Guidance on undertaking a third-pass (detailed) risk assessment

What is a third-pass (detailed) risk assessment and what can it achieve?

A third-pass or detailed climate change risk assessment helps users to develop a better understanding of site-specific climate change-related risks. Before conducting a risk assessment that demands this level of detail and resources, users should consider whether this step is required. Third-pass risk assessments can be helpful, for example, in engineering projects (e.g. construction of seawalls, groynes, beach nourishment) where it is necessary to gather detailed information on risk (e.g. estimated rate and extent of change) before proceeding to implementation planning. It is possible to develop organisation-wide adaptation plans using the outputs of a first-pass or second-pass risk assessment and following the relevant *C-CADS steps*. A third-pass assessment should be used where detailed modelling or hazard studies are required for a complex project (or site) before implementation or investment decision-making.

A third-pass assessment follows a standard risk based approach (similar to a second-pass assessment). It is not purely quantitative — it also involves incorporating qualitative decisions from stakeholders such as identifying risk evaluation criteria, decisions on relative importance of identified risks etc. However, some elements of this process should be quantitative if the system at risk is critical (for example, if the consequences of system failure are severe) or a higher degree of precision is required for making decisions (e.g. engineering design). For example, a third-pass assessment of an at-risk beach may include detailed modelling to estimate erosion rates or areas at risk of inundation. The modelling results can be used to explore what assets might be at risk and to define trigger points at which action may be required to protect those at-risk assets.

Limitations

A third-pass assessment can be resource intensive as it may require further detailed data, which must be commissioned, as well as engagement with relevant experts or consultants.

A third-pass risk assessment will provide increased precision but not necessarily increased accuracy, given the uncertainties of estimates of climate change and sea level rise.

Organisations such as small businesses and councils are unlikely to have sufficient internal expertise or capacity to undertake all elements of a third-pass assessment, so that consultants will be required. CoastAdapt provides guidance on engaging and *Working with consultants*.

How to undertake a third-pass (detailed) risk assessment

Figure 1 shows the four steps to a third-pass assessment. The process may involve engaging with experts or consultants along with stakeholders from your organisation. Therefore, it's worth reading some of the relevant content in CoastAdapt (see *How to get organizational buy-in*, *How to hire and make the best use of consultancy services*, *Checklist for engaging consulting services*).

Step-1: Establish the context (scope)

1.1 Objective

By now, if you have created a first-pass and second-pass assessment, you will have a clear idea of:

- organization-wide climate change risks and
- an adaptation plan that shortlists high-risk areas/systems/assets, identifying those that are critical for your business.

The objective of the third-pass risk assessment is to focus on getting site-specific information through detailed hazard studies, so that you can better estimate the rate of change and extent of possible impacts (both direct and indirect) on areas/systems/assets identified as at high risk.

1.2 Timeframe of the risk assessment and climate scenarios

Detailed hazard studies will build biophysical models (e.g. coastal dynamics model, hydrological model, sediment transport models etc.) and use these to estimate the impacts of future climate change and sea level rise. These estimates are often time-bound, therefore the timeframe of interest needs to be made clear at the scoping stage. Because a third-pass risk assessment is conducted mostly for critical systems, the full breadth of risks should be explored by looking at longer timeframes using high greenhouse gas scenarios.

Other factors to consider in deciding the timeframe and greenhouse gas scenario are the risk appetite of your organization, the criticality of the infrastructure or services that you have identified as potentially at-risk during your first or second-pass assessments, and the advice of experts and consultants.

Step 1

Establish the context (scope)

- Objective
- Timeframe
- Climate change scenario
- System of analysis (e.g. public infrastructure, private properties, ecosystems) and
- Scale of analysis (e.g. a single beach community, a single infrastructure etc.)
- Stakeholder identification and engagement

Step 2

Identify your existing climate risks (past and current)

- Using information derived from a first-pass or second-pass assessment on past hazard in your area list the areas/systems/assets affected by past events.
- What was the consequence of those events? (qualitative or quantitative estimation)
- Are there any risk management strategies in place to tackle any future occurrence of that risk?
- Understand and identify residual risk of a given system (i.e. risk that remains even after putting a risk management strategy in place)

Step 3

Identify your future climate change risks and opportunities

- Identifying relevant climate change and sea level rise projections of your area (for your selected scenarios in step 1) and assess further data needs.
- For the hazards that you have shortlisted in second-pass assessment, commission detailed studies to identify the exact nature, rate and extent of identified risks under future climate and sea level change.
- Use the output of these detailed studies to identify your systems/areas/assets that are at-risk (exposure)
- Understand how sensitive your systems/areas/assets are to the identified risk exposures. This might need to use information generated in the detail site specific analysis and modelling (see guideline for detail).
- Explore and understand the capacity of your systems/areas/assets or organization managing them to respond to any future exposures.
- Using information generated above determine vulnerability of your systems/areas/assets

Step 4

Analyze and evaluate risks

- Identify risk evaluation criteria (e.g. maintain public infrastructure, protect private properties, minimise impact on environment, ensure business continuity etc.)
- Adopt scales for rating consequence of a risk (catastrophic, moderate, low etc.) and likelihood of a given consequence happening (rare, unlikely, possible etc.)
- Take one risk at a time and using adopted scales, rate the consequence of that risk happening in future. Also rate the likelihood of that consequence happening.
- Repeat the above step for each risk evaluation criteria
- Adopt a risk rating scale (e.g. high, medium, low etc.)
- Using information generated above, identify the risk rating of the system components
- Using the risk ratings along with vulnerability ratings (step-3) identify the system components whose risk need to be addressed in priority (e.g. high vulnerability-high risk)

Figure 1: Steps involved in conducting a third-pass (detailed) risk assessment.

Step 2: Identify your existing climate risk

2.1 Using information derived from a first-pass or second-pass assessment on past hazard in your area list the areas/systems/assets affected by past events.

During the first-pass and second-pass assessments you explored previous hazard events in your area. Now you should narrow the focus to the area/system/asset identified as at high risk and requiring further assessment. As an example, a council conducting a detailed site specific hazard study to identify risk to infrastructure or assets located on an at-risk beach will want to investigate any previous history of erosion hazard on that beach. Local knowledge or any earlier studies will be a good source of information.

2.2 What was the consequence of those events (quantitative estimation)?

List the system components that have been impacted by the hazard in the past. For example, if assessing risk to a water supply system from storm surge inundation, then list the type, number and, locations of water supply assets that have been impacted by storm surge inundation in the past.

2.3 What was the consequence of the past hazard on your business (qualitative or quantitative)?

If you have identified that your area has been impacted in the past by coastal climatic hazards then at this stage you need to estimate the damage that occurred during those events. The first and second-pass assessments qualitatively estimated these previous consequences; in the third-pass assessment an attempt should be made to quantify these values. This quantification of previous damage costs may not influence the results of risk assessment directly, but will be required down the track in adaptation planning, for example as a starting point for detailed cost benefit analysis in Step 4 of *C-CADS*. If adequate information is not available for quantification, the assessment can still proceed using qualitative information.

2.4 Are there any risk management strategies in place to tackle any future occurrence of that risk?

If system components have suffered some degree of consequence in the past, then you should ascertain whether there are any risk management strategies in place, and their adequacy. This will allow you to understand the residual risk of the system (see below).

2.5 Understand and identify residual risk of a given system (i.e. risk that remains even after putting a risk management strategy in place).

According to AS/NZS-ISO31000 (2009), residual risk is 'the risk remaining after risk treatment'. Residual climate risks are the risks that the system faces today regardless of future climate change. The information gathered in Sections 2.3 and 2.4 will allow identification of any residual risk for your business.

Step 3: Identify your future climate change risk

3.1 Identify relevant climate change and sea-level rise projections for your area and assess further data needs.

The first and second-pass assessments identified available climate change and sea level projections for your area. In the third-pass assessment, these can be used again if they are at a resolution sufficient for the biophysical models that the detailed hazard studies will use.

In order to develop and run a biophysical model (e.g. sediment dynamics model, hydrodynamic model), there are data requirements in addition to climate change information. For example, a hydrodynamic model to investigate inundation risk may require a digital elevation model (DEM), bathymetry data, tidal records, wave data etc., depending on the type of model to be used. For more information on data requirement in models used in erosion and inundation studies see *Modelling tools for risk assessment*. The *Information Manual 3: Available datasets* provides lists of available datasets and suggestions for their use. Section 6.1 of the information manual provides a checklist on establishing data needs and carrying out a gap audit. Figure 2 provides a framework to explore existing data and information availability and decide whether more detailed data will result in better decision making.

3.2 For hazards shortlisted in the second-pass assessment, commission detailed studies to identify the exact nature, rate and extent of identified risks under future climate and sea level change.

In the third-pass assessment you will need to commission a detailed site-specific study to understand the exact nature, rate and extent of the identified risks. CoastAdapt provides a *guide to select appropriate scale for hazard mapping*, which highlights the processes and data requirements for a site specific hazard study (see table 2 of the *hazard mapping guide*). Your exploration of available datasets and data requirements will help you to clearly scope the study and prepare a budget. It is important that the purpose of the study and intended use of results are conveyed clearly to the consultants as that will help consultants in the design of the technical details of the study and selection of appropriate models to best suit your intended purpose. CoastAdapt provides more information on *Working with consultants* and *Checklist for engaging with consultants*.

One of the main purposes of a third-pass risk assessment is to scope the projected rates of future change, together with the uncertainties involved, and understand the extent of the associated impacts. The commissioned studies should aim to address these issues.

3.3 Use the output of these detailed studies to identify areas/systems/assets at risk

Hazard studies often provide information on at-risk hotspots. Using that information, list the systems/areas/assets that may be at risk under future climate change and sea level rise.

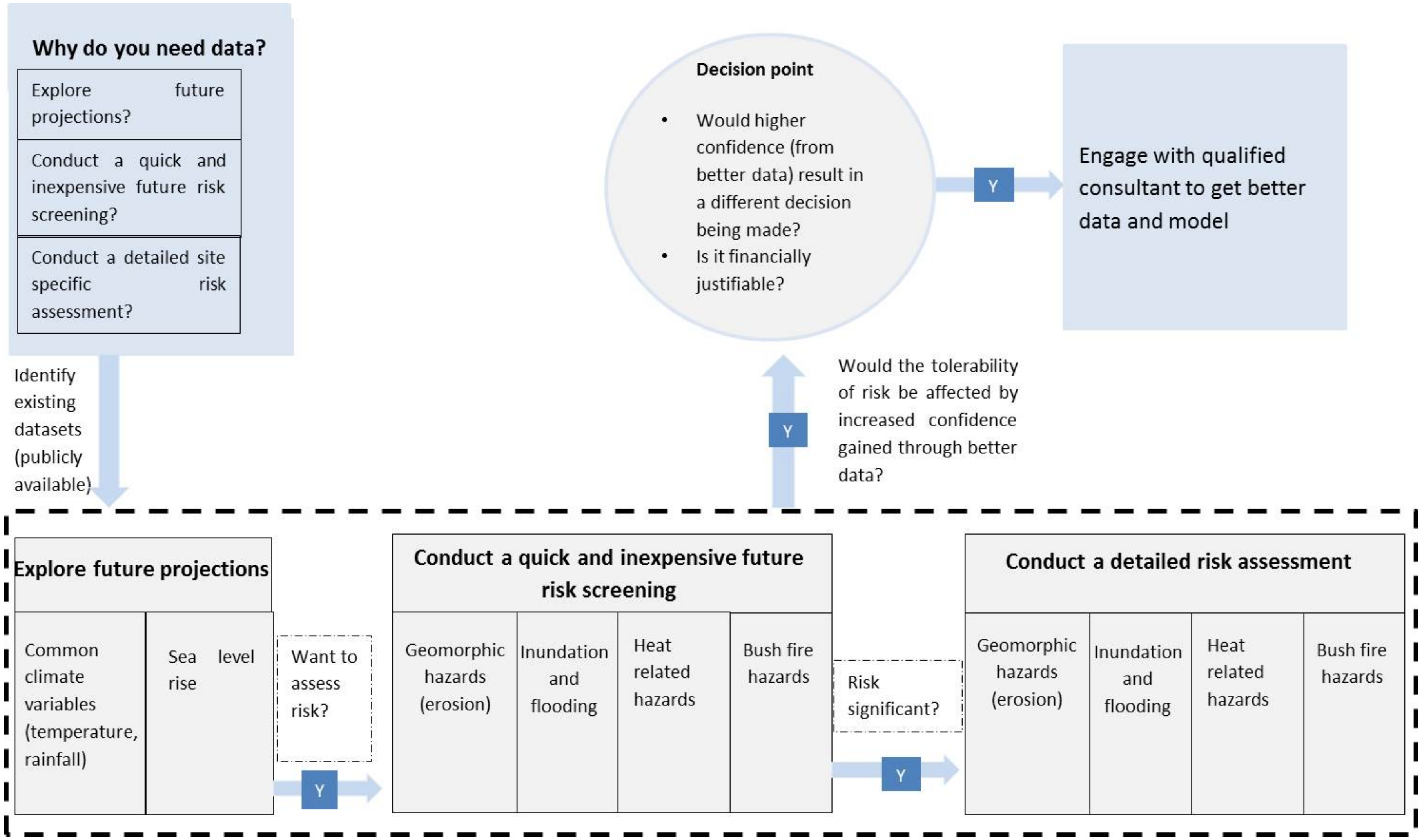

Figure 2: Framework for assessing detailed data need. Source NCCARF, adapted from National Emergency Management Committee 2010.

3.4 Understand how sensitive the areas/systems/assets are to the identified risk exposures.

The detailed modelling carried out in the commissioned hazard study should have identified important information such as when, under different climate change and sea-level rise scenarios, risks will cross tolerable limits and require action. This will indicate the sensitivity of the system to change. For example, an erosion study may determine the potential rate of erosion under a given sea level rise scenario, and the output of the study may show hazard lines for different time frames under that scenario. Change of the location of the hazard line over time will give an indication of how sensitive that particular site is to future sea level rise. In general, the more sensitive a system is to climate change, the more likely it is to experience adverse impacts from future changes, i.e. it is more vulnerable.

Understanding sensitivity requires understanding of how projected changes in climate can impact areas/systems/assets. Considering one component (that you have identified as exposed in Section 3.3) at a time and using study results from Section 3.2, identify how projected climate changes may impact it. If you find that projected changes can impact the performance of a component then you should consider that component as sensitive to climate change impacts. While doing this, also consider whether your component is under current stress or not (residual risk).

It is useful to consider how critical the service is that your area/system/asset provides. A water pumping station that serves a hospital is generally more critical than a similar sized pump serving a few houses, so the consequence of failure of the former is more severe than failure of the latter.

Also consider primary and secondary impacts of a risk by identifying interdependencies among parts of your business or interdependencies of infrastructures that support business continuity. For example, infrastructure systems (water, electricity, transport, telecommunications etc.) are often interdependent and the performance of one system (e.g. electricity) can affect others (e.g. water supply, telecommunications etc.). These interdependencies may only become clear when an extreme event occurs. The more your at-risk area/system/asset is dependent on other components, the more sensitive it is to future climatic change.

Using this information and some simple scales (e.g. high, medium, low) you should qualitatively rate the sensitivity of your area/system/asset. This will help to determine vulnerabilities in later steps.

There are some national guidelines that can be used to understand the climate change sensitivity of your systems. For example, the Australian Rainfall and Runoff (2016) is a national guideline that provides information on understanding climate change sensitivity of infrastructure to flooding. Chapter 6 of Book 1 of this document highlights climate change considerations that need to be taken into account when estimating flood risk to new or existing infrastructure.

3.5 Explore and understand the capacity of area/system/assets or the parent organisation to respond to any future exposures.

The next step is to think about the ability of the area/system/assets, or the parent organisation, to accommodate future impacts. Answering some of the following questions can be useful in this regard.

Q: To what extent are the physical characteristics of your system able to accommodate changes in climate at minimum disruption or cost?

For example, if you are assessing the capacity of an at-risk road to deal with an increased height of storm inundation, then you should consider factors such as its current height above mean sea level, the presence of any protective measures like a sea wall etc.

Q: What is the capacity of your organisation (or community) to deal with the impacts?

Are there any specific barriers (e.g. legal, policy, design standards, financial) that the organisation may face while addressing any climate change impact in future? For example, in assessing the capacity of an at-risk road to deal with an increased height of storm inundation, consider your organisational capacity to deal with such an event (e.g. possibility of diverting traffic, availability of emergency workers, capacity to coordinate with other agencies during the event etc.). If any disruption can flow on to impact users (for example, surrounding communities) then the capacity of the users to deal with service disruption should be evaluated.

Q: Is your system already able to accommodate changes in climate?

Consider whether your system is already designed to accommodate some degree of climate change (flexibility). Examples of coastal systems that are flexible to change include: animal or plant communities that are able to move easily or modify their behaviour in response to external changes, and infrastructure that is designed to accommodate a range of future climate conditions such as a water supply system that has been expanded with reclaimed water.

By exploring the answers to these questions you can qualitatively determine the adaptive capacity of your system components. These can be qualitatively rated using simple scales (e.g. high, medium, low).

3.6 Using information generated above determine the vulnerability of your system.

The findings of the previous two sections (Sections 3.4 and 3.5) can be used to rate the vulnerability of systems/areas/assets. Appendix Table A-5 shows one example of scales that can be used. For example, if the sensitivity of your system component is medium and adaptive capacity is low then its vulnerability is high. Figure 3 shows an example of vulnerability rating using the *CoastAdapt risk assessment templates*.

Systems at risk	Past or existing risk	Projected future change of climate variables related to this risk	Impact of the projected changes on the risk	Consequence of the possible impact	Sensitivity of your system to future risk	Rate the sensitivity	Adaptive capacity	Rate the adaptive capacity	Vulnerability Rating
e.g. storm water management	e.g. Sewer overflow during heavy rainfall	e.g. Precipitation may increase in future	e.g. more localised flooding	e.g. 1. Considerable impact upon access to community assets. 2. Some impact upon private property.	e.g. existing storm water management system has some degree of sensitivity to future precipitation change	Medium	e.g. Possible to upgrade the system but this option is costly;	Low	High

Figure 3: Example of vulnerability assessment using CoastAdapt.

Step 4: Analyse and evaluate risk

Previous steps have established the climate change impacts on your systems/areas/assets, their climate sensitivity, capacity to adapt to any climate change and their vulnerability rating. This should give you a good idea about the possible consequences of your climate change risks. This step qualitatively rates those consequences to understand which system components are more at risk than others. Along with the vulnerability ratings this will help to prioritise risks.

Where possible, you should use your existing organisational criteria and their associated scales (consequence and likelihood) to evaluate risks. This should be agreed with stakeholders and any adjustments can be made accordingly. However, if existing scales do not relate well to climate risks, you may chose example scales provided in the Appendix (Standards Australia 2013, Standards Australia and Standards New Zealand 2009, Australian Greenhouse Office 2006, NSW Office of Environment and Heritage 2011, Snover et al. 2007). These example scales are also used in the CoastAdapt *Risk assessment templates*.

4.1 Identify your risk evaluation criteria (e.g. maintain public infrastructure, protect private properties, minimise impact on environment, ensure business continuity etc.)

Climate change risks need to be evaluated against some criteria. In general, these criteria should be based on the objectives of the risk assessment (defined in Step 1). Selection of criteria also needs to address long-term corporate objectives. For example, if you are a coastal local council and want to assess how climate change and sea level may affect broader issues of your council such as public safety, the local economy and growth, community and lifestyle etc. then these should be your risk evaluation criteria.

4.2 Adopt scales and rate risk consequence and likelihood

Once the risk evaluation criteria are established, take one risk at a time and, using the consequence information developed in Step 3, rate how much each criterion will be affected by the perceived consequence of that risk. This can be achieved by using your chosen consequence scale. Similarly, you also need to describe how likely a given consequence is to happen. This can be achieved by using your chosen likelihood scale. Here, likelihood refers to the likelihood of a given hazard under the chosen climate change scenario. In other words, the likelihood of the risk is contingent on this scenario occurring. Repeat this rating of consequence and likelihood for each risk evaluation criteria.

4.3 Adopt a risk rating scale (e.g. high, medium, low etc.) and rate the risks.

Risk rating scales are qualitative descriptions of the severity of risks. Severity is determined by the potential consequence of a future risk and the likelihood of that risk happening.

Take one risk at a time and use the information generated above to come up with a final risk rating. As an example, if a risk (e.g. destabilisation of foundation of a coastal infrastructure) arising from a hazard (e.g. increased erosion due to sea level rise) has a consequence rating of 'insignificant' and a likelihood rating of 'rare' then using the example risk rating table (Appendix Table A-4), the risk should have a 'low' rating.

4.4 Using the risk ratings along with vulnerability ratings (Step 3), identify the system components whose risk should be treated as a priority (e.g. high vulnerable-high risk).

The vulnerability (Step 3) and risk (Step 4) assessment for your system components can be used to prioritise your planning areas. System components that are at high risk and highly vulnerable should be prioritised. However, be mindful that risks change over time and new information may become available about climate change in your area over the years. Therefore it is important to periodically review your risks, especially those that are in the intermediate priority category (Table 1).

Table 1: Example planning prioritisation matrix (hot-spots).

	Low Risk	High Risk
Low vulnerability	**Least priority**	**Intermediate priority**
High vulnerability	**Intermediate priority**	**Top priority**

Where to go from here

Outputs as well as information generated as part of a third-pass assessment provide the basis for making critical adaptation decisions about a specific project, or system. Hazard studies conducted as part of the assessment should indicate, for a specific climate change and sea-level rise scenario, when the risk will pass a tolerable limit and implementation of your planned action will be necessary. The uncertainties in projections of future climate change are such that it is impossible to time this precisely. To overcome this uncertainty, the adaptation pathways approach allows you to set trigger points which are event dependent rather than time dependent (see *Adaptation pathways* for more detail).

Exploring the vulnerability of your system should have provided sufficient information on organizational capacity to tackle identified risks as well as vulnerabilities and sensitivities in the system. You should now be able to prioritise which of the risks should be treated earlier than the rest. Following the *C-CADS* decision support system will allow you to identify specific risk mitigation options, evaluate their costs and build and test an implementation plan.

References

AGO (Australian Greenhouse Office), 2006: Climate change impacts and risk management: A guide for business and government. Prepared for the Australian Greenhouse Office, Department of Environment and Heritage by Broadleaf Capital International and Marsden Jacob Associates. Accessed 15 June 2016. [Available online at https://www.environment.gov.au/system/files/resources/21c04298-db93-47a6-a6b0-eaaaae9ef8e4/files/risk-management.pdf].

Australian Rainfall and Runoff, 2016: A guide to flood estimation, Chapter 6 of book 1. Accessed 17 January 2017 [Available online at http://book.arr.org.au.s3-website-ap-southeast-2.amazonaws.com/]

National Emergency Management Committee (2010), 'National Emergency Risk Assessment Guidelines', Tasmanian State Emergency Service, Hobart. Accessed 20 April 2017 [Available at https://www.safetyrisk.net/wp-content/uploads/downloads/2010/06/National-Emergency-Risk-Assessment-Guidelines.pdf].

NSW Office of Environment and Heritage, 2011: Guide to climate change risk assessment for NSW local government. Accessed 15 June 2016. [Available online at https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwitwr3E16nNAhUQA1IKHctCAcoQFggdMAA&url=http%3A%2F%2Fwww.climatechange.environment.nsw.gov.au%2F~%2Fmedia%2FCB26EC0A30844A318E33A243FA8CA283.ashx&usg=AFQjCNHuz0m0OvWTYgod8j2QzH_U_Lxm3w&sig2=4jreuMvzH6tiXmGiXt8Bwg].

Standards Australia, 2013: AS5334: Australian Standard for Climate Change Adaptation for settlements and infrastructure – A risk based approach. Standards Australia Limited, Sydney, Australia.

Standards Australia, and Standards New Zealand, 2009: AS/NZS-ISO31000: Risk Management Principles and Guidelines. Standards Australia International.

Snover, A., Binder, L., Kay, J., Sims, R., Lopez, J., Willmott, E., Strickler, A., 2007: Preparing for climate change: a guidebook for local, regional, and state governments. Environmental Health Perspectives, 117(4), 617-623. Accessed 15 June 2016 [Available at http://www.ccap.org/docs/resources/442/King_County_Global_Warming_Adaptation_Guidebook.pdf].

Appendix

Table A-1: Example of risk evaluation/success criteria (adopted from AGO 2006).

Sector	Example of evaluation/success criteria
Local government authorities	• Maintain public safety • Protect and enhance the local economy • Protect existing community structures and the lifestyle enjoyed by the people of the region • Sustain and enhance the physical and natural environment • Ensure sound public administration and governance
Public utility	• Maintain service quality • Ensure reliable service delivery • Manage interaction with other providers to achieve cost-effective operation • Ensure that community and regulatory standards of administration are met • Maintain and strengthen community confidence in the organisation
A business	• Build shareholder value • Achieve planned growth • Protect the supply chain • Maintain required human resources • Ensure regulatory and legislative compliance

Table A-2: Example of consequence scale.

	Criteria-1 Assets that are owned by the organisation assessing risk	Criteria-2 Community asset (infrastructure and services)	Criteria-3 Environmental assets	Criteria-4 Business continuity (capacity of the organization to manage a disruption)
Catastrophic	Asset(s) completely damaged and/or large scale engineering works required for reinstating.	Community assets and private properties completely damaged with irreversible loss	Irreversible loss of environmental assets	Significant disruption in business operation (virtually dysfunctional)
Major	Extensive structural damage to the asset(s) requiring significant engineering stabilisation work. Major disruption in the asset's service	Extensive damage to community assets with wide spread impacts. Long-term loss of private property	Extensive damage to environmental assets with long-term effects and that can have impact in local economy and life style. High cost involve to recover using management efforts	Major disruption in business operation with significant loss of revenue and market reputation
Moderate	Moderate damage to some part of the structure of the asset(s) and require large engineering stabilisation work. Moderate disruption in the asset's service	Considerable impact upon access to community assets. Major long-term impact upon private property.	Considerable impact on environment but with no long-term effects and can be recovered with moderate management efforts	Considerable impact in business operation with loss of revenue
Minor	Limited damage to some part of the asset(s) and require some small scale stabilisation work resulting in minor service disruption	Minor short-term impacts (mainly reversible) on community assets and services. Minor long-term impacts to private property.	Limited impact on the environment but can be recovered using minimum management efforts	Minor impact in business operation as disruption mostly can be managed through standby or alternate options. However, some loss of revenue or cost involved
Insignificant	Little disruption in service but no structural damage to the asset(s)	Little disruption of non-critical community assets	little impact on environment and recovery occurs without management efforts	Little impact in business operation.
No risk	No assets are at risk	No community assets and/or private property are at risk	No environmental assets are at risk	No impact on business operation

Table A-3: Example likelihood scale (adapted from AGO, 2006).

Rating	Recurrent risk	Single event
Almost certain	Could occur several times per year	More likely than not: probability greater than 50%
Likely	May arise about once per year	As likely as not: 50/50 chance
Possible	May arise about once in 10 years	Less likely than not but still appreciable: probability less than 50% but still quite high
Unlikely	May arise about once in 25 years	Unlikely but not negligible: probability noticeably greater than zero
Rare	Unlikely during the next 25 years	Negligible: probability very small, less than zero

Table A-4: Example risk ratings scale (adapted from AGO, 2006).

Likelihood	Consequences				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	Medium
Rare	Low	Low	Low	Low	Medium

Table A-5: Example of a simple vulnerability rating scale (coloured cells show degree of vulnerability).

Adaptive capacity	Sensitivity		
	Low	**Medium**	**High**
High	Low	Low	Medium
Medium	Low	Medium	High
Low	Medium	High	Extreme

This Information Sheet was prepared by staff at NCCARF. Please cite as:

NCCARF, 2016: Guidance on undertaking a third-pass (detailed) risk assessment. CoastAdapt, National Climate Change Adaptation Research Facility, Gold Coast.