decisions often involve long timeframes over changing conditions which have impacts for multiple scales and contexts • Coastal systems are fundamentally complex and dynamic, therefore, there may not be one simple or definitive solution	(Abunnasr et al., 2013; Bedsworth & Hanak, 2010; Kettle & Dow, 2014; Measham et al., 2011; Toimil, Losada, et al., 2020; Valente & Veloso-Gomes, 2020)
What is Adaptation? • Differences of agreement on what adaptation is, and further how is should be implemented	(Kettle & Dow, 2014; Valente & Veloso-Gomes, 2020)

Stakeholder Involvement and Public Perception • Many actors with associations to the coasts with disparate interests • Varying perceptions of risk • Different and conflicting opinions/preferences for options • Lack of public support	(Barnett et al., 2014; Cinner et al., 2018; Niven & Bardsley, 2012)
Jurisdictional and Political Barriers (Adaptive Capacity) • Lack of political support for action • Several and often conflicting management goals • Fragmented and overlapping jurisdictions involved with coastal management and decision making • Decisions impact multiple scales in different ways • Decisions with long time frames often do not align with political timeframes • Lack of leadership and or local expertise	(Bradley et al., 2015; Cinner et al., 2018; Gibbs, 2016, 2019; Measham et al., 2011; Yalçın & Lefèvre, 2012)

Uncertainty

Uncertainties about the timing, and extent of climate hazards and impacts pose a significant barrier to successful adaptation decisions (Abunnasr et al., 2013; Bedsworth & Hanak, 2010; Kettle & Dow, 2014; Nursey-Bray et al., 2015). Uncertainty can result from lack of knowledge, lack of available information, and the lack of understanding about climate change itself (Toimil, Camus, et al., 2020). Uncertainty can result in decision makers ignoring climate change rather than taking the chance of being wrong (Abunnasr et al., 2013). As impacts of climate change differ regionally, it is difficult to estimate when and to what extent a coastal hazard may occur. Uncertainty can also arise through differences of opinion based on preferences and acceptable levels of risk or vulnerability (Toimil, Camus, et al., 2020).

Uncertainty surrounding projected coastal impacts creates difficulty for governments and decision makers to produce and implement robust and effective policy to address future challenges (Niven & Bardsley, 2012). As uncertainty is a major aspect involved with climate change and adaptation, it is important to consider this within adaptation planning processes (Azevedo de Almeida & Mostafavi, 2016). Understanding the influence uncertainty has on the decision making process is vital, as it could affect behaviour, timing, and the level of effort (Kettle & Dow, 2014).

Solutions to reducing uncertainty is by improving adaptation processes and assessments of risk (Abunnasr et al., 2013). This includes clear communication about uncertainties, the increase in available data, multi-deterministic approaches to assessments, and using flexible

adaptive processes (Stephens et al., 2017; Toimil, Camus, et al., 2020). Examples of adaptive processes is using trigger points and assessing for multiple possible options. Trigger points allow for actions to be determined based on physical changes, when a particular adaptation action is no longer viable the next adaptation action can be taken (Olazabal & Ruiz De Gopegui, 2021).

Adaptive capacity

Adaptation actions are dependent on a society's adaptive capacity or resilience. These are the conditions that permit communities to anticipate and respond to change, to minimise the consequences, and to recover (Barnett et al., 2014; Bedsworth & Hanak, 2010; Cinner et al., 2018; Wise et al., 2014). Towards successful adaptation, adaptive capacity involves the ability to implement adaptation actions and relies on a number of characteristics. A characteristic of adaptive capacity is the availability of resources that people have access to. Adequate resources and assets include financial and technological, as well as, sufficient natural and built resources, that enable adaptive capacity as they can facilitate adaptation. Social organisation is another important characteristic for adaptive capacity, as it demonstrates the ways in which a society is able to cooperate, act together, and share knowledge to enable (or inhibit) adaptive capacity. The human capital and their ability to gain knowledge and skills, and process new information about adaptation is also important for adaptive capacity. And finally, the organisational capital, referring to the institutional structures and processes that facilitate the development and implementation of adaptation approaches (i.e., local councils) (Cinner et al., 2018; Cooper & Lemckert, 2012; Thomsen et al., 2012). Adaptive capacity, however, does not equate to action, rather the ability or willingness to take action (Cinner et al., 2018; IPCC, 2022).

Coastal communities regional to capital cities commonly have less adaptive capacity, and therefore may be adversely impacted by climate change to a greater extent (Barnett et al., 2014; DCC, 2009). There are a number of influences contributing to a reduced adaptive capacity. Firstly, lower populated local communities and governments often lack the technical skills and financial resources required (Bradley et al., 2015). Coastal hazard risks to coastal communities located outside capital cities are often considered less significant to those (higher government levels) who control funding and make decisions (Barnett et al., 2014). Finally, decisions at local scales, especially in smaller communities tend to rely on public perception and consensus (Barnett et al., 2014; Cooper & Lemckert, 2012). Public

perception is often related to community awareness. Therefore, an increase in the awareness of climate change impacts and adaptation changes could benefit perception.

Building adaptive capacity can reduce risks (Barnett et al., 2014; Kettle & Dow, 2014). To build adaptive capacity, communities require the ability to act collectively, flexibility for change, a deciding body to determine whether to change, and ability to recognise and respond to change (Barnett et al., 2014; Bhattachan et al., 2018; Bradley et al., 2015; Cinner et al., 2018).

Adaptation plan implementation barriers

The complexity and uncertainty associated with forecasting the timing and magnitude of climate change, and the need to protect coastal communities, means the planning and implementation of adaptation plans is difficult yet important (Bedsworth & Hanak, 2010; Gibbs, 2019; Kettle & Dow, 2014; Lawrence et al., 2018; Mills et al., 2016; Nursey-Bray et al., 2015; Stephens et al., 2017; Stults & Woodruff, 2016; Toimil, Camus, et al., 2020; Toimil, Losada, et al., 2020; Wise et al., 2014). This section outlines the barriers to adaptation plan implementation that relate to adaptation plans directly.

Even though the number of climate and coastal adaptation plans and policies is growing globally, evidence from many different places suggests that implementation of adaptation plans is limited and their effectiveness is questionable (Baker et al., 2012; Lawrence et al., 2013; Rosendo, Celliers, & Mechisso, 2018; Toimil, Losada, et al., 2020; Warnken & Mosadeghi, 2018; Woodruff & Stults, 2016).

Globally, over 58 studies have identified factors inhibiting implementation of adaptation plans (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Measham et al., 2011; Olazabal & Ruiz De Gopegui, 2021; Stults & Woodruff, 2016; R. Wang, 2012; Woodruff & Stults, 2016; Yalçın & Lefèvre, 2012). Of these studies, nine explored the efficacy of adaptation plans by evaluating the content of adaptation plans (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Olazabal & Ruiz De Gopegui, 2021; Olazabal, Ruiz de Gopegui, et al., 2019; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016). The nine studies include four focusing on a global view where adaptation plans from all continents were assessed and compared (e.g., Olazabal et al., 2019b analysed plans from 136 cities within 68 countries), four with a United States focus, two focusing on Australia, one on France, and one on the United Kingdom. Some of these

studies are comparative (e.g., between adaptation plans in the United States and France; (Lioubimtseva & da Cunha, 2020)). Single study locations include a focus on Australia (Baker et al., 2012), and the United States (Stults & Woodruff, 2016; Woodruff & Stults, 2016).

As reported in the nine studies, Table 3 identifies the eight adaptation plan components required for successful implementation. It also includes corresponding barriers for implementation. These components include funding mechanisms and costs, outlined roles and responsibilities for actions, prioritised timing of actions, inclusion of monitoring and evaluation methods, and plans for integration and or mainstreaming with other plans, actions, and sectors.

Table 3: The barriers for implementation with description as reported in several studies

Component	*Implementation Barrier Description*	*References*
Purpose, Aims, and Goals • Clearly defined purpose of plan demonstrating overall vision • Inclusion of respective goals and objectives with measurable components	• Plans lack a clearly defined vision of future outlook for a community • Goals and objectives associated with plan purpose lack components to measure progress or success	(Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Preston et al., 2011; Woodruff & Stults, 2016)
Baseline and Risk Assessment • Identifies existing and projected impacts and conditions • Includes assessments of risk and vulnerability of people and assets • Acknowledges climate and change and uncertainty	• Plan decisions are more likely to be effective if based on empirical evidence or scientific knowledge • Plans often fail to acknowledge climate change and the uncertainty surrounding projected risks and potential decisions	(Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Preston et al., 2011; Woodruff & Regan, 2018; Woodruff & Stults, 2016)
Funding Mechanisms • Inclusion of budgets • Access to funds for specified actions • Description of costs	• Plans fail to address the costs of adaptation actions or where financial means to fund each action will be acquired from • Objectives of plans are less likely to be implemented without related budgets as it inhibits effective resource assignations	(Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Olazabal & Ruiz De Gopegui, 2021; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016)
Roles and Responsibilities • Clearly assigned responsibilities for actions • Identification of parties/organisations responsibilities	• Plans lack clear roles and responsibilities for local governments and stakeholders to implement actions • Plans should outline, who is responsible for what actions, and what is required of them	(Olazabal, Galarraga, et al., 2019; Olazabal & Ruiz De Gopegui, 2021; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016)

Monitoring and Evaluation • Continuous monitoring • Inclusion of evaluation processes to determine progress and effectiveness • Opportunity to update plans over time	• Plans lack clear strategies for monitoring and evaluation, removing the ability to determine progress • Lacking details include definitions of monitoring and/or evaluation processes, methods, when to dedicate efforts, the costs involved and who is responsible for actions	(Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016)
Implementation Plan • Clearly defined, measurable and achievable, timebound actions • Prioritisation of actions • Inclusion of timelines and targets	• Plan content often lacks time lines or time-bound actions • Actions within plans also lack clear prioritisation reducing clarity for which actions should be made when	(Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Olazabal & Ruiz De Gopegui, 2021; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016)
Stakeholder or Community Engagement • Inclusion of engagement plan, including timelines • Continuous engagement beyond implementation of actions	• Engaging with the community allows for public understanding and support of changes • Plans with that lack community engagement are less likely to be implemented	(Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Preston et al., 2011; Woodruff, 2016)
Mainstreaming and Integration • Coordination with other plans (land use, disaster management, sustainability plans) • Integration across sectors	• Plans lack the ability to be integrated with other existing plans or policies (e.g., sustainability or land use planning • Plans often are not able to be integrated across sectors or organisations, which complicates stakeholder involvement and related responsibilities	(Lioubimtseva & da Cunha, 2020; Preston et al., 2011)

Clear definition of plan purpose and vision

The first step of planning is to determine the purpose or goal of the plans intention, as it prepares the foundation for the adaptation decision making process (Lioubimtseva & da Cunha, 2020). However, adaptation plans often lack a statement clearly detailed plan purpose, clearly defined goals or objectives, or both (Preston et al., 2011). Clearly outlining an adaptation plan's purpose and its respective goals and/or objectives is important because it suggests that those producing the adaptation plan have a vision of how the community will adapt to climate impacts, and what the intended outcome is for the future (Baker et al., 2012). Effective goals provide a clear vision for the adaptation strategy and how it aims to support the wider targets of the region, as well as, objectives that involve measurable and prioritised indicators explaining the reason behind them (Preston et al., 2011). Each of these aspects allows for a better understanding of the overall goal to achieve.

If goals and objectives are ambiguous, it possibly demonstrates a lack of willingness to commit to serious adaptation planning and actions, and can inhibit a clear vision for the future outlook of the community (Baker et al., 2012). Ambiguity of goals can also create confusion or lack of understanding surrounding adaptation plan objectives. Determining the success of goals or objectives requires a measurable or prioritised aspect to demonstrate progress (Woodruff & Stults, 2016).

Inclusion of baseline and risk assessments

The first two steps of the adaptation process (Figure 4) are to identify the challenges and assess risks and vulnerability. Generally, it involves determining a baseline of the existing conditions and impacts, and then assessing for the projected conditions and impacts to the community. It is important for adaptation plans to outline and explain what the risks and vulnerabilities are to then allow for understanding about the related adaptation options. An analysis of risks and vulnerabilities can result in the reduction of future risks (Baker et al., 2012; Preston et al., 2011; Woodruff & Stults, 2016).

Risk assessments allow for a scientific or evidence-based approach for adaptation planning. It is important that risks assessments include climate change scenarios or climate trends so that decisions can be informed by the current understanding of sea level rise and coastal hazards for that region (Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019). It is also

critical that risk assessments address the risks to people, stakeholders, and assets, identifying how and to what severity, as well as, climate and non-climate drivers. Information relating to current and future risks assists with decision making, and ensures strategies that are actionable to reduce risks are well informed. Risk assessments based on empirical evidence or scientific knowledge are more likely to result in effective adaptation planning decisions (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Woodruff & Stults, 2016).

As part of assessing the risks, it is important to acknowledge or address the inherent uncertainty surrounding projected climate risks to communities. Uncertainty on the timing and magnitude of impacts is a common challenge within adaptation and adaptation planning. Plans often fail to address uncertainty involved with the projected risks and potential decisions. Uncertainty about potential adaptation options or decisions can be reduced by ensuring multiple future scenarios are addressed and flexible strategies are used (Lioubimtseva & da Cunha, 2020; Woodruff & Regan, 2018; Woodruff & Stults, 2016).

Failure to build in funding mechanisms

Funding is required for the implementation of adaptation actions to support resourcing, improve or call in technical expertise, build networks, and promote outreach (Woodruff & Regan, 2018). Yet, the lack of funding mechanisms outlined in adaptation plans is one of the most common barriers towards implementing adaptation actions (Baker et al., 2012; Woodruff & Regan, 2018). It is common for adaptation plans to fail to address the costs required for adaptation options and actions or where funding for those actions will be sourced (Woodruff & Stults, 2016).

Many studies agree that improvements to adaptation plan implementation can result from defining a clear budget, outlining the costs for actions, including any ongoing costs (i.e., monitoring and evaluation), and funding access or sources (Lioubimtseva & da Cunha, 2020; Olazabal, Galarraga, et al., 2019; Olazabal, Ruiz de Gopegui, et al., 2019; Woodruff & Stults, 2016). Without the inclusion of these funding aspects, adaptation plans are less likely to be implemented as it inhibits effective resource assignations. Not only this, but plan users will be required to undertake additional steps before actions can be implemented (Olazabal, Galarraga, et al., 2019; Olazabal & Ruiz De Gopegui, 2021; Woodruff & Stults, 2016).

Assigning roles and responsibilities

Studies emphasise the absence of clear roles and responsibilities for local governments and other stakeholders within adaptation plans to implement actions or objectives (Baker et al., 2012; Olazabal, Galarraga, et al., 2019; Stults & Woodruff, 2016). Studies show that when roles and responsibilities are ambiguous or unclear to the plan user the implementation of adaptation actions is inhibited, causing a barrier to implementation (Bradley et al., 2015; Olazabal & Ruiz De Gopegui, 2021). Not only this, but local governments are known to have competing responsibilities, so without clear assignations it is unlikely persons or parties will undertake unassigned workloads (Gurran, Norman, & Hamin, 2013).

Successful adaptation plan implementation is also demonstrated by clearly defining and identifying parties/agencies responsible for actions. It is important to outline not only whether parties are assigned but also ensure the role of the responsibility is clearly specified (Olazabal & Ruiz De Gopegui, 2021). Including information about roles and responsibilities within adaptation plans is important as it designates a key role related to decision making and prioritisation of actions (Bradley et al., 2015). Roles and responsibilities are also essential to show readiness and preparedness for adaptation, and have been found to be an important indicator for effective adaptation plan implementation (Olazabal & Ruiz De Gopegui, 2021). Adaptation plans should aim to include roles and responsibilities for sourcing funding, implementing actions, stakeholder engagement, ongoing monitoring, and evaluation to assess plan progress.

Failure to account for monitoring and evaluation processes

Monitoring and evaluation are an important aspect in determining progress of implementation, however, many adaptation plans lack such strategies (Baker et al., 2012; Olazabal, Galarraga, et al., 2019; Olazabal & Ruiz De Gopegui, 2021; Woodruff & Regan, 2018; Woodruff & Stults, 2016). Even if monitoring measures are included, necessary details for implementation are often omitted (Olazabal & Ruiz De Gopegui, 2021). Details important for implementation include, a definition of the monitoring and or evaluation processes, the methods to undertake each process, when to dedicate efforts (time-bound action), the costs involved, and finally who is assigned to be responsible for monitoring and evaluation actions (Olazabal & Ruiz De Gopegui, 2021; Woodruff & Stults, 2016).

Monitoring and evaluation is considered to be an essential element of adaptation and is the sixth step within the iterative coastal adaptation process (NCCARF, 2022). Monitoring and evaluating the situation assists in assessing if and when conditions change, enables the ability to determine effectiveness of actions, and determines if aims and objectives have been achieved or if they need to be reassessed (Thomsen et al., 2012). Measures of monitoring and evaluation also enables flexible processes, as the knowledge of progress is up to date, allowing the ability to act efficiently (Olazabal & Ruiz De Gopegui, 2021). Without the implementation of such measures, the assessment of progress and ability to update adaptation plans over time is inhibited.

Outlining a plan for implementation of actions

A weakness within adaptation plans is comprehensive implementation measures, demonstrating concerns of whether plans will be functional (Woodruff & Regan, 2018). Studies show that adaptation plans lack important information to implement actions (Lioubimtseva & da Cunha, 2020; Olazabal & Ruiz De Gopegui, 2021; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Stults, 2016). Actions described within adaptation plans are less likely to be able to be implemented if they lack time-bound and prioritisation of actions. The inclusion of clearly defined, measurable and achievable time-bound actions, timelines, and targets are crucial for implementation to improve clarity surrounding which actions should be made and when (Baker et al., 2012; Lioubimtseva & da Cunha, 2020).

Failure to include priorities of actions is often compounded by the lack of other important details for motivating adaptation plan implementation. These details include the other implementation barriers discussed, such as associated costs, responsibilities, and evaluation to assess progress related to the implementation of actions (Woodruff & Stults, 2016).

Inclusion of community and stakeholder engagement

Stakeholder or community engagement is considered an essential step within the adaptation planning process (Azevedo de Almeida & Mostafavi, 2016; NCCARF, 2022). Engaging with stakeholders and alike helps communities understand how they can be directly affected by coastal hazards and risk, and what adaptation actions should be taken. It also allows for the community values to be made aware of, which helps provide a strategic direction for decision

makers. Overall, engagement with the community allows for public understanding and often support (Azevedo de Almeida & Mostafavi, 2016; Baker et al., 2012; Preston et al., 2011).

Community engagement should take place throughout the adaptation process to allow for transparency with the community (Azevedo de Almeida & Mostafavi, 2016). The inclusion of community engagement methods, timelines, and responsibilities should all be outlined within an adaptation plan, along with follow up consultations after implementation. It is suggested that community engagement can lead to better quality adaptation plans and more likely to be implemented and maintained (Baker et al., 2012). Reasons for this can be linked to the public ensuring accountability for decision makers actions.

Mainstreaming and integration of plans

Mainstreaming and integration of adaptation plans with other plans is important as it streamlines the focus of actions towards one collaborative approach (Lioubimtseva & da Cunha, 2020). Local governments are likely to implement an adaptation plan, however, there are a number of other potential plans that are related to aspects of adaptation actions such as sustainability, land use, and disaster management. Integrating adaptation plans with other related plans allows for cooperation of sectors and can improve adaptive capacity.

However, adaptation plans often lack the intention to be integrated with existing plans and policies, and also sectors, which can complicate stakeholder involvement and related responsibilities. Without integration with other plans and policies, adaptation plans may be less likely to be implemented to their potential. Adaptation plans should aim to include some form of strategy and timeline to meet to integrate with related plans and policies (Preston et al., 2011). It could also be beneficial to integrate the adaptation objectives with related sectors or neighbouring agencies.

Based on the literature surrounding barriers to implementation of adaptation plans, and those that specifically interrogate adaptation plan content to determine factors inhibiting implementation, it is clear that these eight factors are important for implementation of adaptation plans. Adaptation plans found to be lacking in one or more of these aspects are likely to produce similar results, demonstrating a lack of efficacy in plans.

Chapter 3: Australian Context

More than 85% of Australians live within 50 km of the coastline, where coastal regions are identified as exceedingly vulnerable to climate change (Bradley et al., 2015; DCC, 2009; Niven & Bardsley, 2012; Ramm et al., 2017). In Australia, the coast holds important economic, social, cultural, and environmental significance (DAWE, 2015; DOCCAE, 2010). Australia's coastline spans the tropics, sub-tropics, and temperate zone, demonstrating a vast range of coastal interactions (Bradley et al., 2015). The threats from coastal hazards to the coastal zone are numerous and significant, however, vary greatly (Nursey-Bray et al., 2015). For example, sea level rise trends in Australia are consistent and comparable to those of the global rate, however, the outcomes will differ geographically (Nick Harvey, Clarke, Pelton, & Mumford, 2012; Ramm et al., 2017).

Australian coastal settlements, over time, have been developed under stable climatic conditions, with the expectation that the coastline and extreme events will remain consistent and defined by historical experience (DAWE, 2015; Wainwright et al., 2014). However, changes in weather patterns and the observed threat of sea level rise suggests coastal risk in Australia is increasing (Gurran et al., 2013). The observed increase in exposure and vulnerability to the built environment and valuable industries, threatens public safety, and societal lifestyle values (Niven & Bardsley, 2012; Ramm et al., 2017). It is estimated that across Australia, a value of $63 billion in existing residential assets alone could be at risk of coastal inundation by 2100 (Robb, Stocker, Payne, & Middle, 2017).

Most capital cities in Australia are located along the coast, increasing their risk to coastal hazards. Many coastal communities are at high risk due to dense coastal populations, high value economy, infrastructure and coastal industries, and societal values (Toimil, Losada, et al., 2020). However, many regional, less dense populations are already witnessing the impacts of coastal climate change, increasing their risk and need for adaptation. In Australia, communities will experience impacts of coastal hazards in varying ways depending on their use of the coast. The unique and complex interactions between climate hazards and the increase in coastal development in Australia is causing coastal settlements to be increasingly vulnerable to impacts of climate change (Lemee, Fleury-Bahi, & Navarro, 2019; Lu et al., 2018; Mukheibir, Kuruppu, Gero, & Herriman, 2013; Spalding et al., 2014; Toimil, Losada, et al., 2020).

In the last decade, Australian governments have begun planning and implementing adaptation measures to manage the impacts of climate hazards, in order to continue to protect the economic, social, and environmental security of coastal communities (DOCCAE, 2010; Tribbia & Moser, 2008). In Australia, much of the responsibility to undertake coastal adaptation planning falls upon the local governments, however, each tier of government plays a different role and will be discussed in detail (Gurran et al., 2013; Nick Harvey et al., 2012; Verschuuren & McDonald, 2012).

Government Responsibility

The management of the coast, both ecological and built environments, falls under various institutions across multiple levels of government. In Australia, governments of all levels are responsible for managing the risks of coastal climate change, this is inclusive of the risks to human settlements, public and private infrastructure, and the coastal environments (Bradley et al., 2015; Niven & Bardsley, 2012; Ramm et al., 2017; Tribbia & Moser, 2008). The Australian Governance system is separated into a three tiered system, federal, state, and local governments (Gurran et al., 2013; Nick Harvey et al., 2012). Under the federal system of government, Australia comprises of six states and two territories. All levels of government have a significant role towards coastal management.

In Australia, there is no constitutional or legislative direction to the states on coastal management, therefore, each state differs in their approach to manage the coast (DCC, 2009; Forino, Von Meding, & Brewer, 2018). The Commonwealth government holds few powers relating directly to environmental management. The Commonwealth jurisdiction overarches areas such as defence, shipping, and world heritage sites, but also has substantial influence through funding mechanisms nationally for natural resource management (N. Harvey & Caton, 2010; Nick Harvey et al., 2012). The Commonwealth Government has the ability to use certain powers that can directly and indirectly influence coastal management. The Australian Federal Government has a limited environmental role under the Constitution directed at coastal management (Nick Harvey et al., 2012; Mukheibir et al., 2013). Therefore, various federal legislation are applicable to the coastal zone, however, there is no specific legislation related to national coastal management (Nick Harvey et al., 1999; Robb et al., 2017). However, state governments rely on federal funding mechanisms, which in turn influence state capacity to implement coastal management related action.

State (and territory) governments in Australia have the delegated power under the Constitution to manage the coast (Nick Harvey et al., 2012). States have the legislative responsibility for environmental management within their jurisdiction. All states have a range of legislation and agencies that control uses of the coastal zone, with specific legislation addressing coastal management. However, in practice local governments hold much of the development control, and management of coastal facilities and infrastructure (Nick Harvey et al., 2012).

Therefore, local governments are best placed to tackle the threat of climate change and implement adaptation measures (Bradley et al., 2015; DAWE, 2015; DEW, 2007; DOCCAE, 2010; Forino et al., 2018; Niven & Bardsley, 2012; Thomsen et al., 2012). This is because impacts of coastal climate change (coastal hazards) are experienced at the local level and local governments (councils) hold the responsibility at this level (N. Harvey & Caton, 2010). Coastal climate risks vary significantly due to geographic location, local and seasonal climate variations, and levels of community exposure and vulnerability. Therefore, coastal climate change is often best addressed at local or regional scales (DAWE, 2015; DOCCAE, 2010).

Local governments (councils) in Australia are responsible for the coastal management of their jurisdiction, this includes functions such as planning, development, and land management (Bradley et al., 2015; N. Harvey & Caton, 2010). Councils make most of the planning and development decisions along the coast either through the development of plans, or individual responses to development applications. Not only this but councils are also responsible for the day-to-day maintenance of beaches, coastal facilities (including boat ramps and jetties), and shore protection, along with being involved with decisions about the location of coastal infrastructure, such as roads, access paths, carparks, and use of public coastal land (N. Harvey & Caton, 2010).

Coastal councils therefore, have an increasing number of responsibilities, which is compounded by the heavy use by residents and visitors. Most councils face difficult problems managing coastal resources, as coastal management is not only an expense, but councils often have limited scope to raise revenue (N. Harvey & Caton, 2010). With the addition of coastal adaptation, councils face a complex task to effectively manage the coast (Bradley et al., 2015). However, a localised approach is benefited by the ability to work closely to the problem and directly with the local communities (Ramm et al., 2017). It is important for local

governments to ensure particular local circumstances are adequately considered in response to coastal climate change (DAWE, 2015).

Within the federal system, the position of local councils is both a strength and a weakness in relation to coastal adaptation and management. The concentration of local issues and responsibilities can be overwhelming and hard to undertake effectively, however, a local focus can motivate strong and productive cooperation with the community (N. Harvey & Caton, 2010). Local councils are often responsible for climate impacts as they are also responsible for the assets and people of that community. Local councils also have the ability to respond to their community in relation to climate impacts in a way that produces local benefits (Lioubimtseva & da Cunha, 2020; Stults & Woodruff, 2016; R. Wang, 2012).

In saying this, local councils should consider a number of factors when carrying out coastal hazard risk management and adaptation planning. Although local councils benefit from being able to directly respond to coastal issues, they face a number of challenges when addressing climate change impacts along the coast. With local councils positioned below state and federal government tiers in Australia, challenges can arise in relation to lack of capacity, resourcing, technical expertise, higher political support, and awareness of risks (Barnett et al., 2014; Robb et al., 2017). These challenges are also likely to differ between city-based and regional-based locations, with regional councils experiencing greater challenges (Barnett et al., 2014).

South Australian Context

The South Australian Coastline is more than 4000 km long (including Kangaroo Island and other offshore islands) and is home to approximately 80% of the state's population (Nursey-Bray et al., 2015). The coastline comprises of 34 coastal councils, with 26 of those being regionally located and the other eight being metropolitan coastal councils.

The legislation in South Australia dedicated to coastal legislation is the *Coast Protection Act 1972*. The legislation's main focus is on the protection of the coast, with the main authority for coastal management being the Coast Protection Board (CPB). The role of the CPB is to manage the state's coastline and administer the Act. The state agency Department of Environment and Water (previously Department of Environment and Natural Resources) supports the Coastal Protection Board. Both the Department of Environment and Water and the CPB aim to maintain coastal development, focusing on protecting planned or existing

developments from coastal hazards and directly respond to the threat of sea level rise (Nick Harvey et al., 2012; Nursey-Bray et al., 2015).

Many local governments have ongoing relationships with the CPB, and with other agencies such as the Department of Environment and Water. Councils are demonstrating active progress towards climate change and sea level rise, with adaptation approaches individually, as regions, or in partnership with the state (Australian Coastal Society, 2022; Bradley et al., 2015; Forino et al., 2018). The Local Government Association of South Australia (LGASA) in 2003 launched a Local Government Coastal Management Strategy, with the intent to recognise the need and importance for governments, communities, and industry to work together to sustainably manage coastal resources (Nursey-Bray et al., 2015). More recently in 2019, the South Australian Coastal Councils Alliance (SACCA) was created by councils to provide a collective local government voice on coastal matters. These actions demonstrate a desire to ensure the protection of South Australia's coastline with the intention of working together.

South Australian local councils are showing action towards adaptation, with many demonstrating progress by producing coastal scoping studies and coastal adaptation plans. Of South Australia's 34 coastal councils, at the time of writing, 12 have a published document focusing on the coastal risks for their region, and many of the documents outline adaptation actions for the future.

Chapter 4: Methods

Experience gained both in Australia and beyond suggests that adaptation plans may not meet their intended aims if they lack sufficient and specific information about timelines, roles and responsibilities, and funding sources. Investigating South Australia's coastal adaptation plans is therefore important to establish whether these plans have avoided problems experienced elsewhere. In South Australia, at the time of writing, 12 out of 34 coastal councils had a published coastal adaptation document. Table 4 outlines the characteristics and description of each coastal adaptation document, including council and focus area, the date it was published, and the author.

Of the 12 documents, two were designed for metropolitan councils, the City of Marion Council and the City of Onkaparinga Council. The other 10 documents were designed for regional council coastlines located in various parts of the State. Upon closer understanding of each document, it was identified that three of the documents did not classify as coastal adaptation plans. Coastal adaptation plans by definition must include the assessment and identification of options to enact and when, as well as, monitoring and evaluation indicators (stages one to four of the adaptation process; Figure 4) (NCCARF, 2022). Two of the documents (City of Marion and City of Onkaparinga) were scoping studies, intended to guide the development of a coastal adaptation plan (representing stages one and two of the adaptation process), and the other (District Council of Robe) was solely a monitoring plan to action recommendations made by previous technical studies. All three documents were therefore excluded from the analysis.

Of the remaining nine coastal adaptation plans interrogated for this study, four incorporated the whole coastline of a council, while the other five plans targeted specified sections of coastline within their jurisdiction. All nine coastal adaptation plans within this study were focused on regional council coastlines. The first published plan was produced by the Copper Coast Council in 2013 and the most recent publication was City of Victor Harbour Council's in 2021.

Table 4: Characteristics of South Australian Coastal Council Adaptation Documents.

CAP Title	Council	CAP Focus Area	Date Published	Metropolitan/ Regional	Description	Citation
Port Hughes to Moonta Bay Cliff Top Stability Study: Final Strategy Report	Copper Coast Council	Part of Council Coastline	September 2013	Regional	This document was produced by the Australian Water Environments for the District Council Copper Coast. The focus location is Port Hughes to Moonta Bay (5.5km of coastline), more specifically, a cliff top stability study and strategy. The study was conducted as a response to ongoing erosion between the southern council boundary and the Moonta Bay jetty. The study aimed to develop an appropriate risk framework and management options for addressing the cliff top stability issues as there are a number of residential dwellings near the cliff edge. The Copper Coast is located regionally in the upper Yorke Peninsula in South Australia, 135 km north of Adelaide.	Port Hughes to Moonta Bay Cliff Top Stability Study Final Strategy Report, 2013, Australian Water Environments, South Australia
Coastal Settlements Adaptation Study: Middle Beach	Adelaide Plains Council	Part of Council Coastline	August 2014	Regional	This document was produced by the University of South Australia as a Coastal Settlements Adaptation Study for Middle beach, which is part of the Adelaide Plains Council (formerly the District Council of Mallala at the time of writing). This study aimed to identify and evaluate potential sea level rise adaptation strategies for the coastal settlement of Middle Beach. The Adelaide Plains Council is regionally located north of Adelaide along the Gulf St. Vincent. This area is known for mangrove forests along the coastline rather than sandy beaches and coastal settlements. Middle beach is one of few coastal settlements within the area.	Western, M., Kellett, J., 2014, Coastal Settlements Adaptation Study - Middle Beach, University of South Australia, South Australia
Seawater Flooding Adaptation Pathways for Yorke Peninsula Settlements	Yorke Peninsula Council	Part of Council Coastline	September 2015	Regional	There are four distinct documents which make up the Seawater Flooding Adaptation Pathways for the Yorke Peninsula Settlements, these locations include Coobowie, Pine Point, Port Clinton, and Price. They are all produced by Integrated Coasts ad demonstrate stage 2 of the process, being the adaptation options. The study sites are all situated along the eastern coasts of the Yorke Peninsula and are the focus of the plan as they are considered locations of risk. The aim of the project is to identify seawater flooding risks, assess current (at the time of writing) flood protection infrastructure and provide recommendations for future actions. The Yorke Peninsula Council makes up most of the Yorke Peninsula and is located across the Gulf St Vincent from Adelaide but can also be reached by road driving north of Adelaide (~176 km).	Western, M., Kellett, J., 2015, Seawater Flooding Adaptation Pathways for Yorke Peninsula Settlements, Integrated Coasts, South Australia
Southend Adaptation Strategy: Report Prepared for Wattle Range Council	Wattle Range Council	Part of Council Coastline	March 2018	Regional	This document was prepared for the Wattle Range Council by Wavelength to outline an adaptation strategy for the township of Southend. The reason for the document is because the coastline of Southend has been increasingly subjected to coastal erosion and inundation risks. The purpose of the document was to develop an action plan with specific priority pathways. The township of Southend is located at the southern end of Rivoli Bay on the south-east coast of South Australia and is approx. 400 kms south east of Adelaide.	Southend Adaptation Strategy Report prepared for Wattle Range Council, 2018, Wavelength Consulting, South Australia
Port Broughton Coastal Adaptation Plan	Barunga West Council	Part of Council Coastline	June 2018	Regional	This document was prepared for the Barunga West Council as a coastal adaptation plan by Wavelength. The focus of the plan is Port Broughton, a regional coastal town located at the northern extent of the Yorke Peninsula on the east coast of the Spencer Gulf. It is situated approx. 170 km north west of Adelaide. The coastline of Port Broughton is relatively protected with large expanses of shallow water and seagrasses, along with significant areas of mangroves. The aim of this plan was to provide the residents of this area with sound options and advice regarding the management of the foreshore due to increasing impacts of erosion and flood risks.	Port Broughton Coastal Adaptation Plan, 2018, Wavelength Consulting, South Australia
Coastal Climate Change Adaptation Study	City of Marion	Whole of Council Coastline	June 2018	Metropolitan	This document is a scoping study developed by Integrated Coasts to guide the development of a coastal adaptation plan for the City of Marion whole coastline. The purpose of this study was to review the coastline to create a baseline to build a coastal climate change monitoring and adaptation plan. The coastline was separated into 5 coastal cells for the study due to varying geological types. The cells were made up of the Marino Cliffs, Hallet Cliffs, Hallet Beach, Field River, and South Cliffs. The City of Marion coastline is part of the Adelaide metropolitan coastline, and is 7 km in length and is predominantly cliff face and rocky beach, rather than soft sediment. **This document was removed from this study.**	Western, M., 2018, City of Marion Coastal Climate Change Adaptation Study, Integrated Coasts, South Australia
Kangaroo Island Coastal Hazard Strategy	District Council of	Whole of Council Coastline	November 2018	Regional	This document was produced by Seed Consulting Services for the Kangaroo Island Council, with the objective of describing the potential impacts of coastal hazards present (at the time of writing) and future, and to identify potential response options. The strategy is focused on the coastline of the whole council (island). Kangaroo Island is located 13.5 km south on the mainland of South Australia	Siebentritt, M., 2018, Kangaroo Island Coastal Hazard Strategy, Seed Consulting Services, South Australia

	Kangaroo Island				at its closest point. The island is home to approx. 4500 residents, and popular tourist destination for approx. 200,000 visitors each year. The strategy outlines the potential hazards and risks for the island which is broke into 12 distinct coastal settlements.	
Coastal Adaptation Study: Murray Mouth to Boomer Beach	Alexandrina Council	Whole of Council Coastline	January 2020	Regional	This document was produced by Integrated Coasts for the length of the Alexandrina Coastline, from Chiton Rocks to Goolwa Beach. Four additional locations within the Murray River Estuary were also studied (Beacon 19 Boat Ramp, Sugars Beach, and the Mundoo and Goolwa Channels), due to the use and settlements located within the areas. The document is structured in two main sections: the methodology used in the study and the coastal issues relevant to the entire coastline (part 1), and standalone reports for the nine coastal cells within the council (part 2). The Alexandrina Council is located regionally with a predominantly soft sediment coastline, in the Fleurieu Peninsula region of South Australia.	Western, M, Hesp, P, Bourman, R., 2019, Coastal Adaptation Study for Alexandrina Council, Integrated Coasts, South Australia
Robe Coastline Monitoring Roadmap	District Council of Robe	Whole of Council Coastline	July 2020	Regional	This document was produced by Wavelength as a Coastline Monitoring Roadmap for the District Council of Robe. The monitoring plan covers the entire council coastline, which is divided into 17 coastal units. Each coastal unit represents a predominant geomorphic type. The purpose of this plan is to action previous recommendations from technical studies outlining the hazards and associated risks. The District Council of Robe is located regionally in the Limestone coast area of South Australia, and is approx. 4 hours (336 km) south south-east of Adelaide. **This document was removed from this study.**	Robe Coastline Monitoring Roadmap, 2020, Wavelength Consulting, South Australia
Kingston District Coastal Adaptation Strategy	District Council of Kingston	Whole of Council Coastline	October 2020	Regional	This document was produced by Wavelength and is considered a coastal adaptation strategy, which recommends specific priority adaptation pathways. The focus of this strategy is from Cape Jaffa to Blackford Drain, which encompasses the council's whole coastline. The coastline was divided into six sections based on natural and built features. The District Council of Kingston is located regionally approx. 300 km south east of Adelaide, on the Limestone Coast. The coastline for this area is generally soft sediment, where erosion and coastal flooding are the major hazards.	Sandery, A., 2020, Kingston District Coastal Adaptation Strategy, Wavelength Consulting, South Australia
Coastal Adaptation Study for City of Onkaparinga	City of Onkaparinga	Whole of Council Coastline	June 2021	Metropolitan	This document was produced by Integrated Coasts for the City of Onkaparinga as a Coastal Adaptation Study for the length of its coastline. The purposes of this study were to create a baseline upon which to monitor future changes including identifying key coastal issues and vulnerabilities and provide a risk assessment for each coastal cell. This document does not outline an adaptation plan to act on the risks identified in the risk assessment. The coastline of the City of Onkaparinga was divided into 12 study cells. The City of Onkaparinga is located on the southern fringe of Adelaide and has a coastline that stretches 31 km from Lonsdale to Sellicks Beach. The coastline varies significantly from soft sediment beaches to hard rocky cliffs. **This document was removed from this study.**	Western, M, Hesp, P, Bourman, R, Miot Da Silva, G, 2020, Coastal Adaptation Study for City of Onkaparinga, Integrated Coasts, South Australia.
Coastal Adaptation Study (Stage 1) Coastal Adaptation Strategy (Stage 2) For City of Victor Harbour	City of Victor Harbour	Whole of Council Coastline	July 2021	Regional	This document was produced by Integrated Coasts for the City of Victor Harbour. The plan is made up of two stages, stage one being the Coastal Adaptation Study which reports the methodology utilised in the study and the coastal issues common to the coastline. Stage two is the Coastal Adaptation Strategy which are reports for each of the three conservation cells focusing on actions and plans for the future. The City of Victor Harbour is located regionally on the Fleurieu Peninsula, 80 km south of Adelaide.	Western, M, Hesp, P, Bourman, R, 2021, Coastal Adaptation Study for City of Victor Harbor, Integrated Coasts, South Australia.

Based on the literature that evaluated adaptation plans, an evaluation of South Australia's coastal adaptation plan quality was undertaken to determine the likely efficacy of each plan.

Evaluation

What is evaluation?

Program evaluation is a process that critically examines programs, which are inclusive but not limited to, projects, policies, processes and/or plans against their stated objectives. The process involves collecting and analysing information about the activities, characteristics, and outcomes of a program (Patton, 1982, 2002). Evaluation identifies whether, and how effectively, a program has reached the intended goals and objectives (Guyadeen & Seasons, 2015). The purpose of evaluation is to make judgements about a program to improve its effectiveness or inform decisions. Evaluation outcomes can improve future iterations of a program's design and implementation, as well as demonstrate program impact (Patton, 1982, 2002). Although the purpose and process of evaluation is similar for varying types of programs, this study focuses on plan evaluation.

What is plan evaluation?

In the case of this study, the evaluation will be focused on coastal adaptation plans. Plan evaluation is defined as the 'systematic assessment of plans, planning processes, and outcomes compared with explicit standards or indicators' (Laurian et al., 2010, p. 741). Plan evaluation has a number of purposes depending on the needs of the person undertaking the process (Stevens, Lyles, & Berke, 2014). Purposes include identifying the strengths and weaknesses of a plan, to evaluate the overall quality, and to assess whether the plans are able to meet their intended aims (Berke & Godschalk, 2009; Guyadeen & Seasons, 2015). In this case, evaluating the quality of the plan and if aims are met, are important to help determine the efficacy of plan implementation.

Evaluation methods

Evaluation methods include conformance-based approaches, which identifies how well, in this case, a plan is able to be implemented by meeting a specified criteria, or performance-based approaches which identifies a plan's success by its performance or outcomes (Guyadeen & Seasons, 2015). For both approaches, the plan must be evaluated based on a set

of criteria. In terms of plan quality, the evaluation approach can be either conformance- or performance-based, depending on the aim of the evaluation. In terms of this study, the approach is conformance-based as the success of the plans are not based on their outcomes or what they have achieved. Rather, this study determines plan quality based on the contents of plans only. For this purpose, the main method utilised to determine plan quality is content analysis.

Content analysis

Each of South Australia's coastal adaptation plans were evaluated using content analysis.

What is content analysis?

Content analysis is both a qualitative and quantitative research method used to analyse the content of text, visuals, and audio (Devi, 2009; Patton, 1982). The process of content analysis involves interpreting and identifying concepts, terms, or phrases present in qualitative data (i.e., documents or videos), and uses a systematic classification process of coding to identify themes or patterns (Gheyle & Jacobs, 2017; Prasad, 2008).

There are two general types of content analysis: conceptual analysis and relational analysis. Conceptual analysis focuses on determining the existence and frequency of concepts in a text, often represented by words or phrases. Whereas, relational analysis develops the conceptual analysis further by examining the relationships between the concepts identified (Devi, 2009). Conceptual analysis will be the main type of analysis used for this study.

Why do we do content analysis?

Content analysis enables the investigation and use of qualitative data for research purposes. Advantages of content analysis include being able to analyse numerous bodies of text systematically for the presence or absence of particular content (Stemler, 2000). This is important to identify trends and make comparisons between similar texts, such as plans or reports (Prasad, 2008). Although content analysis is a qualitative method, the findings can be transformed into quantitative measures, which can be beneficial for a number of research applications (e.g., statistical analysis).

How is content analysis performed?

Content analysis determines the presence or absence of text by using guidelines and/or a coding framework. The guidelines are pre-defined and are based on the context of the content, existing theories, previous research, or experience (Patton, 1982, 2002). The purpose of having pre-defined guidelines is to break down the text into manageable categories, which involves creating a coding framework. It is important for each category to be clearly defined to avoid confusion during the analysis. Advantages of using categories is it allows for the text to be organised in a systematic way to better analyse and interpret (Stevens et al., 2014; Woodruff & Stults, 2016).

Coding

Using coding in content analysis allows the qualitative content to be evaluated in a quantifiable way by assigning a weight or value to a category or code (Stemler, 2000). Purposes for using coding methods include data reduction, data organisation, data exploration, analysis and theory building (Devi, 2009; Hay, 2005). Each purpose for coding is dependent in the researcher's goals. The categories and codes can be a word, set of words, or phrases. This allows the researcher to focus on a set criterion based on the research question or questions (Hay, 2005). Once found, the category or code can be assigned a value depending on the level of presence identified. For example, if a code is absent from the content, it would be assigned a value of = 0, if a code was present but vague it would = 1, and if it was clearly present = 2 (Gheyle & Jacobs, 2017; Stevens et al., 2014).

For the purpose of this study, content analysis was used to identify the strengths of existing coastal adaptation plans, as well as potential gaps that may impede their implementation. To achieve this, the presence or absence of pre-defined criteria (categories and codes) associated with the plans was determined and allowed for the conversion of text into a quantitative measurement of plan quality. The measure of whether and to what extent a plan contained specific criteria was determined by assigning a score for each criteria (Stevens et al., 2014). The outcomes of the content analysis enabled the comparison of plans and allowed for the identification of similarities and differences across plans (Woodruff & Stults, 2016).

Analysis of plans

Successful adaptation plans share similar characteristics. They include essential details that are clear and precise and thus enable an adaptation plan to be implemented. The details required for successful adaptation plans are outlined in Table 5.

Table 5: Main aspects essential for the implementation of adaptation plans as cited in the literature

Implementation Barrier	Adaptation Plan Components
1. Purpose, Aims, and Goals	• Outlines intentions including vision for the future • Describes to users the purpose of the plan, including acknowledging climate change
2. Baseline and Risk Assessment	• Assesses the current and future impacts, risks, and conditions • Addresses risks to people, stakeholders, and assets within the community • Acknowledges uncertainty surrounding risks and adaptation options
3. Funding Mechanisms	• Inclusion of budgets • Access to funds for specified actions • Description of costs
4. Roles & Responsibilities	• Clearly assigned responsibilities for actions • Identification of parties/organisations responsibilities
5. Implementation Plan	• Clearly defined, measurable and achievable, timebound actions • Prioritisation of actions • Inclusion of timelines and targets
6. Stakeholder Engagement	• Provides understanding of community wants, needs, and expectations • Change is more likely to be supported through community engagement
7. Monitoring and Evaluation	• Continuous monitoring • Inclusion of evaluation processes to determine progress and effectiveness • Opportunity to update plans over time
8. Mainstreaming & Integration	• Coordination with other plans (land use, disaster management, sustainability plans) • Integration across sectors

Categories

The adaptation plan components shown in Table 5 formed the basis of the coding framework for this study. Overall, there were eight categories outlining the important aspects of adaptation plans, including the essential aspects for implementation. Contextual information about each adaptation plan was documented, such as whether the adaptation plans focused the whole of coastline or part of coastline, the date of publication, and the author of the document. The information important for adaptation plan implementation with respect to each category (and code) are outlined in Table 6.

The first category was ‘aims, purpose and goals’. Inclusions of this category surrounded the importance of outlining the purpose of the adaptation plan, as well as, an overall aim and/or goal the adaptation plan intends to achieve. Importantly, goals and objectives should be timebound or describe a timeline as this creates the ability to demonstrate progress of whether adaptation plans, once implemented, have met their goals and objectives.

The following two categories were ‘baseline’ and ‘risk assessment’. These categories are similar in that they focus on the past and current risks and hazards (baseline), and the future potential risks and hazards (risk assessment) to a community. In terms of the analysis for the category ‘baseline’, it was important to determine whether the existing impacts, conditions, and actions were outlined. This is because it creates a baseline to move forward from in terms of risk assessments, which is the next step in adaptation planning and category. The category 'risk assessment’, aimed to determine if adaptation plans included projected impacts or changes (climate and non-climatic driven) from the baseline with inclusions of the risk assessments, which should outline the risks to people, stakeholders, and assets.

Following risk assessments, adaptation plans generally outline the ‘consideration of adaptation options’, which was category four. The consideration of options should demonstrate that adaptation options were clearly defined, with the consideration and inclusion of multiple future scenarios, prioritised actions, timebound actions, responsibilities for actions, and costs related to those actions. Each of these aspects are essential for implementation and describe a strategy of when, how, and by who these options will be implemented.

Category five is classified as ‘adaptive capacity’. The category covers all aspects relating to institutional aspects of adaptation planning, such as funding mechanisms, coordination between agencies, and integration of adaptation plans with other plans that relate to

adaptation. Funding mechanisms are essential in adaptation plans as it communicates to the plan user the financial needs for implementation. Coordination between agencies and integration of adaptation plans are important to build adaptive capacity, and allows for the adaptation plan to be useful beyond the document. Coordinating the implementation of adaptation plans with neighbouring councils, for example, can benefit the coastline beyond that adaptation plan's focus.

'Stakeholder engagement' is an important stage within the adaptation planning cycle and it is documented that implementation of adaptation plans is often more successful when stakeholders of the community are involved. This constitutes category six and aims to identify whether adaptation plans, firstly undertake or plan to undertake stakeholder or community engagement, and secondly to what level. For example, whether a diverse group of the community are included in the engagement, how they plan to communicate, and when.

The last two categories are 'monitoring' and 'evaluation'. Both of these aspects of adaptation plans are defined within the adaptation planning cycle as important and are known barriers for implementation when missing from adaptation plans. Monitoring allows for ongoing understanding of how the coastline is changing, and therefore important aspects to be included in adaptation plans include monitoring methods, responsibilities, timeframes, costs, and reporting. Similarly, evaluation allows for plan users to document progress and determine if adaptation plans need updating or changing over time. Important aspects of this category to seek in adaptation plans include evaluation methods and metrics, responsibilities, timeframes, including timeframes for plan updates, reporting.

Table 6: Detailed coding framework including descriptions for each code and category for assessment of coastal adaptation plans

Category	Code	Definition/Description of Code
General	• Location	• Defines the geographic location which the plan is focusing on
	• Date of Publication	• Provides the date of publication
	• Consultant	• Provides the consultant group who created the plan
	• Guidelines used	• Outlines which guidelines were used to structure plan
Purpose/Goals	• Plan purpose	• States purpose of the plan
	• Plan need	• Defines reason for needing a plan including mention of adaptation
	• Vision/ future statement	• Includes a vision or target to reach for the future
	• Goals and/or objectives	• Includes measurable goals and or objectives
	• Goals and objective timeline	• Goals and objectives include timeframes
	• Goals and objectives prioritisation	• Includes prioritization of goals and objectives
Baseline	• Base source	• Data sources used identified to make plan
	• Base collection	• Type of data collection identified to make plan
	• Climate change	• Acknowledges climate change
	• Existing Impacts/conditions	• Identifies how changing climate has already impacted the region and identifies current condition
	• Existing actions	• Identifies the actions/plans already planned or in progress with adaptation value
Risk Assessment	• Risk source	• Data sources used identified to complete assessments
	• Risk collection	• Data collection identified to complete assessments
	• Projected impacts/changes	• Assessments include projected impacts/changes for the region
	• Assessment inclusion	• Completion and inclusion of risk, hazard and vulnerability assessments
	• Climatic drivers	• Identification of climatic drivers
	• Non-climatic drivers	• Identification of non-climatic drivers
	• People at risk	• Identifies where and how people/populations are at risk
	• Stakeholders at risk	• Identifies which stakeholders and how they are at risk
	• Assets at risk	• Identifies assets/infrastructure at risk and how
	• Climate trends	• Assessments are informed and include climate trends
	• Uncertainty and sources	• Assessments acknowledge uncertainty;
		• Acknowledges sources of uncertainty
Consideration of Adaptation Options	• Adaptation options	• Identifies specific adaptation options for specific impacts
	• Prioritised options	• Prioritises adaptation options e.g. recommends what options should be undertaken first and why

(Implementation Strategy)	• Informed options • Co-benefits • Adaptation option roles and responsibilities • Adaptation option timeframes • Multiple future scenarios • Flexible strategies	• Options are informed by assessments and scientific knowledge • Recognizes co-benefits of options • Identifies roles and responsibilities for each adaptation option • Includes timeframes for options • Includes multiple future scenarios by including multiple options • Includes flexible strategies (i.e. trigger points)
Adaptive Capacity (Domains: Assets, Organisation, Agency, Flexibility, Learning)	• Coordination between agencies/councils • Increased awareness • Financing/funding strategies and sources • Costs estimation • Cost identification for actions • Funding responsibilities • Cost of inaction • CAP integration • Plan for CAP integration • Integration timeframe	• Includes coordination with other agencies/ neighbouring councils • Includes plan for increasing awareness around adaptation • Includes financing/funding strategies and; • Identifies potential sources of funding • Estimates costs for actions • Identifies costs for specific actions • Includes who is responsible for sourcing funding and; • Includes who is responsible for providing funds • Acknowledges cost of inaction • Integrates CAP with other plans (land use, mitigation, sustainability) and; • Integrates CAP with multiple agencies and stakeholders • Identifies plans to integrate with societal sectors • Includes time frame for integration
Stakeholder Engagement	• Stakeholder engagement plan • Stakeholder inclusivity • Public involvement • Communication methods • Agency coordination • Stakeholder engagement timeline • Roles and responsibilities for engagement	• Identifies plan for stakeholder engagement and; • Includes plan for ongoing/continual public participation/ stakeholder engagement • Includes stakeholders that represent all groups impacted • Identifies opportunities for public involvement (i.e. meetings) • Includes communication and outreach methods for awareness • Involves coordination of a number of different agencies • Includes timetable/timeline for stakeholder engagement • Includes responsible parties for undertaking stakeholder engagement
Monitoring	• Monitoring methods • Monitoring roles and responsibilities • Monitoring timeframe • Reporting of monitoring	• Includes methods to monitor implementation, including what needs to be monitored • Includes roles and responsibilities for monitoring actions • Includes timeframes for when actions should be monitored and how often • Includes methods and requirements of monitoring reporting and responsibilities for reporting

	• Monitoring costs • Monitoring funding	• Includes an outline of costs for monitoring of actions • Includes the funding mechanisms to undertake monitoring
Evaluation	• Evaluation methods • Evaluation metrics • Evaluation roles and responsibilities • Evaluation timeframe • Reporting methods • Next steps • Plan updates	• Includes methods to evaluate progress • Uses metrics to assess progress • Includes roles and responsibilities for evaluation of progress • Includes timeframe for when evaluation should be undertaken • Includes methods of reporting evaluation progress • Acknowledges next steps after evaluation • Includes plan/timeframe for updating the plan

Codes

Once each category was defined, codes were assigned to each category depending on what the literature review illustrated to be essential for adaptation plans. Each code was clearly defined to minimise confusion of a code's meaning during analysis of or between coastal adaptation plans. Each category with the assigned codes and definitions are outlined in Table 6. In total, 60 codes were developed for the eight categories, making up the coding framework to assess plan quality.

Qualitative analysis

For this study Nvivo was used to assess the coastal adaptation plans qualitatively. NVivo is a qualitative data analysis computer software which helps to organise and analyse various textual data. All categories and codes were input into Nvivo and saved as the coding framework. Each coastal adaptation plan was imported into Nvivo for analysis. Each coastal adaptation plan was read carefully to determine the presence or absence of the criteria. Coastal adaptation plans were then coded by seeking a match between the written content within coastal adaptation plans and the codes in the Nvivo coding framework. Nvivo allows for coded content to be highlighted, saved, and grouped within its respective category and code. All references to codes are collated and outlined clearly in a table, demonstrating the number of references per code. References to codes can also be referred back to easily as they are saved within each code, rather than searching individual coastal adaptation plans.

Quantitative analysis

To determine plan quality on a quantitative basis, the coding framework and coastal adaptation plan titles were organised in Microsoft Excel. After each coastal adaptation plan was assessed qualitatively, the content assigned to each code in Nvivo could be assessed in a quantitative way. For every coastal adaptation plan, each code was assigned a score, with scores ranging from zero to two. A score of zero showed that the criteria was not present within a plan, a score of one showed that the criteria was present in plan but missing some aspects, and a score of two showed that the criteria was present and thoroughly addressed (Table 7). For example, for the code 'goals and objectives' a score of 1 was applied if a coastal adaptation plan outlined goals and/or objectives. If the goal or objective of the coastal adaptation plan was timebound, or specific in its intentions, then a score of two was applied.

If a coastal adaptation plan had no goal or objective then a score of zero was applied.

Table 7: Grading system for criteria of coastal adaptation plans

Score	Definition
0	Criteria not present in plan
1	Criteria present in plan, but missing aspects
2	Criteria present and thoroughly addressed in plan

Each coastal adaptation plan was able to be analysed, once each code was assigned a value. Plans were first assessed against all 60 criteria outlined in the Methods – as collated from the international literature. To assess plan quality, 60 criteria were used, assigning either a zero, one, or two to each, meaning coastal adaptation plans could score a total of 120. Plans were analysed by determining which categories within plans met the criteria effectively, and which categories lacked important criteria. A percentage of criteria met within coastal adaptation plans could be determined for each category, and overall. Coastal adaptation plans were also compared, to understand whether strengths or weaknesses of plans were consistent. For this, the percentage of criteria met for each category of each coastal adaptation plan could be compared.

Limitations of the method

There are a number of limitations to these methods which is worth noting. This study solely focuses on the content of coastal adaptation plans, and therefore involves only desk-top research. The limitation with this is when evaluating the content of coastal adaptation plans, certain conclusions can be inferred based on previous literature of best practice, however it is unknown how the implementation of coastal adaptation plans is in practice. This study does not demonstrate if there is a barrier between coastal adaptation plan publication and implementation, rather, can only make educated assumptions based on the document itself. If this study was to be undertaken again, an important improvement would be to assess how implementation of coastal adaptation plans is translated into adaptation actions. How the implementation of coastal adaptation plans is viewed on-the-ground, and if those who are responsible for coastal adaptation share similar opinions and experiences with the literature. For future reference, interviews with local council members and/or those involved with coastal adaptation planning and implementation should be incorporated. This could identify

more specifically the challenges plan users encounter with implementation and why. It could also lead into further research investigating how barriers outside the coastal adaptation plans (i.e., political barriers and uncertainty) impact implementation.

Another limitation within the methods is the 60 criteria used to assess plans is not weighted, and therefore, assumes all criteria are equal. This was an arbitrary decision, and more research could be conducted to evaluate the relative weight of several aspects relating to adaptation plan implementation. It could be an important element to include by providing a basis of what criteria is considered more or less critical to implementation than another.

Finally, although there were only nine coastal adaptation plans published at the time of writing, the sample size was relatively small. As more local councils in South Australia publish a coastal adaptation plan, it will be important to replicate this study with a wider sample size, potentially showing differences between regional and metropolitan councils. It will also be interesting to see if future coastal adaptation plans show improvements or current coastal adaptation plans are updated over time, as coastal climate risks become more apparent, and literature surrounding adaptation barriers becomes more abundant.

Chapter 5: Findings

Assessment of adaptation plans in the other studies addressed in the Literature Review (Chapter 2) suggests that there are fundamental aspects critical for successful adaptation plan implementation. This study aimed to determine the efficacy of South Australian coastal adaptation plans based on an assessment of best practise. This chapter is arranged according to the implementation barriers for coastal adaptation plans as presented in previous evaluations and discussed in Chapter 2. Characteristics of each implementation barrier will be discussed in detail, outlining the criteria assessed and respective findings.

Summary of South Australia's coastal adaptation plans

All of South Australia's nine published coastal adaptation plans were developed for regional coastal councils. The earliest coastal adaptation plan was produced in 2013 (Copper Coast Council) and the most recent produced in 2021 (City of Victor Harbour). For the nine coastal adaptation plans, five different consulting groups have been employed to produce the plans: Australian Water Environments (AWE; 1), University of South Australia (Uni SA; 1), Seed Consulting (1), Integrated Coasts (3), and Wavelength (3).

Table 8 presents a summary of the general characteristics of each coastal adaptation plan including date published and consulting group, as well as, the total percentage of criteria met for all the nine coastal adaptation plans included in this study. It shows that the plan author is important. Wavelength and AWE produced the plans with the most criteria met for coastal adaptation plan efficacy. The results also suggest that over time quality of coastal adaptation plans has not improved. Overall findings showed a low achievement of the 60 criteria across plans. In terms of meeting criteria, Wattle Range Council's plan was the most complete of the nine coastal adaptation plans. Its plan included 55.74% of the 60 different criteria required for effective implementation of coastal adaptation plans (Wattle Range Council; 2018). In comparison, the Adelaide Plains Council's coastal adaptation plan included only 31.15% of these criteria making it the least complete (Adelaide Plains Council; 2014).

Table 8: The characteristics of plans and percentage of criteria present for each coastal adaptation plan

Coastal Adaptation Plan	Consultant	Date Published	Total percentage of criteria met (%)
Wattle Range Council	Wavelength	2018	55.74
Copper Coast Council	AWE	2013	52.46
Barunga West Council	Wavelength	2018	51.64
District Council of Kingston	Wavelength	2020	51.64
City of Victor Harbour	Integrated Coasts	2021	48.36
District Council of Kangaroo Island	Seed Consulting	2018	42.62
Alexandrina Council	Integrated Coasts	2020	38.52
Yorke Peninsula Council	Integrated Coasts	2015	37.70
Adelaide Plains Council	Uni SA	2014	31.15

Inclusion criteria: Purpose, aims, and goals

The literature review explained that adaptation plans should clearly identify the purpose and aims to lay out the foundation of the adaptation planning process and to provide a greater understanding of the end goal to the plan user. Importantly, aims and goals allow for progress or success to be measured.

Table 9 presents a summary of the quantitative analysis of the nine coastal adaptation plans against six criteria that represent plan purpose or aim. These are important for setting up the foundation of an adaptation plan. The criteria in Table 9 include: clear identification of purpose and vision of the plan, a statement of aims and objectives, and prioritisation of these objectives.

As seen in Table 9, all nine coastal adaptation plans included a purpose or aim with a score of '2' – meaning that the criteria were fully met.

An example of a coastal adaptation plan scoring a '2' for a plan aim is as follows:

"The aim of the project is to identify the seawater flooding risks, assess current flood protection infrastructure and provide recommendations for future action to cater for seawater flooding. The project will also improve community awareness of the risks

associated with current and future seawater flooding." – Yorke Peninsula Council (2015) page 2

It is recognised within the literature, that when goals and objectives align with the purpose or vision of an adaptation plan, implementation is more successful. This is especially true if goals and objectives include a timeline, or identify prioritisation of goals and objectives. Six out of nine plans (67%) included a goal or objective, however, not one plan included a timeline or prioritisation of the goals and objectives.

Four of the nine plans (44%) expressed the need for the coastal adaptation plan, each scoring a '2'. Including a statement about the need for an adaptation plan is important to demonstrate the currency or immediacy of the plan. Not one coastal adaptation plan included a vision for the future. Providing a vision statement is important as it demonstrates the long-term vision of how a community might adapt.

Figure 6 shows the percentage of criteria met within coastal adaptation plans for purpose, aims and goals. The highest percentage of criteria met was 50% for District Council of Kingston (2020), Wattle Range Council (2018), Barunga West Council (2018), and District Council of Kangaroo Island (2018), respectively. The lowest performing coastal adaptation plans for these criteria were Adelaide Plains Council (2014), Alexandrina Council (2020), and City of Victor Harbour (2021) which achieved a score of 16.67%. Over time there appears to have been limited learning from the earliest coastal adaptation plans to the most recent.

Table 9: The criteria assessed for purpose, aims, and goals of coastal adaptation plans

CAP Criteria	Barunga West	Wattle Range	Kingston	Kangaroo Island	Copper Coast	Yorke Peninsula	Adelaide Plains	Alexandrina	Victor Harbour
Plan Purpose/Aim	2	2	2	2	2	2	2	2	2
Plan Need	2	2	2	2	0	0	0	0	0
Vision	0	0	0	0	0	0	0	0	0
Goal and Objective	2	2	2	2	2	2	0	0	0
Goal and Objective Timeline	0	0	0	0	0	0	0	0	0
Goal and Objective Prioritisation	0	0	0	0	0	0	0	0	0

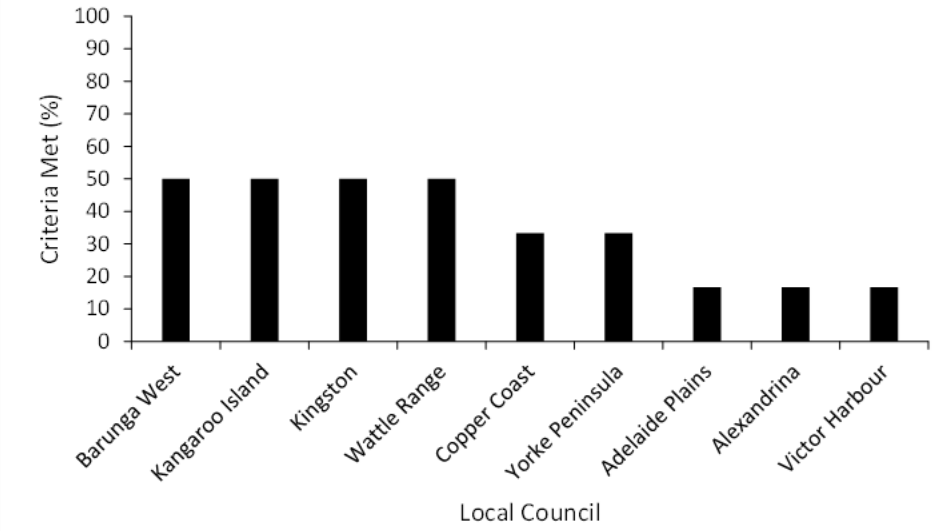

Figure 6: The percentage of criteria present in coastal adaptation plans relating to purpose, aims, and goals.

Inclusion criteria: Baseline and Risk Assessments

Identifying the existing and projected impacts and conditions through evidence-based risk assessments are a critical step in the adaptation process. For adaptation planning, it is highlighted that plan decisions are more likely to be effective if based on empirical evidence and scientific knowledge. The literature also suggest that adaptation plans fail to address a level of uncertainty, which is an inherent challenge for adaptation planning, however if addressed implementation of adaptation actions could be improved.

Table 10 presents a summary of the quantitative analysis of the nine coastal adaptation plans against 17 criteria that represent the requirements for inclusion surrounding identifying a baseline and risk assessments within a coastal adaptation plan. The criteria in Table 10 are broken into two groups, baseline and risk assessment. However, both include criteria about the source of information and how it was collected and the existing and projected impacts and or actions. The risk assessment criteria are more in depth including: addressing climatic and non-climatic drivers, climate trends, the inclusion of risks to people, stakeholders, and assets, and acknowledging and addressing uncertainty and potential sources.

As seen in Table 10, all nine coastal adaptation plans included criteria addressing the baseline of the focus area, as well as, detailed risk assessment criteria. All coastal adaptation plans included a dedicated chapter for the existing conditions, followed by a risk assessment outlining the potential climate hazards and associated risks and vulnerabilities within the focus area. The risk assessments included details on who (people and stakeholders) and what (assets) was at risk and how, while all being supported by climate trends and informed knowledge.

Important areas to note are where coastal adaptation plans lacked in certain criteria. Five out of nine coastal adaptation plans (56%) acknowledged climate change, with four scoring a ‘2’ and one coastal adaptation plan scoring a ‘1’. It is important to acknowledge climate change within adaptation plans as the information pertaining to adaptation actions is related to climate change hazards, and it provides the plan user with a greater understanding of risks.

An example of an excerpt from the City of Victor Harbour’s plan scoring a ‘2’ for acknowledging climate change is as follows:

“The climate change driver under consideration in this project is sea level rise. In this project we focus on the direct impacts of actions of the sea upon backshores along the coast.

Other climate change impacts, such as the projection of a drier climate may produce less vegetation in dunes, and further exacerbate erosion, but these impacts are difficult to quantify and are not addressed. In this study the impact of rising sea levels upon backshores can be quantified through sea flood modelling within digital models." – City of Victor Harbour (2021) page 5

Uncertainty was only addressed in three out of nine coastal adaptation plans (33%), with only one plan scoring a '2'. Of those three coastal adaptation plans, only two plans provided sources of uncertainty. Addressing uncertainty provides the plan user with a greater understanding on the risks and how adaptation options may change over time in relation to those risks. This is because there is an inherent level of uncertainty surrounding the timing and magnitude of hazards, and in turn risks to communities.

An example of an excerpt from the City of Victor Harbour's plan scoring a '2' for acknowledging uncertainty is as follows:

"Managing projected climate change impacts involves dealing with 'deep uncertainty'. This uncertainty is primarily related to the nature of long-term projections which are based on climate models." – City of Victor Harbour page 17

This example scored a '2' because it not only addressed uncertainty but also provided a source of uncertainty. Within this coastal adaptation plan uncertainty was addressed seven more times.

Figure 7 shows the percentage of criteria met within coastal adaptation plans for identifying the baseline and addressing risk assessments within plans. Overall, the percentage of criteria met was the highest for baseline and risk assessments compared to any other category assessed within this study. This could be attributed to the need for a risk assessment to make informed decisions about the following steps within the adaptation process. The highest percentage of criteria met was 97.06% for the City of Victor Harbour plan. The lowest performing plan for criteria met was the Adelaide Plains Council with 44.12%. The findings suggest that coastal adaptation plans have improved over time in relation to detail included for baseline and risk assessment, due to recent coastal adaptation plans scoring higher than older plans (with the exception of Copper Coast Council; 2013).

Table 10: The criteria assessed for baseline and risk assessments within coastal adaptation plans

CAP Criteria	Victor Harbour	Copper Coast	Wattle Range	Alexandrina	Kangaroo Island	Kingston	Barunga West	Yorke Peninsula	Adelaide Plains
Baseline									
Base Source	2	2	2	2	2	2	2	1	1
Base Collection	2	2	2	2	2	2	2	1	0
Climate Change	2	2	2	1	2	0	0	0	0
Existing Impacts	2	2	2	2	1	2	2	2	1
Existing Actions	2	2	2	1	0	2	1	1	1
Risk Assessment									
Risk Source	2	2	2	2	2	2	2	1	2
Risk Collection	2	2	2	2	2	2	2	1	1
Projected Impacts	2	2	2	2	2	2	2	2	2
Assessment Inclusion	2	2	2	2	2	1	2	0	2
Climatic Drivers	2	2	2	2	2	1	1	1	1
Non-climatic Drivers	1	1	1	1	0	1	1	0	0
People at Risk	2	2	2	2	2	1	1	2	1
Stakeholders at Risk	2	2	1	1	2	1	1	1	1
Assets at Risk	2	2	2	2	2	2	2	2	1
Climate Trends	2	1	2	2	2	2	1	1	1
Uncertainty	2	0	0	1	0	1	0	0	0
Sources of Uncertainty	2	0	0	0	0	1	0	0	0

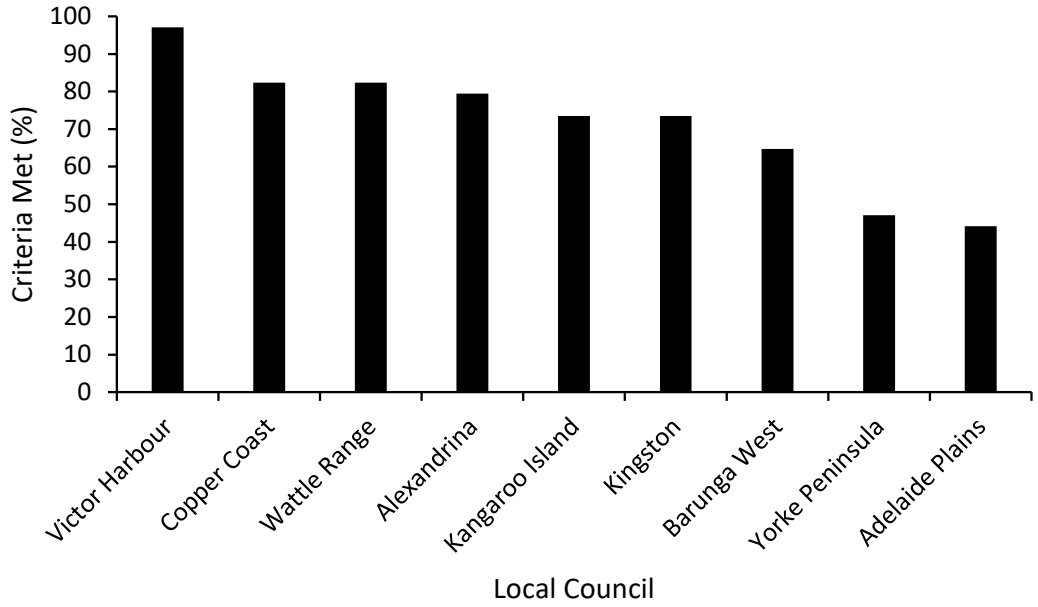

Figure 7: The percentage of criteria present in coastal adaptation plans relating to baseline and risk assessments

Inclusion criteria: Implementation plan

According to the literature, adaptation plans benefit from the inclusion of time-bound and clear prioritisation of actions as it guides the plan user on what actions should be made when (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Woodruff & Stults, 2016). Clearly defining actions that are measurable and achievable increases the likelihood of implementation. It is also suggested that adaptation options and actions are more likely to be implemented if co-benefits, multiple future scenarios, and flexible strategies are provided (Stults & Woodruff, 2016; Woodruff & Stults, 2016).

Table 11 presents a summary of the quantitative analysis of the nine coastal adaptation plans against seven criteria that represent the foundation of an implementation plan or strategy. The criteria in Table 11 include: the inclusion of adaptation options, as well as, outlining prioritisation and timeframes of those options, whether options are informed by scientific knowledge or assessments, co-benefits to options, and finally providing multiple future scenarios and flexible strategies (e.g., trigger points).

Prioritised actions

As seen in Table 11, eight out of nine (89%) coastal adaptation plans identified prioritised actions, five with a score of '2', and three with a score of '1'.

An example from the Adelaide Plains Council plan scoring a '2' for prioritised options is as follows:

Figure A: Example of Adelaide Plains Council adaptation plan (2014) - prioritisation of actions with corresponding timeframes

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Source: (Western and Kellett, 2014; page 31) (Acronyms used: District Council (DC), Australian Height Datum (AHD), Average Recurrence Interval (ARI)).

An example of an excerpt from District Council of Kingston's plan scoring a '1' for prioritised options is as follows:

"Condition assessment of the existing coastal structures (Cape Jaffa Marina breakwaters, Maria Creek breakwater, and Wyomi Beach seawalls) indicates that most structures require considerable repair works to maintain their functionality. Details of the condition assessment, required repairs and associated costs are provided in Appendix A. The following works should be prioritised:

- *The external trunk of the eastern breakwater at Cape Jaffa requires a rework of existing amour and reconstruction with new core and amour layers at the landward end.*
- *Two sections of the western breakwater at Cape Jaffa require a rework of existing armour and placement of additional armour rock in the short term (< 3 years)." – Kingston District Council (2020) page 68*

Timeframe

The prioritisation of options within coastal adaptation plans was often accompanied with timeframes for actions, with all nine coastal adaptation plans including timeframes. The timeframes are a good indicator of what actions should be undertaken before others. Three of these coastal adaptation plans produced a score of '1', while six scored a '2'.

An example of Alexandrina Council's plan scoring a '2' for option timeframes is as follows:

Figure B: Adaptation proposals with corresponding short- mid- and long-term strategies as seen in the Alexandrina Council adaptation plan (2020).

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Source: (Western et al., 2019; page 97)

An example of an excerpt from District Council of Kangaroo Island's plan scoring a '1' for option timeframes is as follows:

"The timing of response options should consider when triggers are met for decision making." – District Council of Kangaroo Island (2018) multiple pages between 17 and 57

All nine coastal adaptation plans based the identification and recommendation of adaptation options on risk assessments and previous informed knowledge. However, not one coastal adaptation plan included co-benefits describing how adaptation options could benefit the community in other ways. Co-benefits are positive effects the actions from adaptation plans have on other policy objectives. Examples of this include benefits from ecosystem-based approaches benefitting both the environment, as well as, the community (i.e., mangrove forest which protects the coastline while benefitting biodiversity) or improvements to public land use which benefit adaptation objectives, as well as, provide improvements to community lifestyles socially, or culturally. However, this may be outside the scope of adaptation plan production.

As described in the literature, flexible strategies and multiple future scenarios are important as they provide the plan user with flexible options that can change as circumstances change, or more than one option depending on circumstances (e.g., financial resources) (Stults & Woodruff, 2016; Woodruff & Stults, 2016). For example, a flexible strategy relies on trigger points, such as when sea level reaches a pre-defined point the adaptation option is triggered to be actioned. Flexible strategies and multiple future scenarios were included in all nine coastal adaptation plans. However, only four coastal adaptation plans scored a '2' for flexible strategies and three plans scored a '2' for multiple future scenarios.

An example of an excerpt from the District Council of Kangaroo Island's plan scoring a '2' for flexible strategies is as follows:

"The timing of response options should consider when triggers are met for decision making. Based on discussions with the community and information obtained during the background analysis for this Strategy, potential triggers for American River may include:

- *impacts on foreshore infrastructure;*
- *experiencing more frequent high impact weather events;*
- *extent of flooding on Tangara Drive; and*
- *impact on Town Centre properties.*

As the response options for American River are further scoped and developed, the triggers can be further quantified. Once this is done, monitoring of indicators that relate to the triggers will help to inform whether any of the proposed response options need to be brought forward or deferred where impacts are less than projected." – District Council of Kangaroo Island (2018) page 17

An example of an excerpt from the Coper Coast Council's plan scoring a '2' for multiple future scenarios is as follows:

"Soft Engineering options

Option 1 - Revegetation of cliff top in conjunction with geotechnical Option 1 (Treatment 2).

Option 2 - Placement of sand bunds and swales at top of cliff face to prevent stormwater discharge over face in conjunction with Geotechnical Option 1.

Option 3 - Sand nourishment through import of sand at base of cliff using sand imported from an external source – ongoing maintenance required to preserve an erosion buffer." – Copper Coast Council (2013) page 47

Figure 8 shows the percentage of criteria met within coastal adaptation plans for implementation plan or strategy. The highest percentage of criteria met was 78.57% for both the Adelaide Plains council (2014) and the Kangaroo Island Council (2018). The lowest performing plans for criteria met was the Alexandrina Council (2020) with 57.14% met.

Table 11: The criteria assessed for implementation strategy of coastal adaptation plans

CAP Criteria	Kangaroo Island	Adelaide Plains	Wattle Range	Kingston	Barunga West	Victor Harbour	Copper Coast	Yorke Peninsula	Alexandrina
Adaptation Options	2	2	2	2	2	2	2	2	2
Prioritised Options	2	2	1	1	1	2	2	2	0
Informed Options	2	2	2	2	2	2	2	2	2
Co-benefits	0	0	0	0	0	0	0	0	0
Adaptation Option Timeframe	1	2	2	2	2	2	1	1	2
Multiple Future Scenarios	2	2	1	1	1	1	2	1	1
Flexible Strategies	2	1	2	2	2	1	1	1	1

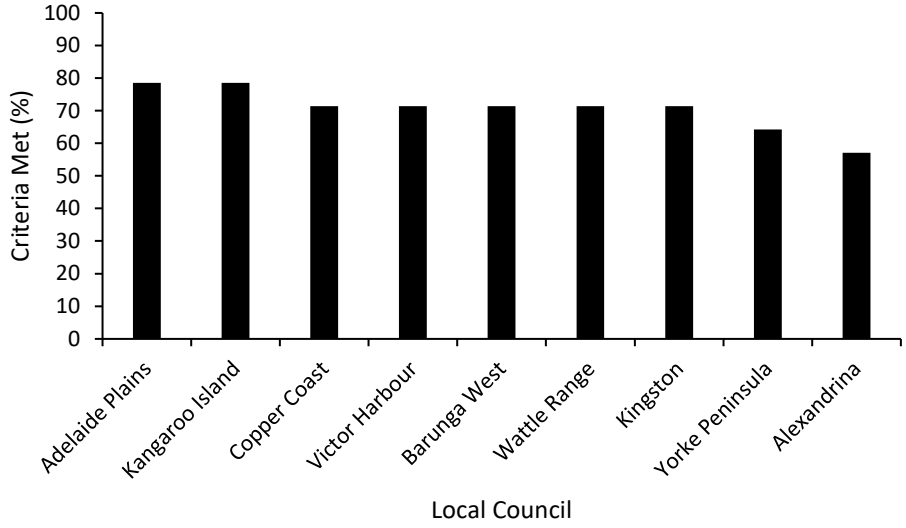

Figure 8: The percentage of criteria present in coastal adaptation plans relating to implementation strategy

Inclusion criteria: Funding mechanisms

The literature suggests adaptation plans have been found to lack information relating to funding mechanisms for adaptation. The problem associated with this is they are less likely to be implemented as coastal managers are unable to anticipate expected costs for recommended options.

Table 12 presents a summary of the quantitative analysis of the nine coastal adaptation plans against three criteria that represent funding mechanisms. The criteria in Table 12 include: sources and/or strategies for funding of adaptation actions, costs identified for specific actions, along with estimations of costs for actions.

As seen in Table 12, six out of nine (67%) coastal adaptation plans both identified costs for specific actions and estimated the costs required for those actions. Only one of these coastal adaptation plans scored a '1' for both criteria with the rests coring a '2'.

An example of the Wattle Range Council's plan scoring a '2' for cost identification and estimations is as follows:

Figure C: The adaptation options with corresponding estimations of costs and recurrent costs for each option as seen in the Wattle Range Council adaptation plan (2018).

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Source: Southend Adaptation Strategy Report prepared for Wattle Range Council, 2018, page 50

An example of the Copper Coast Council's plan scoring a '1' for cost identification and estimations is as follows:

Figure D: the adaptation actions with corresponding estimations of costs and maintenance costs for each option as seen in the Copper Coast Council adaptation plan (2013).

This example provides less detail but also did not provide costs for all options recommended within the coastal adaptation plan, and therefore scored a '1'.

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Source: Port Hughes to Moonta Bay Cliff Top Stability Study Final Strategy Report, 2013, page 54

Three out of nine coastal adaptation plans failed to include any form of funding mechanism, these included: Yorke Peninsula Council; 2015, District Council of Kangaroo Island; 2018, and City of Victor Harbour; 2021. Not one coastal adaptation plan included a funding strategy to source funding, or sources of funding.

Figure 9 shows the percentage of criteria met within coastal adaptation plans for funding mechanism. A total of five coastal adaptation plans met 66.67% of criteria (Adelaide Plains; 2014, Yorke Peninsula; 2015, Barunga West; 2018, Wattle Range; 2018, and Kingston; 2020). One coastal adaptation plan (Copper Coast Council; 2013) met 33.33 % of criteria. Three coastal adaptation plans did not meet any criteria. Date of publication is not a clear indicator of plan improvement over time for funding mechanisms.

Table 12: The criteria assessed for funding mechanisms of coastal adaptation plans

CAP Criteria	Adelaide Plains	Barunga West	Wattle Range	Kingston	Yorke Peninsula	Copper Coast	Kangaroo Island	Alexandrina	Victor Harbour
Funding Strategies and Sources	0	0	0	0	0	0	0	0	0
Cost Estimations	2	2	2	2	2	1	0	0	0
Costs Identified for Actions	2	2	2	2	2	1	0	0	0

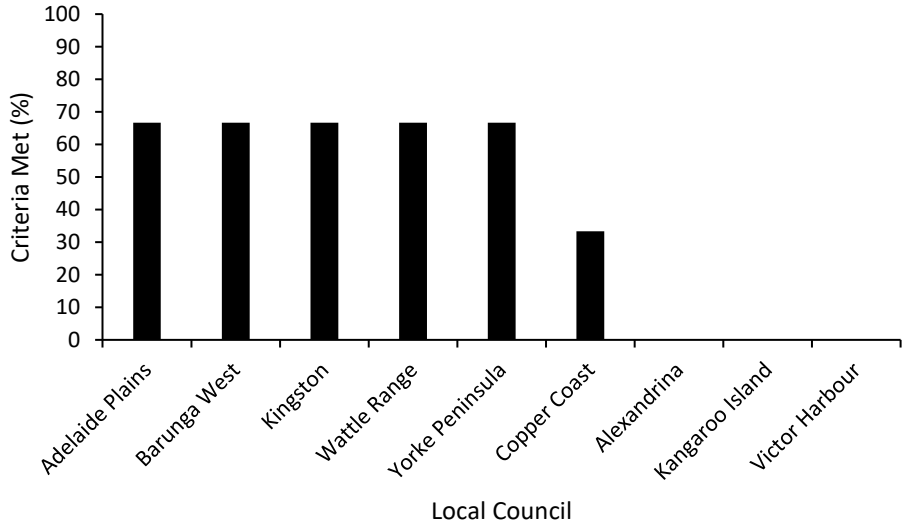

Figure 9: The percentage of criteria present in coastal adaptation plans relating to funding mechanisms

Inclusion criteria: Roles and Responsibilities

The identification of clear roles and responsibilities for actions related to adaptation are suggested to be often lacking from adaptation plans. Actions such as the implementation of adaptation options, sourcing or providing funding, undertaking stakeholder engagement, and undertaking or overseeing the monitoring and evaluation of plan progress are all roles and responsibilities important to implementation. If these actions are not designated to a body/group or person and left open ended, tasks and actions may not be implemented or carried out. In addition, adaptation plans often lack the detail surrounding what responsibilities are required to fulfill each role.

Table 13 presents the summary of the quantitative analysis of the nine coastal adaptation plans against five criteria that represent the foundation of an adaptation plan's roles and responsibilities. The criteria in Table 13 include roles and responsibilities important for implementation surrounding adaptation options, funding, stakeholder engagement, monitoring and evaluation.

As seen in Table 13, eight out of nine (89%) coastal adaptation plans included one or more forms of responsibilities required for plan implementation. Only one coastal adaptation plan (City of Victor Harbour; 2021) failed to outline any roles or responsibilities. However, Table 13 shows most coastal adaptation plans received a '0' or '1' for many of the criteria. The reason for plans receiving a '1' is because most plans included either what responsibilities are required for the role or who is responsible for undertaking the role, but not both. Many coastal adaptation plans did not include any form of role or responsibility for actions and therefore received a '0'.

Seven out of nine (78%) coastal adaptation plans included roles and/or responsibilities for adaptation options, with one coastal adaptation plan (Adelaide Plains; 2014) receiving a '2'. Five out of nine (56%) coastal adaptation plans included funding roles and responsibilities. Both stakeholder engagement and evaluation roles and responsibilities were only present in two out of nine coastal adaptation plans (22%). And finally, monitoring roles and responsibilities were found in five out of nine (56%) coastal adaptation plans, with one plan (Kingston; 2020) receiving a '2'. A '2' requires the coastal adaptation plan to provide both the description of a role to be undertaken and who is responsible for the role.

An example of an excerpt from the District Council of Kingston plan scoring a ‘2’ for ‘roles and responsibilities for monitoring’ is as follows:

“Assessment of monitoring results should involve trend analysis and proximity to pre-defined triggers. Monitoring results should also inform future re-analysis of hazards and risks as part of on-going risk management programs. Erosion markers, with graduated markings, could be installed at key locations to identify when pre-defined triggers have been exceeded. These markers could be monitored on a regular basis by Council officers.” – District Council of Kingston (2020) page 33

Figure 10 shows the percentage of criteria met within coastal adaptation plans for roles and responsibilities. The highest percentage of criteria met was 50% for District Council of Kingston (2020). The lowest performing coastal adaptation plan was City of Victor Harbour (2021) meeting none of the criteria. The overall low percentages of criteria met for coastal adaptation plans is likely due to the lack of detail rather than the lack of inclusion of criteria.

Table 13: The criteria assessed for roles and responsibilities within coastal adaptation plans

CAP Criteria	Kingston	Adelaide Plains	Barunga West	Wattle Range	Copper Coast	Kangaroo Island	Yorke Peninsula	Alexandrina	Victor Harbour
Adaptation Options	1	2	1	1	1	1	1	0	0
Funding	1	1	1	1	0	0	1	0	0
Stakeholder Engagement	0	1	0	0	0	0	0	1	0
Monitoring	2	0	1	1	1	1	0	0	0
Evaluation	1	0	1	0	0	0	0	0	0

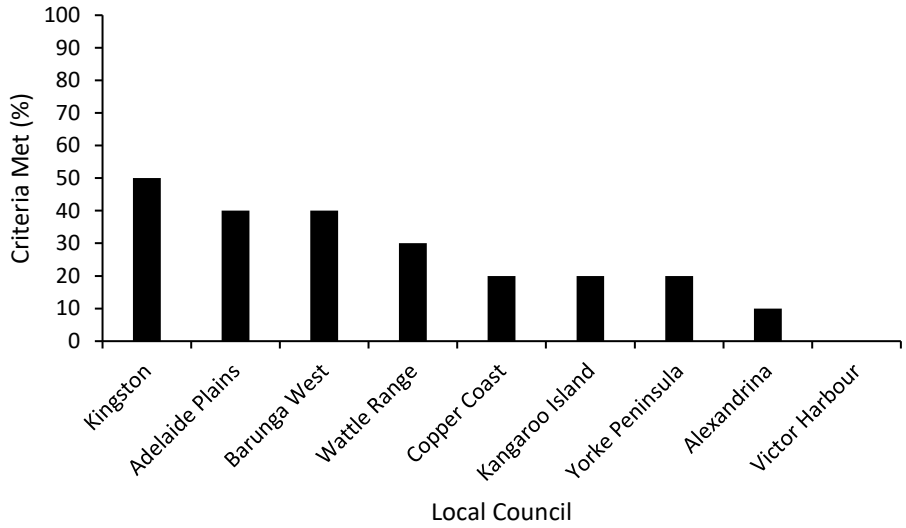

Figure 10: The percentage of criteria present in coastal adaptation plans relating to roles and responsibilities

Inclusion criteria: Monitoring and Evaluation

The literature suggests that adaptation plans lacking clear strategies for monitoring and evaluation of adaptation actions are flawed because without these elements it is difficult to track performance of implemented actions. This knowledge is valuable for informing future adaptation plans as well as monitoring the progression of pre-identified risks. Even though the monitoring and evaluation steps within the adaptation process is undertaken after plan implementation, it is important to address what is required for monitoring and evaluation processes in the adaptation plan. Without clear strategies for monitoring and evaluation, the ability to determine progress in reducing risks will be inhibited.

Table 14 presents a summary of the quantitative analysis of the nine coastal adaptation plans against five criteria that represent monitoring requirements within a plan. The criteria in Table 14 include: an outline of monitoring methods and timeframes associated, requirements for reporting monitoring findings, as well as the funding and costs required to undertake monitoring.

As seen in Table 14, eight out of nine (89%) coastal adaptation plans included timeframes associated with monitoring. Of the eight, six coastal adaptation plans scored a '2', while two plans scored a '1'. Six out of nine coastal adaptation plans (67%) included methods about what to monitor and/or how; only one plan (Kingston; 2020) scored a '2'. Only one coastal adaptation plan (Adelaide Plains; 2014) failed to provide any information relating to the monitoring criteria. Three out of nine coastal adaptation plans (33%) outlined reporting requirements for monitoring information. Not one coastal adaptation plan included information surrounding the funding requirements or cost associated with monitoring requirements.

An example of an excerpt from the District Council of Kingston's plan scoring a '2' for monitoring timeframes and methods is as follows:

"Monitoring will be paramount to the success of implementing the adaptation plan. Results from the monitoring recommended below should be used to update and refine the adaptation planning as required. As a minimum, the following is recommended:

- *Cross-shore profiles captured by DEW to be collated and reviewed annually for changes.*
- *Coastal hazard maps to be updated every five years. Updated coastal hazard mapping to include a review of the latest sea level rise predictions relevant to the study area.*

- *Condition assessment of the Cape Jaffa and Maria Creek breakwaters to be completed every five years.*
- *Condition assessment of the Wyomi Beach protection structures to be completed annually, particularly to assess the progression of erosion at the ends of the structures." – District Council of Kingston (2020) page 68*

An example of an excerpt from the District Council of Kangaroo Island's plan scoring a '1' for monitoring timeframes is as follows:

"The timing of response options should consider when triggers are met for decision making. Based on discussions with the community and information obtained during the background analysis for this Strategy, potential triggers for Kingscote may include:

- *extent of erosion at Reeves Point; and*
- *frequency of inundation and extent of erosion along Governor Wallen Drive.*

Both of these triggers can be readily monitored by periodically assessing erosion at the site." – District Council of Kangaroo Island (2018) page 45

This particular example highlights the need for monitoring periodically however does not provide a specific timeframe or definition of periodically for the plan user to easily understand and then undertake actions.

Figure 11 shows the percentage of criteria met within coastal adaptation plans for monitoring requirements. The highest percentage of criteria met was 50% for District Council of Kingston (2020). The lowest performing coastal adaptation plan for criteria met was Adelaide Plains Council as it failed to provide any monitoring requirements within the plan. Of the coastal adaptation plans which did provide monitoring requirements, the lowest percentage of criteria met was found in the District Council of Kangaroo Island (2018) and the Yoke Peninsula Council (2015), both with 10% of criteria met.

Table 14: The criteria assessed for monitoring within coastal adaptation plans

CAP Criteria	Kingston	Barunga West	Wattle Range	Copper Coast	Alexandrina	Victor Harbour	Kangaroo Island	Yorke Peninsula	Adelaide Plains
Monitoring Methods	2	1	1	1	1	1	0	0	0
Monitoring Timeframes	2	2	2	2	2	2	1	1	0
Monitoring Reporting	1	1	1	0	0	0	0	0	0
Monitoring Costs	0	0	0	0	0	0	0	0	0
Monitoring Funding	0	0	0	0	0	0	0	0	0

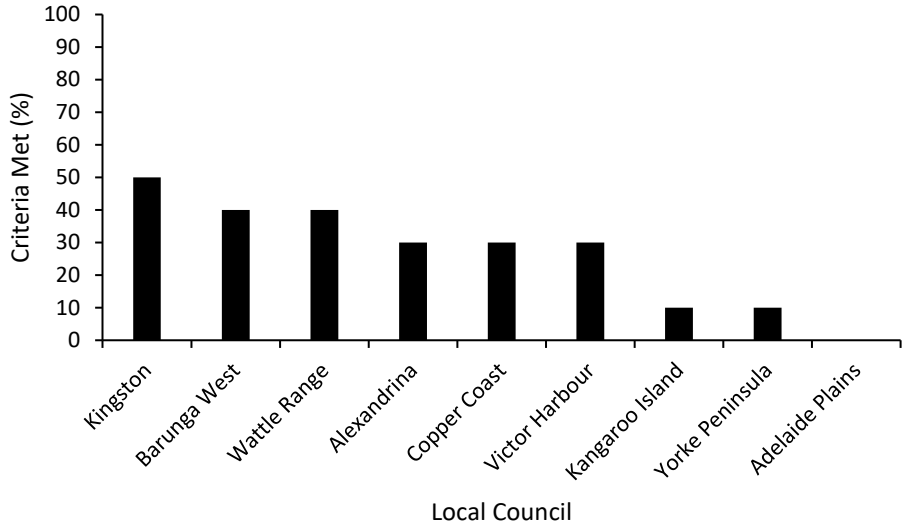

Figure 11: The percentage of criteria present in coastal adaptation plans relating to monitoring

Table 15 presents a summary of the quantitative analysis of the nine coastal adaptation plans against six criteria that represent the foundation of evaluation requirements for adaptation plans. The criteria in Table 15 include: requirements for evaluation methods, evaluation metrics which is used to identify what evaluation is measured against to determine progress, and timeframes for evaluation. Also, the requirements for methods of reporting evaluation findings, inclusion of next steps beyond plan implementation and any plan updates.

Four out of nine (44%) coastal adaptation plans provided a timeframe for when evaluation should be undertaken. However, only one coastal adaptation plan (Wattle Range Council; 2018) provided evaluation methods within the plan. Not one coastal adaptation plan included any form of evaluation metrics. Two out of nine (22%) coastal adaptation plans provided methods of reporting evaluation findings (Barunga West Council; 2018 and District Council of Kingston; 2020). Overall, all coastal adaptation plans that included information about evaluation methods, timeframes, and reporting lacked sufficient detail, only receiving a '1' for criteria met.

Five out of nine (56%) coastal adaptation plans included information about next steps, suggesting a thought process beyond the plan. Only one of these coastal adaptation plans scored a '2' (Copper Coast Council; 2013). Five out of nine (56%) coastal adaptation plans also included information about plan updates, with two plans receiving a '2' for criteria met (Barunga West Council; 2018 and District Council of Kingston (2020).

An example of an excerpt from the Barunga West Council's plan scoring a '2' for plan updates is as follows:

"Further to this, it is important to note that coastal adaption is an ongoing process and the plan itself should be reviewed approximately every five years, over which time any updates to the understanding of coastal hazard risk for Port Broughton or changes to planning policies in SA would need to be considered. Where new information or methods become available that significantly modify the understanding of the coastal hazards, then adaption within coastal compartments would need to be reviewed again as part of the ongoing monitoring and review process." – Barunga West Council (2018) page 73

Figure 12 shows the percentage of criteria met within coastal adaptation plans for evaluation requirements. The highest percentage of criteria met was 41.67% for both Barunga West Council and District Council of Kingston. The lowest performing coastal adaptation plans for

criteria met was Adelaide Plains Council, District Council of Kangaroo Island, and Alexandrina Council all failing to include any evaluation criteria.

Table 15: The criteria assessed for evaluation within coastal adaptation plans

CAP Criteria	Barunga West	Kingston	Wattle Range	Copper Coast	Victor Harbour	Yorke Peninsula	Alexandrina	Adelaide Plains	Kangaroo Island
Evaluation Methods	0	0	1	0	0	0	0	0	0
Evaluation Metrics	0	0	0	0	0	0	0	0	0
Evaluation Timeframe	1	1	1	1	0	0	0	0	0
Reporting Methods	1	1	0	0	0	0	0	0	0
Next Steps	1	1	0	2	1	1	0	0	0
Plan Updates	2	2	2	0	0	0	0	0	0

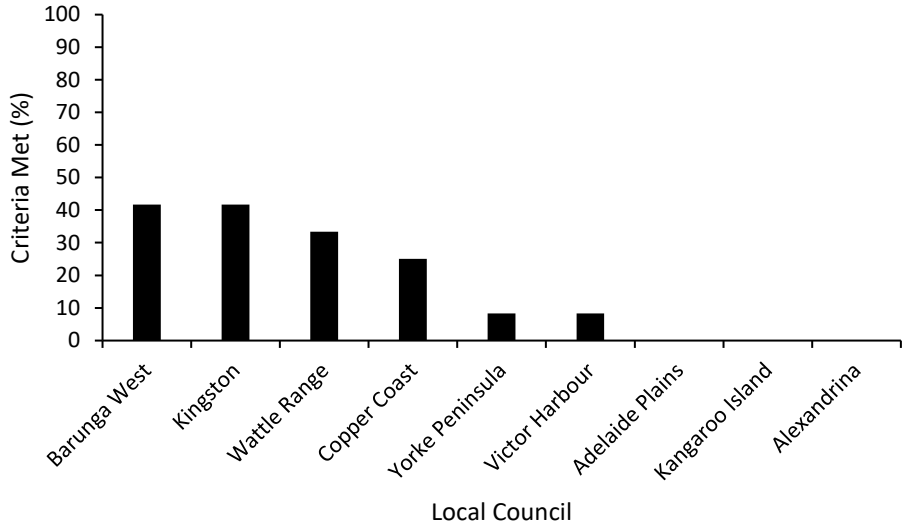

Figure 12: The percentage of criteria present in coastal adaptation plans relating to evaluation of plans

Inclusion criteria: Stakeholder engagement

Stakeholder engagement is considered to be a critical aspect of adaptation planning according to the literature, as it allows for community involvement and often increased support for change. When the community is able to be involved and supports the changes, implementation of adaptation plans is often more successful. Reasons for this can be attributed to the community driving the change when it positively impacts their local areas.

Table 16 presents a summary of the quantitative analysis on the nine coastal adaptation plans against six criteria that represent stakeholder engagement within plans. The criteria in Table 16 includes: an outlined plan of what engagement will be undertaken, inclusivity of multiple types of stakeholders and community members, methods of communication to the public, coordination with other agencies, and a timeline for engagement.

It is important to note that most coastal adaptation plans included stakeholder engagement in the past tense, as it had already been conducted prior to publishing the plan. Therefore, some of the results may be inaccurate for the criteria that was asked. For example, timeframes for stakeholder engagement may have been provided to the public at the time that engagement was undertaken, however, were not included in the coastal adaptation plan, and therefore affecting the result.

As seen in Table 16, all nine coastal adaptation plans included information about a stakeholder engagement plan, whether in past or present tense. However, only two (22%) coastal adaptation plans received a ‘2’, while the other seven (78%) plans received a ‘1’. Not only this, but all nine coastal adaptation plans ensured that various stakeholders and members of the community were or planned to be consulted, and opportunities for the community members to be involved were be made aware of. Four plans (44%) received a ‘2’ for stakeholder inclusivity, while six plans (67%) received a ‘2’ for public involvement.

Methods of communication to the community were included in seven out of nine (78%) coastal adaptation plans, with only one plan receiving a ‘1’. Five out of nine coastal adaptation plans (44%) addressed agency coordination, with only one of those plans receiving a ‘2’. Stakeholder engagement timelines were also only present in five out of nine coastal adaptation plans (56%), with all receiving a ‘1’.

An example of an excerpt from the Yorke Peninsula Council's plan scoring a '2' for their stakeholder engagement plan, public involvement, and communication methods, also demonstrating stakeholder inclusivity and agency coordination scoring a '1' is as follows:

"7.1 Consultation methodology

All land owners were mailed an invitation to attend a community workshop on 20th August 2015 at 7.00pm. The invitation included the summary table from the State of Play Report (p. 69-70) and notification that the State of Play report had been uploaded to the Council website. Mark Western gave a formal presentation in which a review was undertaken of the State of Play report and the adaptation options presented. At the conclusion of the formal presentation, maps showing the location of the proposed adaptation options and a feedback sheet were provided for participants to record responses.

Participants were also asked to give responses as to how to be 'flood ready':

- *Do you think it necessary to be flood ready?*
- *What type of warning systems could be implemented?*
- *What emergency procedures could be implemented?*

The facilitators of the meeting were Mark Western (Integrated Coastal Management), Natasha Hall (Central Region Climate Change Officer), Stephen Goldsworthy (Yorke Peninsula Council)." – Yorke Peninsula Council (2015) page 36

This excerpt is a clear and concise example demonstrating the methods of stakeholder engagement, as well as, communication methods and public involvement. This coastal adaptation plan, however, only received a '1' for stakeholder inclusivity as only land owners were included, and agency coordination due to the limited coordination. This plan also received a '0' for timeline as only one workshop seemed to be conducted throughout the planning stages and seemingly no intention of continuous engagement.

Figure 13 shows the percentage of criteria met within coastal adaptation plans for stakeholder engagement requirements. The highest percentage of criteria met was 91.7% for the Copper Coast Council (2013). The lowest performing coastal adaptation plan for criteria met was the Adelaide Plains Council with 16.67% of criteria met.

Table 16: The criteria assessed for stakeholder engagement within coastal adaptation plans

CAP Criteria	Copper Coast	Victor Harbour	Wattle Range	Yorke Peninsula	Barunga West	Kangaroo Island	Alexandrina	Kingston	Adelaide Plains
Stakeholder Engagement Plan	2	1	1	2	1	1	1	1	0
Stakeholder Inclusivity	2	2	2	1	2	1	1	1	0
Public Involvement	2	2	2	2	2	2	1	1	0
Communication Methods	2	2	2	2	2	2	1	0	0
Agency Coordination	2	1	0	1	0	0	1	0	1
Engagement Timeline	1	1	1	0	0	0	1	0	1

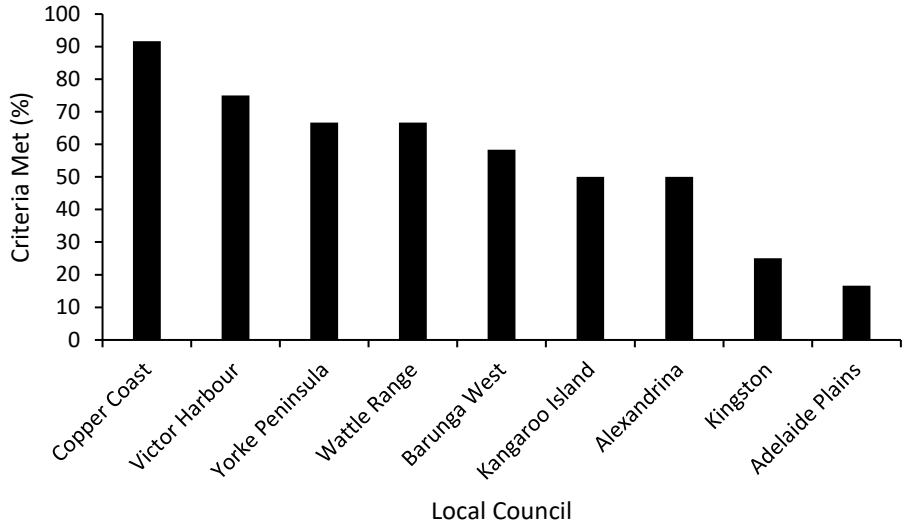

Figure 13: The percentage of criteria present in coastal adaptation plans relating to stakeholder engagement

Inclusion criteria: Mainstreaming and Integration

Although according to the literature, mainstreaming and the integration of adaptation plans is considered to be important for implementation of plans, the coastal adaptation plans assessed in this study lacked details surrounding the assessed criteria. The summary of the quantitative analysis of the nine coastal adaptation plans against three criteria representing mainstreaming and integration include: coastal adaptation plan integration (current), a plan towards adaptation plan integration, and a timeframe for adaptation plans to be integrated with other plans or agencies.

Findings showed that not one coastal adaptation plan included a plan towards integrating adaptation plans with other plans, or a respective timeframe to do so. Not one coastal adaptation plan, at the time of publication, had integrated the plan with other plans or agencies, however, six out of nine coastal adaptation plans (67%) included some information which could be seen as steps towards integration. Examples of this included, incorporating previous data or studies into the current adaptation plan, or working with other agencies to conduct stakeholder engagement, and make decisions and recommendations for adaptation options.

The lack of detail or intention to include integration or mainstreaming information suggests that it is not considered to be of high importance for adaptation planning in South Australia or it is outside the scope of the consulting group producing the coastal adaptation plans.

Summary of findings

Overall, 60 criteria were assessed as part of eight categories pertaining to the importance for coastal adaptation plan implementation. The common barriers to adaptation plan implementation included: aims purpose and goals, baseline and risk assessment, implementation plan, funding mechanisms, roles and responsibilities, monitoring and evaluation, and integration and mainstreaming.

The categories which showed the highest percentage of criteria met over all coastal adaptation plans was baseline and risk assessment, followed closely by implementation plan. These two categories are critical to the understanding of risks and what actions should be undertaken to address those risks. Each of these categories are also major steps within the

adaptation process and therefore can be assumed as a large focus of the coastal adaptation plan production. The lowest performing categories overall were evaluation, and mainstreaming and integration. Evaluation of coastal adaptation plans is critical to measure plan progress, while integration is critical for ensuring capacity building. On the other hand, mainstreaming and integration also showed a low performance, however is likely outside of the plan producers' scope, or considered less important as an inclusion.

There were consistent gaps in coastal adaptation plans shown within the findings surrounding sources of funding for adaptation options, as well as monitoring requirements, roles and responsibilities relating to adaptation planning and implementation, and monitoring and evaluation requirements as a whole. Importantly, plans included the identification and estimation of costs for actions, and outlined adaptation options with prioritisation and timebound actions. Critically, plans often failed to acknowledge climate change and uncertainty related to such changes. However, plans included information, although limited, for multiple future scenarios and flexible strategies.

In terms of overall plan performance, the Wavelength produced coastal adaptation plans demonstrated higher percentages of criteria met for five out of eight categories (63%), while the lowest performing coastal adaptation plans by category were consistently shown to be the Adelaide Plains Council, Alexandrina Council, and City of Victor Harbour Council. However, the City of Victor Harbour did produce the highest percentage of criteria met for the baseline and risk assessment category.

The findings demonstrate that all coastal adaptation plans lack mechanisms for implementation with the highest performing plan meeting 55.74% of criteria and the lowest meeting 31.15%.

Chapter 6: Discussion & Conclusion

The findings of this study are important to determine if adaptation plans designed to reduce risks to communities could be effective. Previous studies suggest that without clear mechanisms for implementation, such as assigning roles and responsibilities, sources of funding, and outlining monitoring and evaluation processes, adaptation plans are less likely to be implemented (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Preston et al., 2011; Stults & Woodruff, 2016; Woodruff & Regan, 2018; Woodruff & Stults, 2016). Findings of this study demonstrated that South Australian coastal adaptation plans share similar strengths and weaknesses to other studies assessing adaptation plan quality.

Only nine out of 34 councils, at the time of writing, have a published coastal adaptation plan, while three others have published documents relating to coastal adaptation. There is, therefore, variation in the progress for preparing for adaptation between councils. The variation is likely attributed to councils which are already experiencing impacts of coastal hazards, such as coastal flooding and erosion, are more advanced than councils not yet pressured by coastal hazards. Many councils with published coastal adaptation plans highlighted the need for the adaptation plan, demonstrating that coastal hazards and risks were already apparent (Sandery, 2020; Siebentritt, 2018; Wavelength Consulting, 2018a, 2018b).

Although overall, the South Australian coastal adaptation plans met a high percentage of the criteria for plan aspects involving risk assessments, consideration of options, and implementation strategies, adaptation plans were lacking in areas critical to ensuring these actions can be implemented. Overall, for the nine coastal adaptation plans analysed in this study, the quality of plans was average, scoring between 31 - 56% of criteria met. If coastal adaptation plans are to be successful in helping councils respond to a changing climate the literature suggests they need to provide estimates of costs and sources of funding, include prioritized and timebound actions with assigned responsibilities, and detailed monitoring and evaluation processes (Lioubimtseva & da Cunha, 2020; Stults & Woodruff, 2016; Woodruff, 2016; Woodruff & Regan, 2018). Given the findings of this study, the existing South Australian coastal adaptation plans are less likely to be effective, as the majority lacked details for funding sources, assigning roles and responsibilities, and monitoring and evaluation processes.

The South Australian coastal adaptation plans share common strengths and weaknesses with each other and to other adaptation plans that expose potential gaps within the adaptation implementation process. Many of these gaps are also consistent with the literature assessing adaptation plan content and quality (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Stults & Woodruff, 2016; Woodruff & Stults, 2016). The strengths and weaknesses of this study will be compared to the nine studies which assessed adaptation capacity for implementation (Chapter 2 – Literature Review).

This study found that adaptation plans scored highest in categories relating to risk assessments and implementation strategies, showing that the South Australian coastal adaptation plans are effective in determining what the risks are and how risks can be reduced. This finding is consistent with studies assessing local adaptation plans in the United States and France. For example, Woodruff and Stults (2016) and Lioubimtseva and da Cunha (2020) also found that local adaptation plans scored higher for plan aspects relating to risk assessments and adaptation strategies for implementation, but lacked clear mechanisms for translating adaptation plans into actions. The mechanisms important for adaptation plans to become actionable and lacking from the United States adaptation plans included prioritisation of strategies, co-benefits of adaptation plans, associated costs and assigning responsibilities (Woodruff, 2016). Woodruff and Stults (2016) suggested that adaptation plans provided stronger strategies for adaptation but weaker implementation components. However, the South Australian coastal adaptation plans differed to Woodruff and Stults (2016) by including prioritisation of actions and associated costs for actions. The addition of prioritisation and associated costs to coastal adaptation plans may benefit plan users by understanding what actions are more important or required earlier, and how to account for the costs.

Although including associated costs for actions was a strength found in the majority of the South Australian coastal adaptation plans, the sources of funding were not included. Identifying sources of funding has been highlighted as a crucial aspect of adaptation plan preparation for implementation by a number of studies assessing adaptation plan quality (Lioubimtseva & da Cunha, 2020; Stults & Woodruff, 2016; Woodruff, 2016; Woodruff & Regan, 2018). Providing funding sources as part of adaptation plan preparation could be beyond the scope of plan producers (consultants); however, sourcing necessary funding has been identified as a challenge for local governments in many studies (Preston et al., 2011; Tribbia & Moser, 2008; Woodruff & Stults, 2016; Yalçın & Lefèvre, 2012).

The South Australian coastal adaptation plans assessed for this study failed to sufficiently address roles and responsibilities of adaptation actions. Local governments (councils) hold much of the development control and management of coastal facilities and infrastructure, and therefore are responsible for coastal risks and hazards (Nick Harvey et al., 2012). Local governments in South Australia are responsible for implementing coastal adaptation plans designed for their region, however, the responsibilities of local governments are substantial. Without clearly assigned roles and their associated responsibilities for actions within coastal adaptation plans, it is unlikely that these actions will be undertaken, as local governments may be reluctant to take on additional responsibilities (Baker et al., 2012; Woodruff, 2016).

The lack of evaluation criteria such as methods, metrics, and adaptation plan updates to measure plan progress is a weakness in the South Australian coastal adaptation plans. This weakness is consistent with previous studies (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Woodruff, 2016; Woodruff & Regan, 2018), where evaluation of adaptation plans was a low or the lowest scoring criteria of plan quality. The ability to evaluate the progress of adaptation plans is critical in determining the plans success towards adaptation (Woodruff & Regan, 2018). The lack of evaluation methods and metrics suggests that consultants may not have a clear idea of how the implementation of coastal adaptation plans or adaptation itself can be measured, or potentially how successful adaptation could be identified (Woodruff, 2016; Woodruff & Regan, 2018).

Another weakness commonly found in adaptation plans relates to addressing uncertainty. Uncertainty is an inherent challenge within adaptation planning, due to the uncertain timing and magnitude of climate hazards and risks (Abunnasr et al., 2013; Kettle & Dow, 2014). As a result, it is important to address uncertainty within risk assessments and when considering adaptation options. Ways to address uncertainty include providing multiple adaptation options for particular risks and ensuring strategies are flexible to change (i.e., trigger points) (Lawrence et al., 2018). The South Australian coastal adaptation plans failed to address uncertainty directly within risk assessments, however, all coastal adaptation plans addressed uncertainty by including multiple future scenarios and/or flexible strategies for adaptation options. Both approaches are highlighted to reduce uncertainty of adaptation actions and build resilience (Baker et al., 2012; Woodruff & Stults, 2016). By providing multiple scenarios, plan users have more options to determine which is most feasible in terms of costs and public perception. With more options, it is more likely that action will be taken than with only one. Flexible strategies are also beneficial and reduce uncertainty, because they rely on

trigger or tipping points. Once a hazard has met an assigned trigger (e.g., sea level rise reaching a certain point), the options to be taken are changed, demonstrating that previous options are now not feasible (Lawrence et al., 2018; Lin et al., 2017; Ramm et al., 2017).

A consistent opinion within the literature, is the importance of integrating adaptation plans with social, land use, disaster management, or sustainability planning processes (Baker et al., 2012; Lioubimtseva & da Cunha, 2020; Preston et al., 2011). This is because it allows for a wider understanding of policy requirements and actions within a local community. However, this study found that integration of South Australian coastal adaptation plans with other local plans and policies was limited, if not, non-existent. The lack of integration or plan to integrate coastal adaptation plans could be attributed to being beyond the consultant's scope, and therefore falls onto local governments. It is unclear how much of a barrier failing to integrate coastal adaptation plans in terms of adaptation plan implementation may be in practise in South Australia.

The failure to include funding sources, roles and responsibilities, and evaluation processes within South Australian coastal adaptation plans raises concerns about the ability to translate plans into action (Preston et al., 2011; Woodruff & Stults, 2016). The absence of implementation of adaptation plans could have major implications for coastal adaptation. We live in a changing climate, where sea level rise and the associated coastal hazards are only increasing (Bradley et al., 2015; Cooper & Lemckert, 2012; DCC, 2009; He & Silliman, 2019; Lu et al., 2018; Ramm et al., 2017; Spalding et al., 2014). Adaptation is crucial to ensure the safety and longevity of coastal communities. Without adaptation the cost of inaction economically, socially, culturally, and environmentally will be significant (Baills et al., 2020; Bedsworth & Hanak, 2010; IPCC, 2022; Wise et al., 2014). If coastal adaptation plans are not able to be implemented, actions towards coastal hazards and risks will be inhibited, and coastal adaptation plans will be rendered useless (Measham et al., 2011; Olazabal & Ruiz De Gopegui, 2021). In turn, risks to coastal infrastructure and communities are likely to increase, reducing the options to adapt over time. Likely consequences include the loss or damage of the natural coastal environment, damages and losses to coastal infrastructure, the inability to insure coastal assets, changes to social and cultural norms, and major financial implications to residents and stakeholders (Bongarts Lebbe et al., 2021; Hauer et al., 2021; Tribbia & Moser, 2008).

To improve future coastal adaptation plans, details around funding sources, clearly assigned responsibilities, costs for ongoing monitoring, and methods of how to measure implementation progress (evaluation) should be addressed. Each of these factors would allow a greater understanding of the expectations associated with adaptation, and encourage a continuous and iterative process. There is potential that the details important for adaptation plan implementation are lacking due to adaptation plans being produced by consultants, and the consultant's scope and understanding of where funding may come from or who would be responsible for actions.

Future research should explore how and if coastal adaptation plans in South Australia have been implemented. The challenges plan users face with implementing adaptation options and recommendations, and whether the challenges are consistent with the literature describing implementation barriers should be investigated. It would also be important to identify the role of the plan producer (consulting group in South Australia), to determine if areas where coastal adaptation plans are lacking are beyond their scope. For example, identifying funding sources and determining integration of adaptation plans with other plans/agencies.

In conclusion, coastal communities will continue to require adaptation and adaptation planning as coastal hazards and risks increase over time with climate change. Local governments face a great challenge in adapting to coastal climate change, where adaptation plans are designed to guide and assist. However, if plans are unable to be implemented, the challenge of coastal adaptation will only become greater. This study has highlighted the gaps within South Australian coastal adaptation plans in relation to the efficacy of implementation, with previous studies assessing adaptation plan quality finding consistent gaps. This study provides a baseline for the efficacy of coastal adaptation plans in South Australia. The persistent inadequacies of failing to include important details for implementation, highlight concerns about whether plans are able to be translated into actions that reduce risks to communities. Furthermore, whether progress of plans can be measured, if coastal adaptation plans are implemented. Future plans should reflect and learn from the strengths and weaknesses in existing plans. As adaptation planning becomes more prevalent and the understanding of implementation barriers within plans is improved, plan quality will likely improve.

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