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# Table of Contents

|   |    |
|---|----|
| Executive summary .....   | 1  |
| 1 Introduction .....  | 3  |
| 1.1 Context .....   | 3  |
| 1.2 Objectives .....  | 3  |
| 2 Methodology .....   | 5  |
| 3 Results and discussion .....  | 7  |
| 3.1 Interview results .....   | 7  |
| 3.2 Examples of pathways approaches being adopted by Local Government in Australia .....      | 7  |
| 3.2.1 Western Australia .....   | 7  |
| 3.2.2 South Australia .....   | 8  |
| 3.2.3 Victoria .....  | 10 |
| 3.3 Current integration of pathways with the C-CADS decision-making process .....             | 12 |
| 4 Discussion .....  | 14 |
| 4.1 Adaptation pathways approaches being adopted for coastal adaptation decision making ..... | 14 |
| 4.2 Extent to which the C-CADS approach is compatible with reviewed pathways approaches ..... | 15 |
| 4.3 Recommendations on how C-CADS could further integrate adaptation pathways .....           | 16 |
| 5 References .....  | 20 |
| Attachment A .....  | 22 |
| Attachment B .....  | 25 |

## Executive summary

Sea-level rise as a result of climate change will result in increasing amounts of damage to natural and built assets along the Australian coastline. Knowing when to respond to this threat is challenging given that increasing sea levels over the coming century will mean that the options required for protection from, for example, storm surge now may not be the same as those needed in the future. The choice of when to act has a major impact on investment decisions on the one hand, and potential risk exposure on the other.

Adaptation pathways approaches have been increasingly used around Australia to assist with developing coastal adaptation strategies. This is in part due to the underlying pathways principle that adaptation options can be sequenced through time, reducing the pressure on decision makers to choose the “right” option now.

While traditional adaptation decision-making frameworks have been described as competing with the pathways approach, this has not been assessed for NCCARF’s C-CADS (Coastal Climate Adaptation Decision Support) process. In this regard, Legatus Group councils are seeking guidance on the use of pathways approaches and how these can be applied as part of CoastAdapt’s C-CADS process. To consider this issue, NCCARF supported a research proposal from the Legatus Group and Seed Consulting Services to undertake a comparison of the use of adaptation pathways approaches in coastal adaptation decision making with CoastAdapt’s C-CADS process.

The study sought to compare how pathways approaches are being adopted in Australia to inform coastal adaptation decision-making and assess the extent to which various pathways approaches are compatible with the C-CADS approach delivered through CoastAdapt. An additional objective was to develop recommendations on how future versions of CoastAdapt could further integrate adaptation pathways.

Interviews were undertaken with coastal adaptation decision makers and practitioners in New South Wales, South Australia, Tasmania, Victoria and Western Australia. The interviews identified at least five specific adaptation pathways approaches that have been undertaken across the Australian coastline.

Interview responses indicated that adaptation pathways as a general approach are being well received because they encourage decision makers to not lock in options now for the longer term, they provide a way to have conversations about long term futures in the present, and enable decision makers to start the conversation of long term adaptation in a “safe way”.

Assessment of the effectiveness of adaptation pathways approaches is limited at this stage due to an absence of evaluations and limited time since most have been implemented. Coastal adaptation decision makers indicated that one of the more significant challenges with the approach is the reliance on triggers and thresholds, for which information is not always readily available.

Of the five approaches reviewed, three follow formal pathways methods. All of the five methods follow the general approach of sequencing options through time, with most also focussing on identifying triggers and thresholds. The three formal approaches present specific, stepwise methods for the development of pathways, which are presented either as a figure or table.

One of the projects where a pathways approach was used (Resilient Hills and Coasts in South Australia) was subjected to further analysis to determine which aspects of its development and implementation have been successful and unsuccessful. The results of this analysis are presented as a case study.

Four key elements of the pathways approaches reviewed for this study were used to determine compatibility with the C-CADS approach:

- builds on a broad concept of sequencing the implementation of options
- draws on the concept of triggers and thresholds
- defines a multi-step methodology rather than general principles
- generates a visual pathways map or table.

The C-CADS approach addresses the first two of these elements, but not the second two. For example, C-CADS has an extensive integration of pathways concepts through Steps 2 to 6 in particular, however, it does not present a multi-step methodology for developing adaptation pathways.

A number of recommendations on how C-CADS could further integrate adaptation pathways are presented in this report, including the following;

- Present adaptation pathways as a potential general framing for coastal adaptation planning in Step 1, which would provide further context for references in Steps 2 to 6.
- Provide an overview of where pathways concepts (e.g. triggers, thresholds, decision points) are spread through the process. This will make it easier for users to adopt a pathways approach should they wish to do so.
- Noting the challenge faced by regions in identifying triggers and thresholds, strengthen the focus of using risk and vulnerability assessment information to identify thresholds and triggers for decision-making.

Passages of additional text are provided and recommended for inclusion in the C-CADS process, including a case study on recent experience with moving beyond adaptation pathways planning and into implementation.

# 1 Introduction

## 1.1 Context

Australian coastal zones will be exposed to a broad range of direct and indirect climate change impacts. Sea-level rise as a result of climate change will exacerbate the impact of storm surge events resulting in increasing damage to built assets. It will also lead to the salinisation of soils on the coastal zone, flooding of low lying areas, and intrusion of sea water further into estuaries, changing their ecology and human use values (e.g. recreation, fisheries).

The coastal zone will also be impacted by increasing intensity of rainfall which will influence stormwater discharge and hence flooding and water quality. Extreme heat will influence how communities interact with the coastal zone and the ability for natural and built assets to maintain condition. The nearby coastal zone will be exposed to warming ocean waters and increased acidification, which will cause changes in marine ecosystems.

A key aspect of this challenge is knowing when to implement adaptation options given that increasing sea levels over the coming century will mean that the options required for protection from, for example, storm surge now may not be the same as in the future. The choice of when to act has a major impact on investment decisions on the one hand, and potential risk exposure on the other.

In response, some regions and organisations with adaptation responsibilities have adopted an “adaptation pathways” approach. There are numerous broad definitions for an adaptation pathway, including that by Hasnoot et al. (2013), which defines it as an “analytical approach to planning that explores and sequences a set of possible actions that are based on external developments over time”.

Adaptation pathways as a broad concept has been part of the Australian adaptation planning lexicon for at least 10 years, with the notion of a broad sequencing approach popularised by initiatives such as the Federal Government’s “Coastal Adaptation Decision Pathways” program from 2011 to 2012.

## 1.2 Objectives

Adaptation pathways approaches have been increasingly used around Australia to assist with developing coastal adaptation strategies. This is in part due to the underlying pathways principle that adaptation options can be sequenced through time, reducing the pressure on decision makers to choose the “right” option now and invest significant up-front funds while uncertainty regarding the extent and rate of climate change effects remains. Adaptation pathways approaches are often seen as alternatives to traditional (risk-based) adaptation decision-making frameworks, potentially putting users in positions where they need to select a particular approach to follow.

C-CADS (Coastal Climate Adaptation Decision Support) has been developed by NCCARF as an iterative decision support process designed to support adaptation planning and decision-making about all climate change related risks on the Australian coast. The C-CADS process has integrated elements of a pathways approach into its framework. However, NCCARF has not considered whether additional support tools and products are required to support its inclusion in C-CADS. Reviewing the integration is challenging because different

adaptation pathways approaches have been used between regions and states, ranging from strategic and qualitative to more operational and quantitative.

NCCARF supported a research proposal from the Legatus Group and Seed Consulting Services to undertake a comparison of the use of adaptation pathways approaches in coastal adaptation decision making with CoastAdapt's C-CADS process. The specific objectives of this study were to:

1. review and compare how pathways approaches are being adopted in Australia by Local Government to inform coastal adaptation decision-making, considering what aspects of the process have been effective and not effective
2. determine the extent to which various pathways approaches are compatible with the C-CADS approach
3. develop recommendations on why pathways approaches should be integrated with the beta version of the C-CADS decision-making process and how this should be done
4. develop recommendations on how future versions of CoastAdapt could further integrate adaptation pathways
5. provide information on comparative advantages of different pathways approaches for use by Local Government.

This report has been designed to provide advice to NCCARF on potential revisions that could be made to C-CADS to further integrate pathways approaches.

While it is not intended to provide independent advice to decision makers and practitioners on options for developing adaptation pathways, it does provide the first compilation of examples of pathways approaches that have been used for coastal adaptation planning in Australia. This provides the basis on which to conduct a further review and audit of pathways approaches.

## 2 Methodology

The method focused on reviewing the types and outcomes of adaptation pathways approaches in practice to inform the extent of alignment with C—CADS, determining how to improve integration of the approaches and assessing how CoastAdapt could be further revised in the future to better account for adaptation pathways.

### 2.1 Engagement

An engagement strategy was developed to identify practitioners known to have been involved with adaptation pathways projects across Australia or who have worked on coastal adaptation plans or decision making processes. Interviews were conducted with contacts in New South Wales (Geoff Withycombe), South Australia (Natasha Hall, Kathy Hayter), Tasmania (Katrina Graham), Victoria (Jon Barnett, Chris Pitfield) and Western Australia (Craig Perry).

Interviews used the following standard questions:

1. What do you understand adaptation pathways to be?
2. Has it been used in your region at all?
3. Have you used a formal approach?
4. Have you used an informal approach?
5. What aspects of it have been effective?
6. What aspects have been less effective?

Following the interviews, reports were identified for five projects that were assessed as having used a formal adaptation pathways approach. Reports were reviewed to identify the methodology used for developing adaptation pathways to enable comparison with the C-CADS approach. Importantly, this analysis was not intended to be a state-by-state audit and hence examples of pathways projects that may exist in NSW and Queensland in particular were not identified. However, this would be a useful next step if this analysis was to be expanded on in the future.

Following the interviews and desktop research, two of the five projects (Resilient Hills and Coasts in South Australia, and Lakes Entrance in Victoria) were selected to further consider what aspects of the adaptation pathways process have been effective and not effective. This involved conducting interviews for the Resilient Hills and Coasts project with the program coordinator and two members of the steering committee who have begun the process of using adaptation pathways to inform broader adaptation actions. The results of this analysis are presented in this report as a case study.

For Lakes Entrance, interviews were conducted with a State and Local Government representative, however, this revealed that the previous work described in Barnett et al. (2014) was more of a research project, and that a pathways project designed to more directly inform decision making is only just about to commence. As such, it was decided that this project was not yet suitable as a case study for the purpose of this report.

### 2.2 Review of C-CADS process

Steps 1 to 6 of the C-CADS process were reviewed to determine whether the guidance was appropriate for establishing a pathways approach. This was done by determining whether

common elements of a pathways approach are sufficiently addressed in C-CADS. The pathways approaches that were identified from the projects reviewed for this study were similar in that they:

1. articulated a goal or area of decision making
2. built on a broad concept of sequencing the implementation of options
3. incorporated the concept of triggers and thresholds
4. defined a multi-step methodology rather than general principles
5. generated a visual pathways map or table
6. advocated for the monitoring and evaluation of indicators that describe triggers and thresholds.

The review also identified references to adaptation pathways and key pathways concepts such as triggers, thresholds, tipping points, used-by-dates, decision-points, sequencing to determine whether they are described in a way consistent with the other pathways approaches.



## 3 Results and discussion

### 3.1 Interview results

Interviews were undertaken to identify examples of pathways projects and to obtain initial feedback on the benefits and drawbacks of pathways approaches. Most interviews focussed on the general framing of pathways as a way to sequence options through time, and as such, the benefits of this approach were identified as:

- not locking in options
- start the conversation in a safe way – start the process of adapting
- there are conversations about long term futures that they can now have
- they can have a safe discussion
- allowing for some flexibility to account for uncertainty that will happen on the coast.

There was a general view that it is too early in the application of pathways approaches to assess their effectiveness. However, it is recognised that while there is a need to identify triggers and thresholds, this has rarely been undertaken in a quantitative way yet.

### 3.2 Examples of pathways approaches being adopted by local governments in Australia

#### 3.2.1 Western Australia

##### Developing flexible adaptation pathways for the Peron Naturaliste Coastal Region of Western Australia

A pathways approach is described in the *Developing flexible adaptation pathways for the Peron Naturaliste Coastal Region of Western Australia* project (ACIL Tasman, 2012). The report indicates that the aim was to “join feasible options together into pathways such that protection is assured throughout the 100-year period.” This was done by considering pathways of options for case study areas in the region.

The report noted that while a net present value (NPV) approach could be used to assess investment options, it was not preferred because it provides limited information in terms of understanding whether an investment is a good idea (i.e. when if ever should the infrastructure be built) and only provides an indication of the net benefits of a single future outcome, which is insufficient given the uncertainty regarding the future climate.

Instead of applying NPV, the analysis used a “real options” approach to assess optimal strategies for each of the case study areas. The process involved two steps:

- to divide the case study areas into aggregated groups of assets and derive an annualised value for these assets using the value at risk (VAR) approach
- generate “pathways” for each of the sets of assets in terms of how their value at risk might evolve from different climate change impacts.

The aim is to identify the optimal timing of an option within a pathway. This is fundamentally a data rich, detailed economic analysis. The output of this approach is an option-by-option analysis of the optimal timing for implementation.

Further information on this project is available from:

<http://www.peronnaturaliste.org.au/wp-content/uploads/2016/12/PNP-Climate-Change-Adaptation-Options-Assessment-Report.pdf>

### 3.2.2 South Australia

#### Resilient Hills and Coasts

Resilient Hills and Coasts is a regional climate change adaptation initiative for the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region in South Australia. Resilient Hills & Coasts (RHC) is a partner project between local government, NRM Boards and state and federal governments

During the development of the region's climate change adaptation plan an Applied Adaptation Pathways approach was used following the method outlined in Siebentritt and Stafford Smith (2016). This was used to structure a participatory workshop process that generated information to assist the development of a series of adaptation pathways maps for a range of key areas of decision making for the region covering agriculture, water management, community services, emergency management and coastal management. The pathways maps underpin discussion of priority adaptation options in the regional climate change adaptation plan and how they can be sequenced through time.

The focus of the pathways maps were on two key areas of decision making:

- *How do we maintain the condition and extent of sedimentary coastal ecosystems given projected increases in sea?* for the mainland part of the region's coastline.
- *How can built assets along the coast be managed in the face of sea-level rise and coastal inundation?* for the Kangaroo Island coastline.

In addition to describing sequencing of priority options, the pathways approaches informed the identification of qualitative triggers and thresholds that stakeholders believe could influence when adaptation options are implemented in coastal areas. The approach has a strong emphasis on the use of graphical adaptation pathways maps to illustrate key concepts such as sequencing of options through time and the role that triggers play in determining decision points; points in time when decision makers may change their adaptation options at points in time based on the extent and impacts of climate change.

The pathway approach used for the Resilient Hills and Coasts region is similar to that applied for other coastal regions in South Australia:

- Eyre Peninsula
- Far North and Outback
- Western Adelaide
- Southern Adelaide
- South East.

The Resilient Hills and Coasts initiative was selected for further analysis after the initial review was conducted. To this end, the program coordinator and two of the steering committee members were interviewed.

Experience since the completion of the regional plan is that an adaptation pathways approach is being integrated with traditional methods of planning and assessment, such as cost-benefit and risk analysis. For example, the notion of sequencing and use-by-dates is being embraced by recognising that some coastal assets may no longer be viable in their current locations as sea levels rise and that such assets may need to be removed or relocated to higher elevations in the future.

Adaptation pathways have been effective in communicating the importance of sequencing implementation through time and identifying “chunks” of options to address. The approach is seen as being “infinitely” tailorable across spatial scales, easy to change through time and providing a way to plan proactively in the coastal zone, rather than being reactive to impacts as they occur, such as following major storm surge events.

The benefit of a pathways approach has been found to differ depending on the audience. Elected members and council executives have engaged well with the notion of sequencing options through time and the strategic nature of a single page pathways map visualisation; counter to this though is that decision makers who have not been closely involved in the development of the pathways may not fully understand how to interpret them and the underlying concepts.

Middle managers are at the interface of taking pathways approaches from strategic outputs to driving operational outcomes. To date they are being used primarily to communicate the broader work plans, but are yet to be operationalised in detail.

Based on the experience of the Resilient Hills and Coasts region, as councils move toward implementing pathways there are a number of challenges that need to be addressed in their further development and application. These include:

1. The construction of pathways maps on a single page means that prioritisation is required to generate a manageable, subset of options. This can be interpreted by stakeholders who have not been involved with their development as meaning that some options have not been considered at all or have been discarded and points to the need for broader capacity building in relation to the approach.
2. Developing adaptation pathways through a participatory process has meant that strategic adaptation options (e.g. retreat of built coastal assets) are sometimes blended with local scale options (e.g. relocate car park at location X). This could be addressed by developing pathways at multiple spatial scales and differentiating those intended for strategic versus operational decision-making.
3. A key element of an adaptation pathways approach is to understand triggers and thresholds. Experience to date is that obtaining the data needed to develop triggers and thresholds is difficult and will often require drawing on the experience of council staff with significant corporate knowledge. This will require more dedicated information capture in the future with the support of appropriate monitoring and evaluation programs.

These conclusions form the basis of a case study presented in Attachment B.

## Yorke Peninsula Council

In 2015, a Seawater Flooding Adaptation Pathways study was conducted for the Yorke Peninsula Council for the settlements of Port Clinton, Price, Pine Point and Coobowie. The project was jointly funded by the Commonwealth Natural Disaster Resilience Program, the Coast Protection Board, and the Yorke Peninsula Council. The study used the Local Government Association of South Australia's Coastal Adaptation Decision Pathways Investigative Framework (Balston, et al., 2012).

Each settlement was reviewed within the following framework:

- establish settlement history
- analyse existing sea-flood protection
- analyse the impact of sea-flood scenarios
- analyse emergency access and egress
- establish profile of the assets at risk
- identify current policy framework
- explore liability issues
- propose adaptation actions.

While pathways are referred to in a general way in the framing of the study, the approach has a clear focus on how to sequence options through time as sea levels rise. The study analysed three, one-in-one hundred ARI scenarios to assist in providing the context from which to make decisions that relate to the viability and also the timing of responses, which are framed in five broad ways: protect, accommodate, retreat, defer and do nothing.

The approach acquires information about the timing of responses through the following questions:

- What level of protection can be realistically provided (at current threat, 2050 threat, 2100 threat)?
- Where protection falls short, what accommodation responses can be employed?
- Where protection and accommodation strategies fall short, what longer-term retreat options should be employed (if any)?

An output of the approach is a graphical illustration of the different protection, accommodation, and retreat options over time. However, while implicit in the approach, it does not explicitly describe triggers and thresholds although there are some references to these concepts e.g. "Policy should be developed so that a predetermined event triggers the removal of buildings, for example, when a certain sea level height is reached, residents may have five years (for example) to remove dwellings." (Western & Kellett, 2015, p. 37).

Further information on the project outputs is provided at:

<https://yorke.sa.gov.au/news/news-articles/seawater-flooding-study>

### 3.2.3 Victoria

#### Lakes Entrance

In 2014, the University of Melbourne published the results of a local coastal adaptation pathway project undertaken in Lakes Entrance (Barnett, et al., 2014). The study builds the case for the use of adaptation pathways to assist with climate change adaptation, stating that: "adaptation pathways are a sequence of linked strategies that are triggered by a

change in environmental conditions, and in which initial decisions can have low regrets and preserve options for future generations” (Barnett et al. 2014, p. 1103).

The study noted that some past attempts at adaptation pathways had focussed on addressing the risks of flooding and sea-level rise in the Thames Estuary and the Rhine-Meuse delta using intensive processes of scenario generation. However, it was recognised that such approaches may not be suitable for smaller local communities and governments that rarely have the technical skills for such analyses and for who decisions about adaptation at local scales typically rely far more on consensus within local constituencies.

The Lakes Entrance study adopted a community-focused approach to developing adaptation pathways, generating information from a workshop with local decision-makers and focus group interviews with local residents. There was significant effort invested in understanding community values

There were three key features of the local adaptation pathways generated for the project: (a) a sequence of triggers, (b) the areas they are likely to effect and (c) the policy steps they activate. The triggers describe a physical impact and its related social and economic impact on the community. For example, Trigger 1 is described as “Inundation of the Esplanade for more than 5 days in a year, causing frequent and detrimental disruptions to the infrastructure necessary for the orderly functioning of the town.” Each trigger is then connected to an action, for example, Step 1 (connected to Trigger 1) states: “Stringent controls over new developments, and steps to prepare for the relocation of critical infrastructure and dwellings to more elevated parts of the town.” (Barnett et al. 2014, Figure 1).

The approach was not explicit about the timing of such triggers or the sea level height at which they might occur, removing the need for extensive discussions about sea-level rise projections.

The study argues that it was able to demonstrate that:

- a locally focused and socially-relevant adaptation pathway is feasible
- such an approach can facilitate a level of consensus sufficient to enable adaptation to begin, coupled with a framework that leaves future generations better prepared.

### Swan Bay coastal wetlands

Adaptation pathways were developed for a range of natural asset groups in the Corangamite Natural Resources Management region, including for coastal wetlands in Swan Bay. The development of pathways was underpinned by a guide prepared by the Southern Slopes Climate Change Adaptation Research Partnership (SCARP) called “Adaptation Pathways: a playbook for developing robust options for climate change adaptation in Natural Resource Management” (Bosomworth et al. 2015). This approach has also been applied outside of the Corangamite Natural Resources Management region.

The Playbook identifies five key activities for pathways planning:

- define objectives for pathways
- understand the current situation
- analyse possible futures
- develop adaptation pathways
- implementation, monitoring, evaluation, reporting, improvement (MERI) and learning.

Adaptation options are ‘tested’ against possible or plausible futures. The key system drivers, identified and described in the current situation analysis, provide the basis for developing the future scenarios. Unlike other pathways approaches, options are tested against specific possible or plausible futures rather than general trends of, for example, increasing sea levels and associated storm surge risk.

The following six steps are applied in identifying adaptation pathways for a particular objective:

1. identify options to address existing drivers of vulnerabilities under current conditions
2. identify tipping points, turning points and trigger points
3. identify alternate and additional options that could help address objectives under the range of potential futures
4. sequence potential actions into draft pathways (document)
5. analyse and evaluate the pathways
6. finalise and document or map pathways.

The SCARP approach provides a way to communicate pathways using a table rather than a diagram. The table-based approach presents actions in the pathway as “management types” and “management actions” with each action described as being either: a ‘resilience’, ‘transitional’ or ‘transformational’ type.

### **3.3 Current integration of pathways with the C-CADS decision-making process**

A summary of references to adaptation pathways and key underlying concepts is provided in Attachment A.

References to key concepts for adaptation pathways, such as sequencing, triggers, thresholds, decision points and use by dates are spread throughout the six steps of the C-CADS process.

While there is no discussion of pathways as a general framing for adaptation in Section 1 of C-CADS, pathways and underlying concepts are specifically referred to in subsections of Steps 2-6.

- C-CADS Section 2 – “Determine thresholds, lead times and decision points for current practices”. This sub-section outlines some of the key-steps involved in some of the formal adaptation pathways approaches, however, it is not mentioned that these are key pathways concepts. While presented in Section 2, there is not a clear link with this sub-section and the purpose of the Section, which is “Assess risks and vulnerabilities”
- C-CADS Section 3 – “Integrated solutions and adaptation pathways”. This sub-section explains the role of adaptation pathways concepts as part of identifying options.
- C-CADS Section 4 – “Flexible adaptation pathways: timing actions and decisions”. This sub-section focuses on how to create pathways by sequencing actions through the use of triggers and thresholds and by understanding decision points.

- C-CADS Section 5 – “What do I need to do and when? (sequencing your actions)”. This sub-section recognises that automatically implementing options according to a plan is not advisable and instead priority options should be reconsidered when thresholds are reached.
- C-CADS Section 6 – “Monitoring trigger points for implementation of adaptation actions”. This sub-section discusses the importance of identifying indicators that can be monitored to determine when thresholds are crossed or triggers for implementing new actions are reached.

Aside from references to adaptation pathways in the C-CADS steps, there are several other sources of information on pathways, for example:

- A dedicated adaptation pathways page called “What is a pathways approach to adaptation?” (<https://coastadapt.com.au/pathways-approach>). This section provides an overview of what is a ‘pathways approach’, how can it be used in adaptation planning, examples of adaptation pathways outputs, and the theoretical basis for adaptation pathways.
- The Coast Adapt Information Manual called “Assessing the costs and benefits of coastal climate adaptation” (Wise & Capon, 2016), which includes an informative 7-page summary of pathways approaches and their potential application in the coastal zone.
- Valuation information on the “Valuation of adaptation options relative to the avoided impacts” webpage (<https://coastadapt.com.au/how-to-pages/valuation>) and the “Real options fact sheet” ([https://coastadapt.com.au/sites/default/files/factsheets/T4W5\\_Real\\_options.pdf](https://coastadapt.com.au/sites/default/files/factsheets/T4W5_Real_options.pdf)).

## 4 Discussion

### 4.1 Adaptation pathways approaches being adopted for coastal adaptation decision making

Interviews with coastal decision makers provided insight into where adaptation pathways approaches are currently being used around Australia. The interviews revealed a general understanding of the pathways concept, being one that allows for the sequencing of adaptation options through time, and that does not lock in options now for the future.

There are no known formal evaluations of the pathways approaches that were identified during this study and insufficient time has passed to understand what aspects of the approaches have been least effective. Initial feedback, however, is that there is a recognition that better understanding of triggers and thresholds is important but that this is difficult because of limited knowledge of the responses of systems to projected climate change. There is also a view that pathways provide a broad strategic direction for adaptation, but limited direction for day-to-day, operational decision-making.

Of the five projects reviewed, three followed a published pathways methodology and the other two incorporated key pathways concepts. The three published methodologies that were followed were:

- A User Guide for Applied Adaptation Pathways (Siebentritt & Stafford Smith, 2016)
- Adaptation Pathways: a playbook for developing robust options for climate change adaptation in Natural Resource Management (Bosomworth et al. 2015)
- Coastal Adaptation Decision Pathways Investigative Framework (Balston, et al., 2012)

All three published methodologies explicitly consider the sequencing of options through time and present the results in either a table or figure. In contrast to the Coastal Adaptation Decision Pathways Investigative Framework, both the Applied Adaptation Pathways approach and the SCARP Playbook have a greater focus on identifying and characterising triggers and thresholds.

In the case of the flexible adaptation pathways for the Peron Naturaliste project, the broad notion of sequencing and selecting the optimal timing for implementation was considered using a detailed, economic valuation method called real options analysis to inform when investment might occur. In contrast, Barnett et al. (2014) identified triggers for decision-making and related actions, delivered through a participatory, community focused process.

A key common feature of most of the approaches reviewed is the designed method of delivery through a participatory process. While many adaptation planning approaches can be undertaken as desktop analyses (e.g. risk and vulnerability assessments) there is growing recognition that because of the impacts that climate change will have on the community and economy, extensive stakeholder engagement is essential in the decision-making process.

In many ways the differences in the pathways approaches adopted for these projects reflect the types of project to which they were applied. For example, the Resilient Hills and Coasts project was a regional scale climate change, adaptation, planning project and hence the adaptation pathways were broad and strategic, presenting a more generic pathway for



management of the region's coastline. In contrast, the work of Barnett et al. (2014) identified specific triggers for the town of Lakes Entrance and the Corangamite Natural Resource Management Plan for Climate Change identifies pathways for specific river reaches or wetlands in a specific location.

Despite the intention of reviewing and comparing how pathways approaches are being adopted in Australia by Local Government to inform coastal adaptation decision-making, this study has shown that extensive experience with the use of adaptation pathways in planning and implementation is limited. This means that there was only a small sample size that could be used to determine common elements of pathways approaches, and hence compatibility with C-CADS.

A broader question to arise during this study is whether risk based approaches (such as C-CADS) are an alternative to adaptation pathways or whether they can be effectively integrated, as is attempted by CoastAdapt. This could be considered by also assessing whether the pathways approaches used would have benefited from the application of elements of the C-CADS process (in addition to the aims of this study which were to assess the elements of the C-CADS process that incorporate pathways approaches and language). Hinkel and Bisaro (2016) are instructive in this regard and suggest that rather than being alternatives, risk assessment and adaptation pathways approaches address different aspects of the adaptation problem. For example, it can be argued that identifying climate risks and vulnerabilities is primarily a concern where there is a desire to identify adaptation needs. In contrast, the adaptation pathways approach is designed to appraise response options once adaptation needs are agreed.

In South Australia, pathways approaches have been undertaken subsequent to the completion of steps equivalent to 1 and 2 of C-CADS (although at a regional scale with the development of Regional Adaptation Plans). First pass risk and IVA processes have identified climate risks, with pathways approaches then used to appraise or communicate the sequencing of mitigation options. An advantage of using C-CADS to inform pathways approaches could therefore be to ensure that risk management concepts and risk based language, such as that developed in steps 1 and 2 of C-CADS are used because they align with a range of existing organisational procedures in local government, which helps to build the case for further assessment of options. Pathways approaches could also benefit from greater attention to C-CADS Step 5, by further describing how to implement options, especially for the first step of an agreed sequence.

Whether there is a need to use one approach over another, or combine them into a single integrated method is a case-by-case decision for decision makers and practitioners. This decision should preferably be made prior to a new project commencing.

## **4.2 Extent to which the C-CADS approach is compatible with reviewed pathways approaches**

There are common elements of the pathways approaches reviewed for this study that can be used to determine compatibility with the C-CADS approach. These are that the approaches:

1. articulated a goal or area of decision making
2. built on a broad concept of sequencing the implementation of options
3. incorporated the concept of triggers and thresholds
4. defined a multi-step methodology rather than general principles
5. generated a visual pathways map or table

6. advocated for the monitoring and evaluation of indicators that describe triggers and thresholds.

The C-CADS approach addresses the majority of these elements. For example, C-CADS has integrated the broad concept of sequencing the implementation of options thoroughly, with references in multiple steps of the process. There are also extensive references to the importance of understanding triggers and thresholds and related concepts such as decision points and adaptation tipping points. However, C-CADS does not present a stand-alone methodology for developing adaptation pathways. While some of the key steps are present, they are spread throughout C-CADS and the CoastAdapt website making it unlikely that a comprehensive pathways approach, as described in one of the three formal methodologies reviewed in this study, will emerge. Furthermore, although visual examples of pathways maps are provided in a C-CADS supporting section, there is limited guidance on how to prepare a visualisation of sequenced adaptation options.

Information referred to on linked web pages (e.g. “What is a pathways approach to adaptation?” and “Valuation of adaptation options relative to the avoided impacts”) and supporting documents such as “Assessing the costs and benefits of coastal climate adaptation” and “Real options fact sheet” provide an excellent source of supplementary material.

An alternative approach to this analysis would have been to assess whether the pathways approaches used would have benefited from the application of elements of the C-CADS process rather than assessing the elements of C-CADs that incorporate pathways approaches and language. While this is a different question than was the aim of this study, it would ensure that the pathways approaches in use build on what is broadly regarded as leading practice. It is anticipated that such a review would highlight that (a) most of the pathways projects assessed for this analysis build on past studies where climate risk or vulnerability assessments have already been undertaken, which helped to identify the “adaptation need” (*sensu* Hinkel and Bisaro’s 2016) and (b) monitoring and evaluation, while prescribed by pathways approaches, has been limited in practice. These possible findings should be treated as hypotheses for testing in a broader research study.

### **4.3 Recommendations on how C-CADS could further integrate adaptation pathways**

Key concepts underpinning adaptation pathways are already well integrated and present in the C-CADS process, with explicit sub-sections describing concepts such as sequencing, triggers and thresholds. Further integration of pathways could occur as follows (NB. Figure 1 indicates which parts of the C-CADS process are recommended for revision using the numbering system below):

1. While the general description of pathways concepts is well integrated into Steps 2 to 6, coastal adaption decision makers may wish to adopt a pathways approach from the start. It is recommended that specific words to this effect be included and a link to the supplementary section called “What is a pathways approach to adaptation?” provided. A further amendment would be to include additional text on the “Using C-CADS” page in relation to the C-CADS process diagram as proposed in Attachment B.
2. While pathways concepts are referred to throughout the C-CADS process, they are not always linked or clearly identified as such. For example, each of Sections 2 to 6 has a sub-section that specifically deals with pathways concepts, yet this is not stated. It is recommended that a sub-section is included in Section 1 stating where pathways concepts have been integrated throughout the C-CADS process.

3. There is a question as to whether a pathways approach is different to a risk-based approach. This is a subject of debate amongst researchers and practitioners. This report expresses the view that they are not incompatible, but do relate to different adaptation challenges. Proposed text to address this issue is presented in Attachment B.
4. An important part of undertaking a pathways approach is to identify triggers and thresholds. Often identifying triggers and thresholds can prove difficult because of a lack of information or conceptual models, especially when being developed through participatory processes. Risk and vulnerability assessments provide an opportunity to start to accumulate the knowledge required for identifying triggers and thresholds. Therefore, Step 2 could be improved by indicating that as part of the risk and vulnerability process, there is merit in considering how the results inform understanding of triggers and thresholds (and related concepts such as tipping points and use-by-dates). Attachment B presents text that outlines how thresholds and triggers can be established.
5. Box 3, titled “Thresholds, lead times and decision points” only deals with thresholds and provides no description of lead times or decision points.
6. Step 6 provides a section on a “Theory of change diagram” which refers to a pathway. It is not clear whether this is an adaptation pathway or another type of pathway diagram.
7. Section 4 refers to “Flexible adaptation pathways”. While there are several references to flexibility being an advantage of a pathways approach, this is one of the few places in C-CADS that refers to “Flexible adaptation pathways” which then reads as a specific approach. It is recommended that this section be changed to read “Adaptation pathways”
8. Additional detail should be included on the basic steps involved with developing a pathways map. Proposed text to address this issue is presented in Attachment B.
9. In addition to the above suggestions on how C-CADS could further integrate adaptation pathways, it is recommended that the Resilient Hills and Coasts case study be included in CoastAdapt. This provides a rare insight into how local government staff are addressing the challenging of implementing adaptation pathways approaches in practice. The proposed case study is provided in Attachment B.
10. Figure 2 below from C-CADS (<https://coastadapt.com.au/pathways-approach>) is described as “Incorporating the adaptation pathways approach into C-CADS”. While this diagram eludes to pathways, it doesn’t necessarily capture the distinction between C-CADS and “Adaptation Pathways” as a specific approach. This distinction could be strengthened.

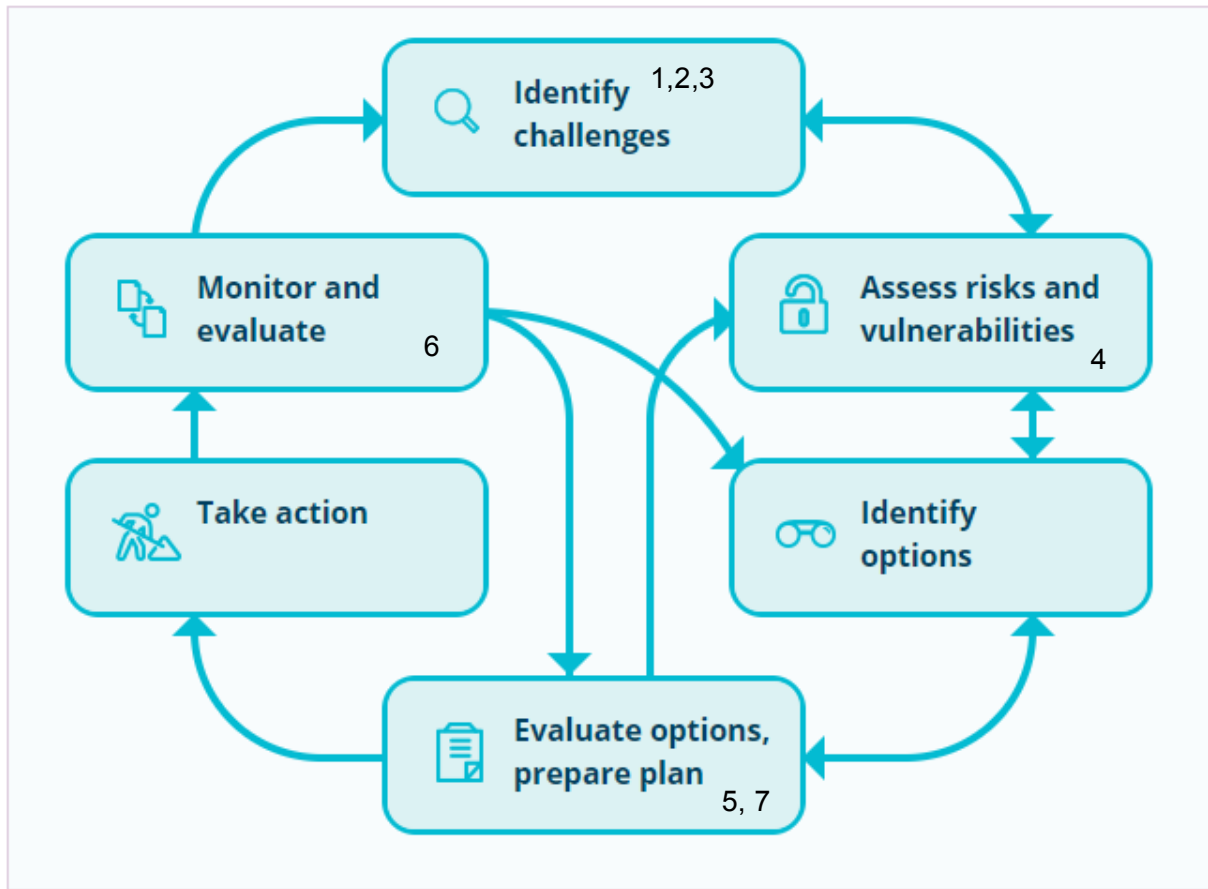


Figure 1: Numbers on the diagram refer to which aspect of the C-CADS process the listed recommendations in Section 4.3 relate to.

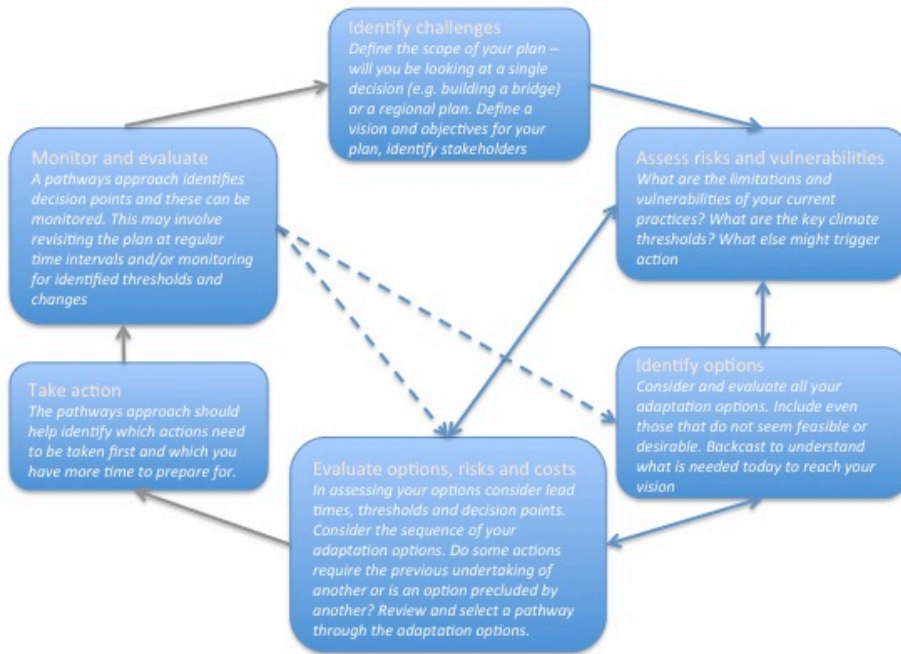


Figure 2: Incorporating the adaptation pathways approach into C-CADS. Source: CoastAdapt.

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# Attachment A

Examples of text containing key adaptation pathways concepts from each of the C-CADS steps. Italics are used to indicate a sub-section that provides one or more paragraphs of content relevant to adaptation pathways.

| C-CADS Section                              | Relevant text   |
|---|---|
| Step 1: Identify the challenges             | <p>Your adaptation planning will be most effective if it follows a flexible, iterative process.</p> <p>Determining and monitoring thresholds, and implementing actions when certain triggers are reached, prevents unnecessary spending and enables effective stakeholder engagement.</p> <p>Considering a range of climate futures may also require you to consider what adaptation responses are required for drought, for floods, and importantly, for a rapid switch from one to the other.</p> <p>It may not be essential to spend money at an early stage of adaptation planning, but it is essential to consider the challenge, the risks and the costs and begin to engage with stakeholders. This is part of considering and developing an adaptation pathway.</p>   |
| Step 2: Assessing Risks and Vulnerabilities | <p>More information on establishing indicators and on climate adaptation pathways can be obtained from <a href="#">Identifying indicators</a> and a <a href="#">Pathways approach</a>.</p> <p>Understanding vulnerabilities and limitations of current practices also helps identify who amongst internal and external stakeholders should be involved in your planning process. Their involvement will help them understand why current practices might have a 'use-by-date'.</p> <p><i>Sub-section: Determine thresholds, lead times and decision points for current practices</i></p>  |
| Step 3: Identify options for action         | <p>A good way forward is to develop a sequence of options that can be implemented as effects of climate change become more apparent.</p> <p>Consider suites and sequences of options, enabling you to take a pathways approach and avoid unnecessary expenditure and adverse side-effects from your actions.</p> <p>It is important that these actions are identified and captured in a single plan. This enables interactions between actions to be considered and for sequencing of actions to be effective.</p> <p>Some actions may no longer be relevant under climate change or will conflict with adaptation options.</p> <p>Most options can be staged or incremental, changing as the effects of climate become greater. There is the potential however that eventually the effects of climate will become so great, that significant changes are required to address them.</p> |



| C-CADS Section                                   | Relevant text   |
|--|---|
|  | <p>It is possible that at some time taking a series of actions that are gradually more intensive and costly might not be sufficient to address the challenge of climate change.</p> <p>The uncertainty about the scale, types and timing of change provides a challenge for decision makers who may not wish to implement expensive adaptation options until they are certain they are required. This can be dealt with by sequencing adaptation actions, starting with no regrets options and building to different options when selected thresholds are reached.</p> <p><i>Sub-section: Integrated solutions and adaptation pathways</i></p>  |
| <p>Step 4: Assess options and prepare a plan</p> | <p>You can also identify options that will achieve short term as well as long term outcomes, and work on sequencing when these options should be implemented and identifying thresholds and trigger levels for implementing various actions.</p> <p>Put together a plan that contains a suite of options, and identifies thresholds at which options will be implemented.</p> <p>Note that it is possible to stage the implementation of your selected option by developing a suite of ‘actions’—then you can sequence these actions by identifying thresholds that, when reached, should trigger the implementation of a particular action.</p> <p>This document should also outline a process to indicate what will be required to prompt action in future (e.g. trigger events, new information) and how these would be determined and measured.</p> <p>You can then determine trigger levels or thresholds that can be tracked (monitored), and that when reached, will indicate the need to start engaging and building to implementation (see information on <a href="#">Monitoring and evaluation</a> and <a href="#">Identifying indicators</a>).</p> <p>It is important that climate risk and options are considered, and that a decision is made not to implement any actions until a particular threshold or set of thresholds are reached that will trigger actions.</p> <p><i>Outline proposed responses (selected options) and your sequencing/adaptation pathway.</i> Your plan should indicate the approach you are taking to sequence actions and what trigger and decision points will be used. This component of your plan should link to the monitoring and evaluation component of the plan. There are different ways in which pathways can be represented (see <a href="#">Pathways approach</a>).</p> <p>Trigger points indicate which action should be implemented (ensuring time for detailed planning, consultation that may be required).</p> <p>Having a stand-alone adaptation plan enables you to take a pathways approach and enables specific monitoring and evaluation activities to be implemented that enable sequencing to occur.</p> |

| C-CADS Section                       | Relevant text   |
|--------------------------------------|---|
|                                      | <i>Sub-section: Flexible adaptation pathways: timing actions and decisions</i>  |
| Step 5: Take action                  | <p>Your plan should have been designed to be flexible to enable changes to be made in response to changing information, conditions and thresholds.</p> <p><i>Sub-section: What do I need to do and when? (sequencing your actions)</i></p>  |
| Step 6: Monitor, Evaluate and Review | <p>Trigger points can be identified and monitored and, when reached, can stimulate the implementation of the next action in a sequence. In identifying trigger levels for response, it is important to consider the time required for the decision to be made and implemented.</p> <p>Identify when an action is no longer effective for the degree of change that is happening, and a new action or suite of actions is required</p> <p><i>Sub-section: Monitoring trigger points for implementation of adaptation actions</i></p> |

## Attachment B

This Attachment contains passages of text for proposed inclusion in C-CADS in order to provide further information about integration of adaptation pathways approaches.

### Introducing pathways early

*The final paragraph in the “Important to keep in mind” section on the Using C-CADS page could read as follows.*

The iterative nature of C-CADS supports you to take actions and learn from your experiences, making appropriate changes and then trying again. The approach supports you to select actions for particular conditions and also to monitor various threshold indicators. Only when a threshold is reached, will this trigger the implementation of a different action (often more expensive or controversial).

Introducing the concept of a pathways approach early as a way of framing adaptation responses means that decision makers and practitioners do not form the view that they have to answer every possible scenario immediately and that there can be multiple pathway options that may be viable depending on the actual impacts realised. This staging of actions ensures that you do not use unnecessary resources or alarm your stakeholders without sufficient evidence.

### Is a pathways approach different to a risk-based approach?

*Text recommended for inclusion in either the “Using C-CADS” or “Step 2: Assessing Risks and Vulnerabilities” sections.*

C-CADS is a logical assessment and decision-making framework to support climate change adaptation. It combines elements of climate risk assessment and adaptation pathways planning. These approaches are fundamentally different, but not necessarily incompatible, because they address different types of adaptation challenges (Hinkel, 2014; Hinkel & Bisaro, 2016).

Identifying climate risks and vulnerabilities is primarily a concern where there is a desire to identify adaptation needs. By contrast, the adaptation pathways approach is designed to appraise response options once adaptation needs are agreed. Whether there is a need to use one approach over another, or combine them into a single integrated method is a case-by-case decision for decision makers and practitioners. This decision should preferably be made prior to a new project commencing.

Many initial climate change plans for an organisation, region or sector have focussed on risk and vulnerability assessments in order to identify adaptation needs and prioritise issues for action. This occurred in the regional adaptation plans in South Australia that were prepared from 2013 to 2016, where an integrated vulnerability assessment was mandatory. Yet in some regions of South Australia, such as the Eyre Peninsula, there was a much greater emphasis on the use of a pathways approach because pre-existing work sufficiently described adaptation needs and there was a desire to focus stakeholder participation on assessing solutions instead.

## Setting triggers and thresholds

*Text recommended for inclusion on the “What is a pathways approach to adaptation?” webpage <https://coastadapt.com.au/pathways-approach>*

A common feature of adaptation pathways approaches is the identification of thresholds and triggers or a suite of similar concepts such as tipping points, turning points, used by dates, and stopping points (e.g. (Werners, et al., 2013; Siebentritt & Stafford Smith, A User Guide for Applied Adaptation Pathways, 2016; Kwadijk, et al., 2010). A threshold can be described as the point at which a system starts to operate in a significantly different way. Triggers on the other hand occur when a monitored system driver changes to a point where existing response options should be reviewed and new options implemented i.e. a decision point is triggered (Siebentritt & Stafford Smith, A User Guide for Applied Adaptation Pathways, 2016). Triggers and thresholds can be economic, environmental, physical, political and social.

While experience suggests that thresholds and triggers are conceptually intuitive and therefore attractive to incorporate into adaptation planning, it has been argued that the assumed simplicity of adaptation pathways planning can be lost because thresholds may not be easily defined and possible action triggers have multiple drivers (Bosomworth, et al., 2017).

The ease of which triggers and thresholds can be identified depends on a range of factors such as the focus of the threshold or trigger (e.g. simple versus complex system) and the extent to which qualitative versus quantitative information is required. Bosomworth et al. (Bosomworth, et al., 2017) provide a further discussion of challenges to defining tipping points.

While there may at times be a strong desire for quantitative thresholds and triggers, qualitative or semi-quantitative information can be equally informative and is capable of being generated from social research, stakeholder engagement and participatory processes. For example, (Barnett, et al., 2014) was able to identify a series of triggers and response options based an extensive interview process with residents in Lakes Entrance.

Given the inherent challenges in identifying triggers and thresholds, decision makers and practitioners may wish to consider a staged approach based on the three levels of the climate challenge (see Table 2 in “Using C-CADS”). At the Scan level, the aim would be to raise awareness about the existence of triggers and thresholds in order to build capacity amongst decision makers. This could be done using examples of past impacts and resulting decision-making. At the Plan level, participatory processes and social research techniques can be used to generate information, as was done by (Barnett, et al., 2014). Both the Scan and Plan approaches described here can be achieved with modest budgets. At the Delve Deeper level, more analytical techniques can be used requiring quantitative data sets and the development of predictive models. Across all three levels, risk assessments should not be discounted as a useful source of information to inform the identification of thresholds and triggers.

When using triggers and thresholds, other issues to consider include:

- Does your organisation intend to be proactive and act in advance of a trigger being reached or does it plan to be reactive, using the breaching of a threshold or trigger as an opportunity to build the business case for action?
- Are thresholds and triggers locked in such that when they occur a response will be initiated, or are they flexible and a guide only?

- Is there a commitment to ongoing monitoring and evaluation of thresholds and triggers, which is essential if they are going to be used to initiate adaptation responses?

### **Suggested case study**

Case study recommended for inclusion on the “What is a pathways approach to adaptation?” webpage <https://coastadapt.com.au/pathways-approach>

#### **Case study - Using adaptation pathways to inform coastal adaptation decision-making**

The Resilient Hills and Coasts region (Adelaide Hills, Fleurieu Peninsula and Kangaroo Island) completed a regional climate change adaptation plan in 2016<sup>1</sup>. This involved local councils, natural resource management organisations and businesses and featured the use of adaptation pathways across multiple areas of decision-making, including coastal management. The region is now moving from planning to on-ground action within individual councils.

Experience since the completion of the regional plan is that an adaptation pathways approach is being integrated with traditional methods of planning and assessment, such as cost-benefit and risk analysis. For example, the notion of sequencing and use-by-dates is being embraced by recognising that some coastal assets may no longer be viable in their current locations as sea levels rise and that such assets may need to be removed or relocated to higher elevations in the future.

Adaptation pathways have been effective in communicating the importance of sequencing implementation through time and identifying “chunks” of options to address. The approach is seen as being “infinitely” tailorable across spatial scales, easy to change through time and providing a way to plan proactively in the coastal zone, rather than being reactive to impacts as they occur, such as following major storm surge events.

The benefit of a pathways approach has been found to differ depending on the audience. Elected members and council executives have engaged well with the notion of sequencing options through time and the strategic nature of a single page pathways map visualisation; counter to this though is that decision makers who have not been closely involved in the development of the pathways may not fully understand how to interpret them and the underlying concepts.

Middle managers are at the interface of taking pathways approaches from strategic outputs to driving operational outcomes. To date they are being used primarily to communicate the broader work plans, but are yet to be operationalised in detail.

Based on the experience of the Resilient Hills and Coasts region, as councils move toward implementing pathways there are a number of challenges that need to be addressed in their further development and application. These include:

1. The construction of pathways maps on a single page means that prioritisation is required to generate a manageable, subset of options. This can be interpreted by stakeholders who have not been involved with their development as meaning that some options have not been considered at all or have been discarded and points to the need for broader capacity building in relation to the approach.

<sup>1</sup> <https://www.alexandrina.sa.gov.au/resilienthillscoasts>

2. Developing adaptation pathways through a participatory process has meant that strategic adaptation options (e.g. retreat of built coastal assets) are sometimes blended with local scale options (e.g. relocate car park at location X). This could be addressed by developing pathways at multiple spatial scales and differentiating those intended for strategic versus operational decision-making.
3. A key element of an adaptation pathways approach is to understand triggers and thresholds. Experience to date is that obtaining the data needed to develop triggers and thresholds is difficult and will often require drawing on the experience of council staff with significant corporate knowledge. This will require more dedicated information capture in the future with the support of appropriate monitoring and evaluation programs.

### Developing an adaptation pathways graphic

*Text recommended for inclusion on the “What is a pathways approach to adaptation?”*  
<https://coastadapt.com.au/pathways-approach>

A key feature of adaptation pathways planning is the development of a pathways graphic, sometimes referred to as a pathways map, train-line map, route map, or decision pathways map. A pathways map can be a powerful tool for communicating key messages about sequencing adaptation options through time, often on a single page; on the other hand, they can provide a sometimes confusing diagram for some decision makers not involved with their development, detracting from key messages about thresholds and triggers.

If you do choose to develop a pathways map, there are several guides, reports and papers which provide different styles and approaches, some of which present options in a table rather than map (e.g. (Bosomworth, Harwood, Leith, & Wallis, 2015; Haasnoot, Kwakkel, Walker, & ter Maat, 2013; Siebentritt & Stafford Smith, 2016). Most of the approaches can be developed through using simple drawing software.

Key steps to consider when developing your adaptation pathways graphic include:

- *Assemble a short list of options.* For the sake of developing a graphically simple map, you may need to consolidate or discard some options. If this is necessary it will require further assessment or consultation with decision makers and key stakeholders. Options are often assembled on the y-axis or left hand side of the page.
- *Decide how time will be presented on the map.* This can be done by referring directly to blocks of years (e.g. 5,10, 20 years), specific years (e.g. 2020, 2050, 2070) or indirectly by reference to changing climate factors (e.g. increasing sea level heights or temperature). The time component of the map will appear most often on the x-axis.
- *Determine whether to represent both sequencing and triggers on the diagram.* Sequencing of options can be shown in a simple way by extending a line (or bar) over time covering the years for which an option can be implemented. The addition of triggers to a pathways map introduces the complexity of showing the relationship between options i.e. when to switch from one option or combination of options to another.
- *Choose between a single or multiple pathway.* A single pathway can be used to describe high level sequencing of strategic options through time (e.g. the move from incremental

to planned then transformational adaptation) or imply preference for what may be considered a “robust” combination of options. Alternately multiple pathways can communicate the different options that exist, but also introduce complexity on how to structure the pathway map.

Examples of specific methods for developing pathways maps or tables are described in the following:

- A User Guide for Applied Adaptation Pathways (Siebentritt & Stafford Smith, 2016).
- Adaptation Pathways: a playbook for developing robust options for climate change adaptation in Natural Resource Management (Bosomworth et al. (2015).
- Coastal Adaptation Decision Pathways Investigative Framework (Balston, et al., 2012).