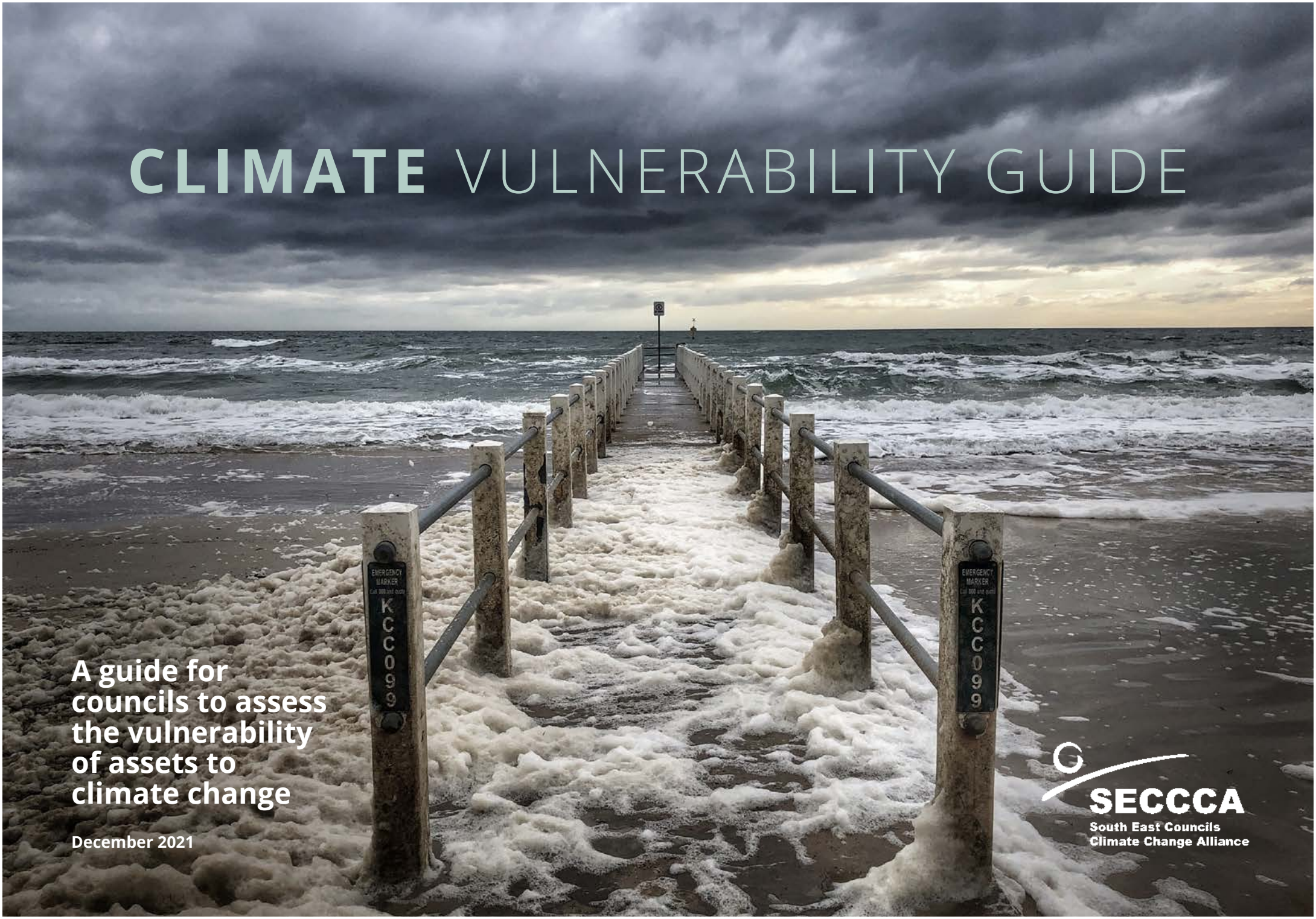
CLIMATE VULNERABILITY GUIDE



A guide for councils to assess the vulnerability of assets to climate change

December 2021

SECCCA
South East Councils Climate Change Alliance

ACKNOWLEDGEMENTS

SECCCA respectfully acknowledges the Traditional Owners of the land on which we work, and pays respect to their Elders, past, present and future.

SECCCA acknowledges the funding contributions of the 9 SECCCA members to develop and deliver the Asset Vulnerability Assessment (AVA) Project. These councils include:

- Bass Coast Shire Council
- Bayside City Council
- Cardinia Shire Council
- City of Casey
- Frankston City Council
- City of Greater Dandenong
- City of Kingston
- Mornington Peninsula Shire Council
- City of Port Phillip.

Also, SECCCA is grateful to the numerous council staff that contributed to the project and especially those that participated in the Project Control Group (PCG) and Project Working Group (PWG).

SECCCA would also like to acknowledge those organisations that participated in the Technical Reference Group (TRG): the Insurance Council of Australia (ICA), the Department of Environment, Land, Water and Planning (DELWP) and the Bass Coast Shire Council.

Funding provided to SECCCA for the evaluation of the project and guide development was from Melbourne's Climate Journey. Melbourne's Climate Journey is a community-led project supporting Greater Melbourne communities to adapt to a changing climate, supported by DELWP and funded through the *Supporting Our Regions to Adapt* program.

Finally, SECCCA would also like to acknowledge the expert consultants engaged to deliver the AVA project, Spatial Vision and Marsden Jacob Associates.

This guide was written and produced by Scientell Pty Ltd for SECCCA. Design by Soggy Brolly.

Cover photo: Kingston City Council (Tim Kenington)

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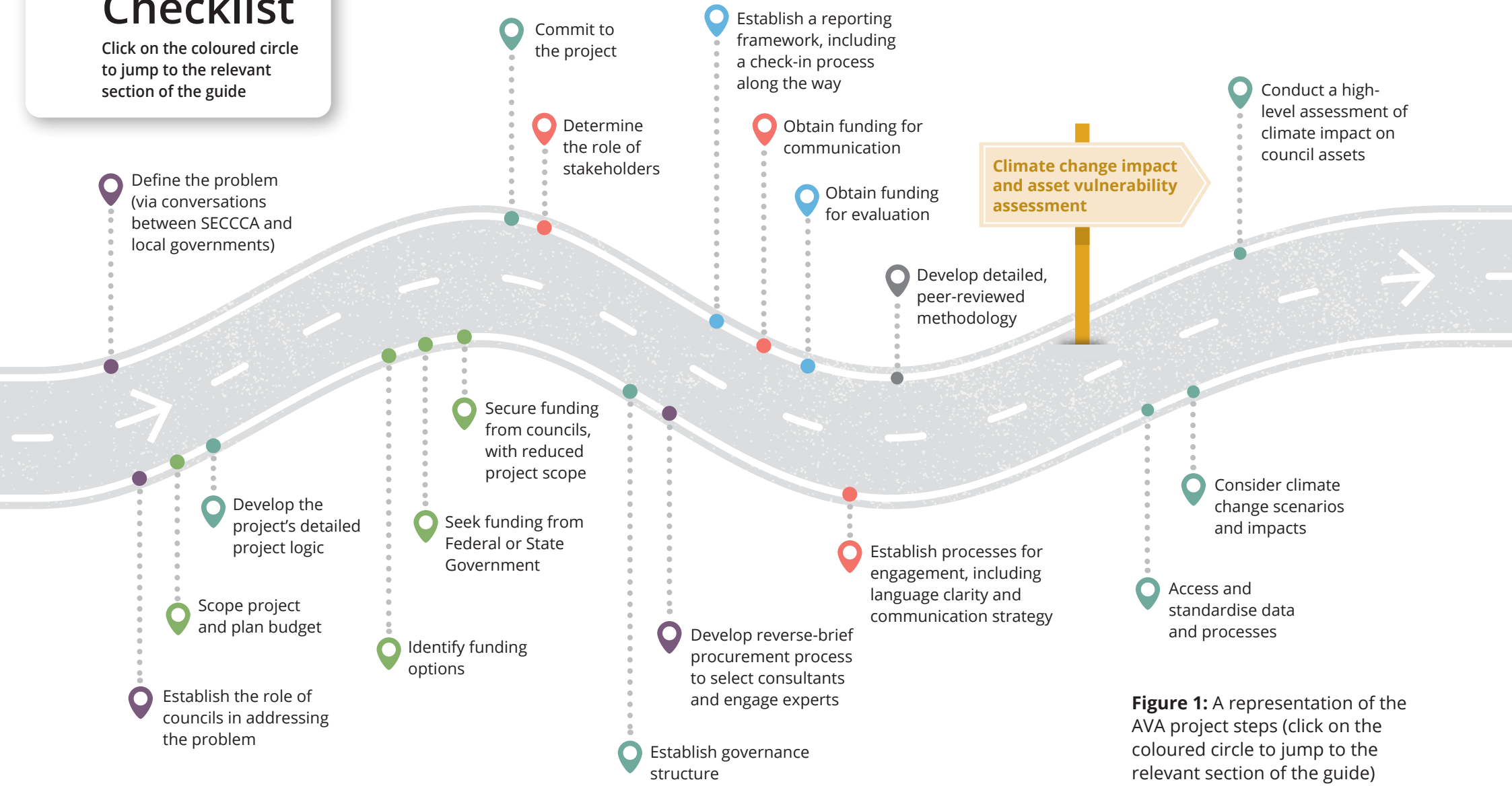
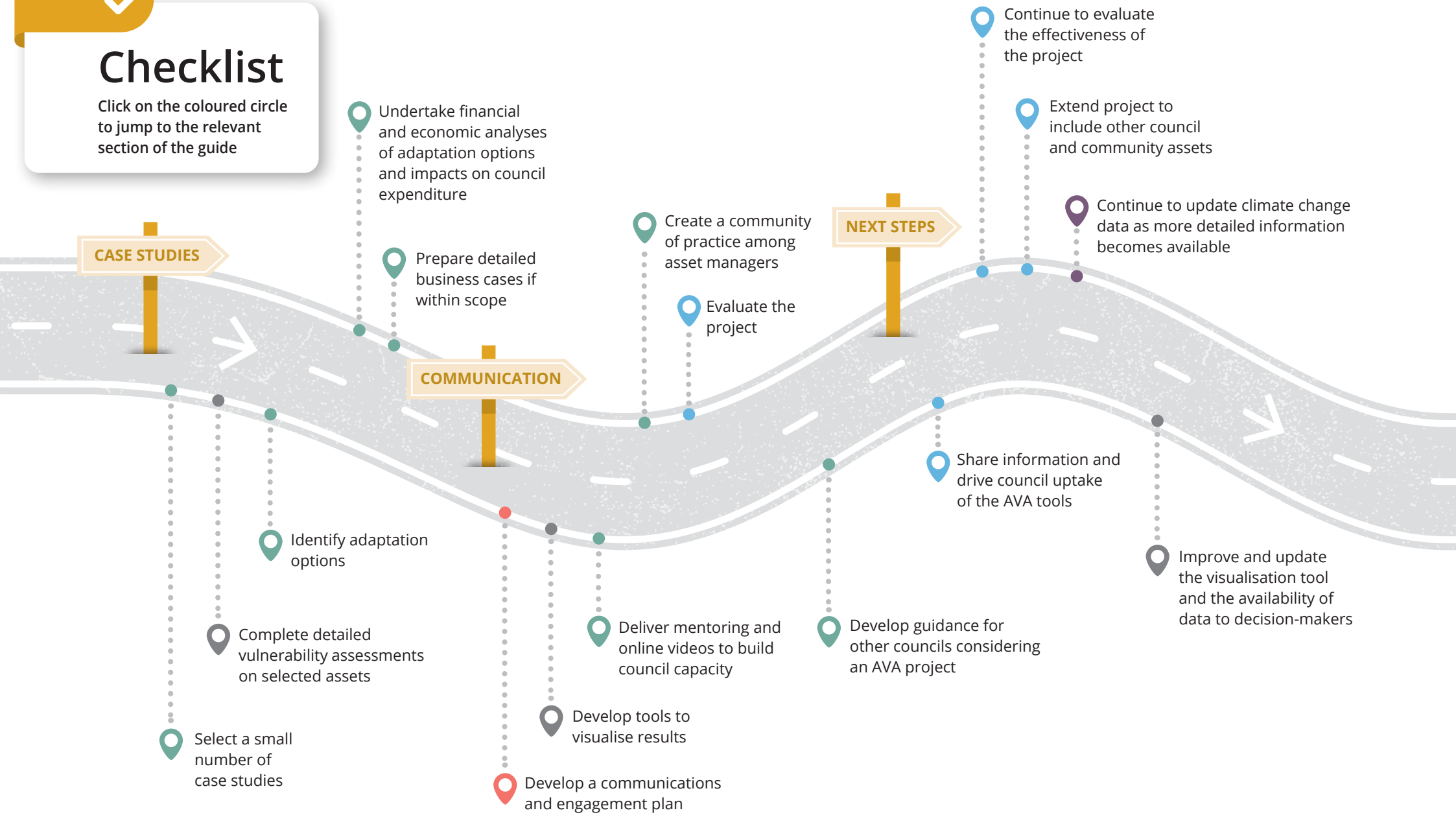


Figure 1: A representation of the AVA project steps (click on the coloured circle to jump to the relevant section of the guide)

Checklist

Click on the coloured circle to jump to the relevant section of the guide



Summary

This guide summarises the approach taken by the South East Councils Climate Change Alliance (SECCCA) to complete an Asset Vulnerability Assessment (AVA) project in 2021. The guide aims to help others understand the problem, step through how to do an AVA, provide lessons to help navigate potential pitfalls, and offer ideas on how to manage expectations and evaluate the process. It provides the critical components for achieving a successful asset vulnerability assessment.

Photo: Bass Coast Shire Council

With many council assets built with an expectation of lasting 20 to 80 years, councils must incorporate planning for a different future – one affected by a changing climate. Victoria's *Climate Change Act 2017*, the Local Government Act 2020, and other overarching governance principles create obligations for councils to understand the impact of climate change on their business. The Task Force on Climate-related Financial Disclosures guides disclosure of climate-related risk, and the Climate Measurement Standards Initiative helps asset owners in Australia understand financial disclosures relating to climate change. Within this policy, planning and regulatory environment, councils need information on the vulnerability of their assets to climate change.

SECCCA's AVA project assessed the vulnerability to climate change of roads, buildings and stormwater drains across 9 councils in southeast Melbourne. The most important needs and short-term outcomes from the AVA project were a regional climate change impact assessment; a vulnerability assessment of council roads, drains and buildings; an AVA methodology; the financial and economic impact of different adaptation options; capacity building and mentoring; and ongoing access to a visualisation tool.

The AVA tool provides participating councils with a high-level assessment of how climate change will affect council assets, and (for selected case studies) the related impacts on council expenditure. This information can be used to inform decision-making and create prioritised, costed plans to make assets more resilient to climate change.

The project started with conversations between SECCCA and the participating local governments to develop a shared understanding of what would be needed. The project team planned a budget and identified funding options.

Funding by the participating councils was essential to the project and was provided by assets, sustainability, risk management, and finance departments, and council insurance providers.

SECCCA established a governance structure including a management committee, a project control group, a technical reference group and a project working group. An effective governance structure and a dedicated project manager were key to the success of the project. It was also important to establish processes and expectations for communication from the start of the project.

SECCCA conducted a comprehensive procurement process to select consultants Spatial Vision, in partnership with Marsden Jacob Associates, to deliver the project. With funding from DELWP, SECCCA appointed *Science into Action*, in partnership with Scientell, to evaluate the project and create communication material.

An important step at the start of the project was to develop the project's detailed approach: the 'project logic'. This process informed the reverse brief and guided the work throughout the project.

Photo: Bass Coast Shire Council

Data access and standardisation was a significant undertaking due to differences between councils' data, commercial confidentiality, and variation in data quality, format and completeness. Staff prioritising the required time, commitment from all key stakeholders, clear terms of reference for the project, and sound planning all contributed to overcoming barriers.

The consultant used a range of timescales for the projections (2030, 2050, 2070 and 2090, compared with 1981–2010), a range of emissions scenarios (low RCP 2.6, moderate RCP 4.5 and high RCP 8.5) and a suite of climate variables (maximum and minimum temperature, rainfall, and sea-level rise, and extremes including heatwaves and flooding) to examine the vulnerability of council assets. The results of the impact and vulnerability assessment were represented spatially using a GIS application (QGIS) to enable councils to view and work with the outcomes and continue to update data and asset information on an ongoing basis.

In addition, there was a more detailed vulnerability assessment undertaken for 3 case studies. The team ensured that at least one of the case studies was relevant to each participating council. The case studies identified financial and economic impacts of various adaptation options where possible, and how council expenditure is likely to be affected by climate change. The results will guide how councils can plan for, and reduce costs of, the changes through a range of adaptation options.

Photo: Cardinia Shire Council

The case studies provided the basis of mentoring sessions that developed council capability in planning for anticipated climate change and assessing adaptation options. They provided practical examples for future reference by councils when undertaking assessments of adaptation options.

An evaluator was embedded as an independent member of the project team to evaluate the project and report on recommendations for activities to maximise the value of the AVA project. A communicator worked with the team to develop a guide to provide clear and concise guidance for other institutions planning to embark on a similar journey on what worked, and what didn't.

Recognising that this project is the start of asset adaptation for some SECCCA councils, following the completion of the AVA project there are further activities needed to maximise the uptake and enable implementation of the project outputs.

LESSONS LEARNED

MANAGEMENT LESSONS

- An AVA tool will help you manage future risk
- AVA projects need council champions
- An AVA project will take longer than you think it will
- Scope creep needs to be managed
- Council officers need to be committed and have relevant expertise
- Contractors need to demonstrate the required competence
- Obtaining the funding is key, with the scope of project matched to available funding
- A reverse brief approach allowed the market to respond with up-to-date methodologies
- Allow time for considered decisions

GOVERNANCE LESSONS

- A lead entity and dedicated project manager are important
- A detailed project logic is required to guide the project
- Strong project management and governance are essential
- The PCG needs to constantly be considering the whole of the project, including the next steps, not just the current point
- Explain the project's importance to council decision-makers from the start
- An AVA project is just the start

DATA LESSONS

- Prepare for data to be disparate, unavailable, and requiring time to collate
- Not all climate data are freely available
- Investigate asset data gaps well before case study commencement
- Revise the schedule for ongoing asset data collation for future vulnerability assessments

COMMUNICATION LESSONS

- Communicate early and often: develop a communication and engagement plan early in the project
- Engagement and broad communication are essential
- Language clarity is fundamental
- Communicating about uncertainty and risk is essential
- Frame adaptation options as beneficial, as opposed to just cost minimisation
- Training and mentoring must be targeted to the needs of the council officers
- Evaluation is needed

Figure 2: Lessons learned

1 THE WHY

The South East Councils Climate Change Alliance (SECCCA) completed an Asset Vulnerability Assessment (AVA) project because council assets are becoming more affected by climate change. The impacts of climate change are costing councils more to maintain assets; they are costing more to insure, and are damaged more frequently, which means services need to be suspended or relocated. This disadvantages communities.

Forward planning requires councils to think ahead and plan budgets (in most cases) 10 years in advance. With many council assets being built with an expectation of lasting 20 to 80 years, councils must incorporate planning for a different future – one affected by a changing climate.

Photo: Frankston City Council

1.1. Introduction to the guide

This guide has been designed to:

- share the journey that SECCCA went through
- help you understand the problem you are trying to address
- step you through how you could do an AVA
- provide lessons to help you navigate potential pitfalls
- offer ideas on how to manage expectations and evaluate the process.

In 2021, SECCCA completed an AVA project, which assessed at a high level the vulnerability to climate change of roads, buildings, stormwater drains, and other assets across 9 councils in southeast Melbourne, Victoria.

The project journey began several years earlier. This document tells the story of the project development to help other councils and similar organisations investigate the potential vulnerability and risks of climate change to their assets. It represents a climate vulnerability guide for councils to assess the vulnerability of assets to climate change.

An asset vulnerability assessment study is a complex process, particularly when involving a network of organisations across a region. To be meaningful for each council, a level of detail and granularity is required in the data and results to provide confidence in decisions about the future. This guide outlines an AVA project's planning and design, decisions, governance and people to involve, data and technical requirements, assumptions and questions to ask, organisational practices and processes, external influences, evaluation, and what needs to be done in a complex organisational environment to make such a project work.

The audience for this guide is primarily local governments embarking on an asset vulnerability assessment process. This includes decision-makers within councils (including Councillors, CEOs and CFOs), staff with operational responsibilities, and others who need to consider long-term investment to address climate change.

The guide uses non-technical language to provide clear and concise guidance for institutions – local councils in particular – planning to embark on a similar journey.

It provides lessons learned, what worked, and what didn't. It highlights the importance of such a project for asset planning, to give staff in councils and other organisations the confidence to drive action, build capability, skills and knowledge, and make recommendations to decision-makers in order to achieve the goals of a vulnerability assessment.

In summary, if the AVA project is the feature film, this guide is the 'making of' documentary – the critical components and recipe for achieving a successful asset vulnerability assessment.

KEY MESSAGE

This document is a climate vulnerability guide for councils to assess the vulnerability of assets to climate change.

1.2. Introduction to the AVA project

SECCCA is a network of 9 local councils located in the south-east of Melbourne (Figure 3). It is one of 7 Victorian Greenhouse Alliances that advocate, educate and deliver projects to reduce greenhouse gas emissions and build resilience to climate change. For a tiny operation, SECCCA adds a lot of value. SECCCA supports communities, businesses and industries in the region to address, respond to, and adapt to the impacts of climate change. Member councils include the Shires of Bass Coast, Cardinia and Mornington Peninsula, and Cities of Bayside, Casey, Frankston, Greater Dandenong, Kingston, and Port Phillip. The network of councils collaborates with all levels of government to deliver regional climate change projects that benefit over 1 million residents (SECCCA, 2021a).

SECCCA's AVA project developed a tool that provides participating councils with a high-level assessment of how climate change will affect council buildings, roads, drainage and other assets, and (for selected case studies) the related impacts on council expenditure. The tool shows how assets will be affected by various natural hazards under different climate scenarios, attributing a vulnerability rating to the assets and the project's associated case studies, and identifying adaptation actions that may increase asset resilience. This information can then be used to inform decision-making and create prioritised, costed plans to make assets more resilient to climate change.

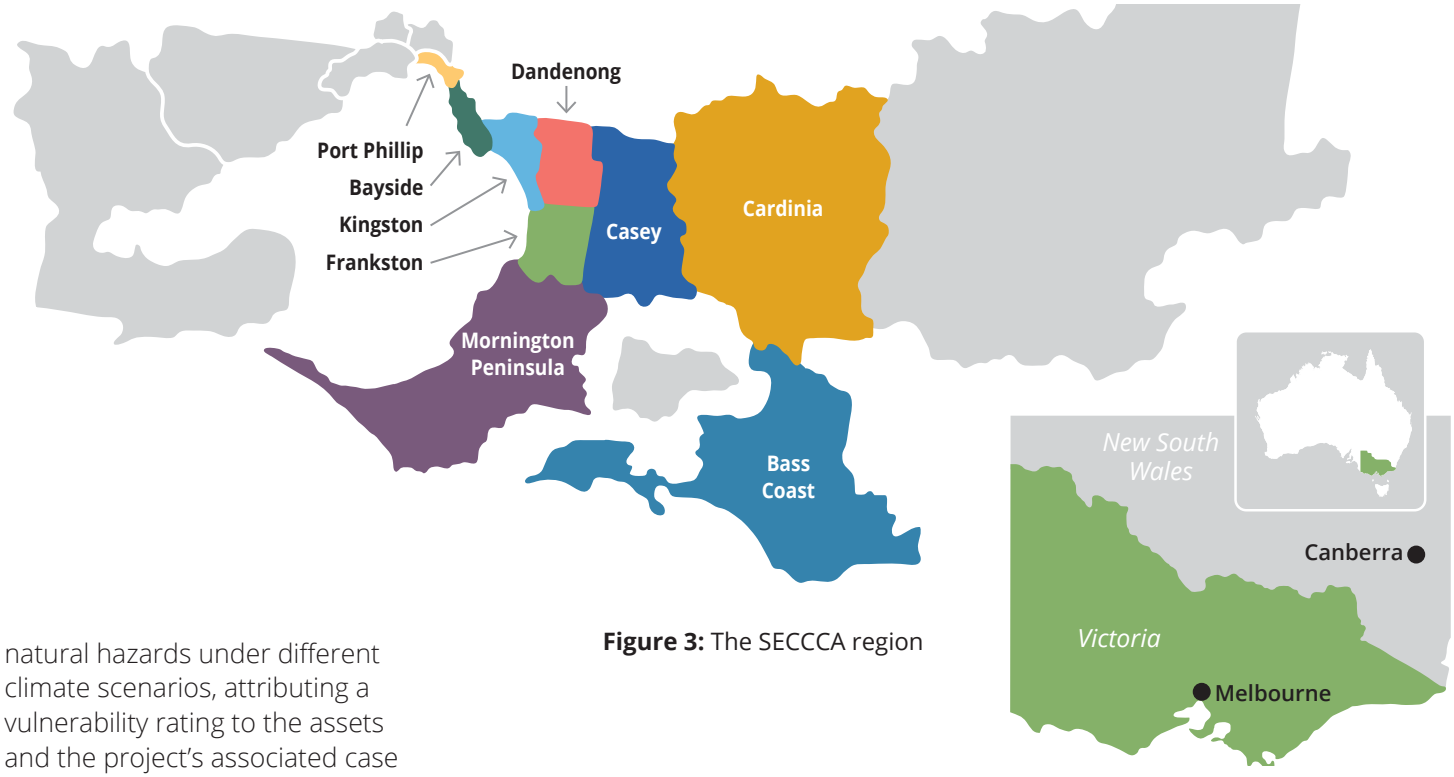


Figure 3: The SECCCA region

KEY MESSAGE

The South East Councils Climate Change Alliance covers 9 Councils in and around Melbourne's southeast.

Ensuring assets and service delivery are more resilient to climate change is a key part of council planning. Information on potential future asset vulnerability is essential to enable strategic asset management and financial planning by councils, and to ensure appropriate planning and maintenance of assets into the future (SECCCA 2021b). SECCCA developed the AVA project in response to member councils requesting help in gathering data to enable more informed decisions about future budget and resourcing needs, and to create prioritised, costed asset and service delivery plans. Before the project began, councils had varying levels of understanding about how climate change is likely to affect assets and service delivery.

Consultants on the AVA project developed tools to help councils demonstrate how council buildings, drainage and local road assets will be affected by various climate scenarios, attributing a vulnerability rating to

the assets. The project's case studies identified potential adaptation actions to increase asset resilience, and potential changes to the delivery of services required to adapt to climate extremes. It also examined how climate change will affect expenditure associated with council assets by calculating the cost of action and the cost of inaction (such as higher insurance premiums and maintenance and repair costs), and how income-generating actions may be affected (such as a reduction in parking income due to permanently inundated coastal car parks).

The project started with conversations between SECCCA and the participating local governments to develop a shared understanding of what would be needed (see Figure 4). The project team planned a budget and identified funding options (see section 1.3. Funding the project).

With funding secured, SECCCA established a governance structure including a project control group (PCG), a project working group (PWG), and a technical reference group (TRG) to identify the objectives and outcomes at the start of the project, and provide advice, guidance and decisions throughout the project (see section 4.2. How the project was managed).

KEY MESSAGE

Ensuring assets and service delivery are more resilient to climate change is a key part of council planning.

SECCCA conducted a comprehensive procurement process to select consultants to deliver the project, appointing Spatial Vision, in partnership with Marsden Jacob Associates. With funding from DELWP, SECCCA appointed *Science into Action*, in partnership with Scientell, to evaluate the project and to create communication material to share outcomes with other Victorian councils and organisations (specifically, this guide).

Figure 4: Keywords relating to the inception of this project, identified in a survey of project participants

1.3. Funding the project

Once the need for the project was identified and the budget scoped, SECCCA approached the Victorian Government for support. While recognising the merits of, and need for, such an asset vulnerability assessment at the local council level, the government could not provide funding. Hence self-funding by the councils was essential to the project, with SECCCA making a case to the participating councils that it was a significant, worthwhile project to fund.

Council funding was provided by assets, sustainability, risk management, and finance departments. Some funding came from council insurance providers due to the risks of climate change to budgets, assets, businesses and the community.

To justify spending council funds on the AVA (and hence not on other projects), it was important for teams in councils to understand the issues being faced due to climate change. Specifically, council practice is for 10-year budgets to be developed for major infrastructure. Taking into account future risks to assets in order to avoid poor decisions, mistakes and maladaptation is good practice.

Building on the core AVA project, SECCCA secured additional funding under the Victorian Government's Adaptation Planning Strategy. The Department of Environment, Land, Water and Planning (DELWP) provided funding for evaluation, documentation and sharing of the processes and approaches developed during the delivery of the project. The funding enabled an evaluation of the project and production of this guide to build local government capacity and help other Victorian councils undertake AVA projects themselves.

So, SECCCA councils paid for the AVA project and DELWP funded evaluation and production of this guide.

MANAGEMENT LESSON:

SCOPE CREEP NEEDS TO BE MANAGED

It needs to be clear what the AVA will deliver and what needs to be done after the results are available – it should be clear that such a project is the start of something, not the end. The AVA project included several potential and actual items of scope creep. Some were driven by external parties, some by internal interest, some by new knowledge, and some by opportunity. Each was dealt with on its merits using the decision principles outlined earlier. An opportunity-based scope creep that was discussed and decided against was adding the non-climatic stressor of population growth. The PCG followed a sound decision-making process: it sought advice, discussed risk and reward, discussed a future option to incorporate population growth later into project models, and made the decision not to expand the scope. Any additional project should have its own governance process, especially if it will exceed the timeline of the original project, so the project management groups can remain focused on the main project.

MANAGEMENT LESSON:

OBTAINING THE FUNDING IS KEY, WITH THE SCOPE OF PROJECT MATCHED TO AVAILABLE FUNDING

While council funding enabled more control over the project compared with a contracted, externally funded project, the amount of funding generated internally was not of the scale normally required for a comprehensive AVA. Increased funding could have enabled more to be done, such as extra case studies. Nonetheless, the AVA project provided useful information for the SECCCA region that can represent the basis for future, expanded activities at individual council level.

1.4. Intended outputs

The AVA project's purpose was to examine the vulnerability of council assets. The project was the start of detailed discussion about adaptation options at council level. It aimed to provide sufficient information for councils to develop climate change vulnerability assessments and adaptation options that can potentially be funded.

Questions that the project was designed to address are:

- how might more extreme weather events and sea-level rise impact a particular asset?
- how might the council's service delivery be impacted by and have to change, to adapt to future climate extremes?
- how much extra will it cost to maintain an asset?
- how much extra can councils expect to pay to respond to damages or make assets resilient?
- how might council income streams be impacted by climate change?

The priority project outcomes (the most important needs and short-term outcomes from the AVA project), in order of priority, were:

1. a regional climate change impact assessment
2. a vulnerability assessment of priority council assets: roads, drains and buildings
3. an AVA methodology: the process of how to develop adaptation options
4. the financial and economic impact of different adaptation options
5. capacity building and mentoring for asset representatives to use spatial data and financial assessments in council processes
6. ongoing access to a visualisation tool.

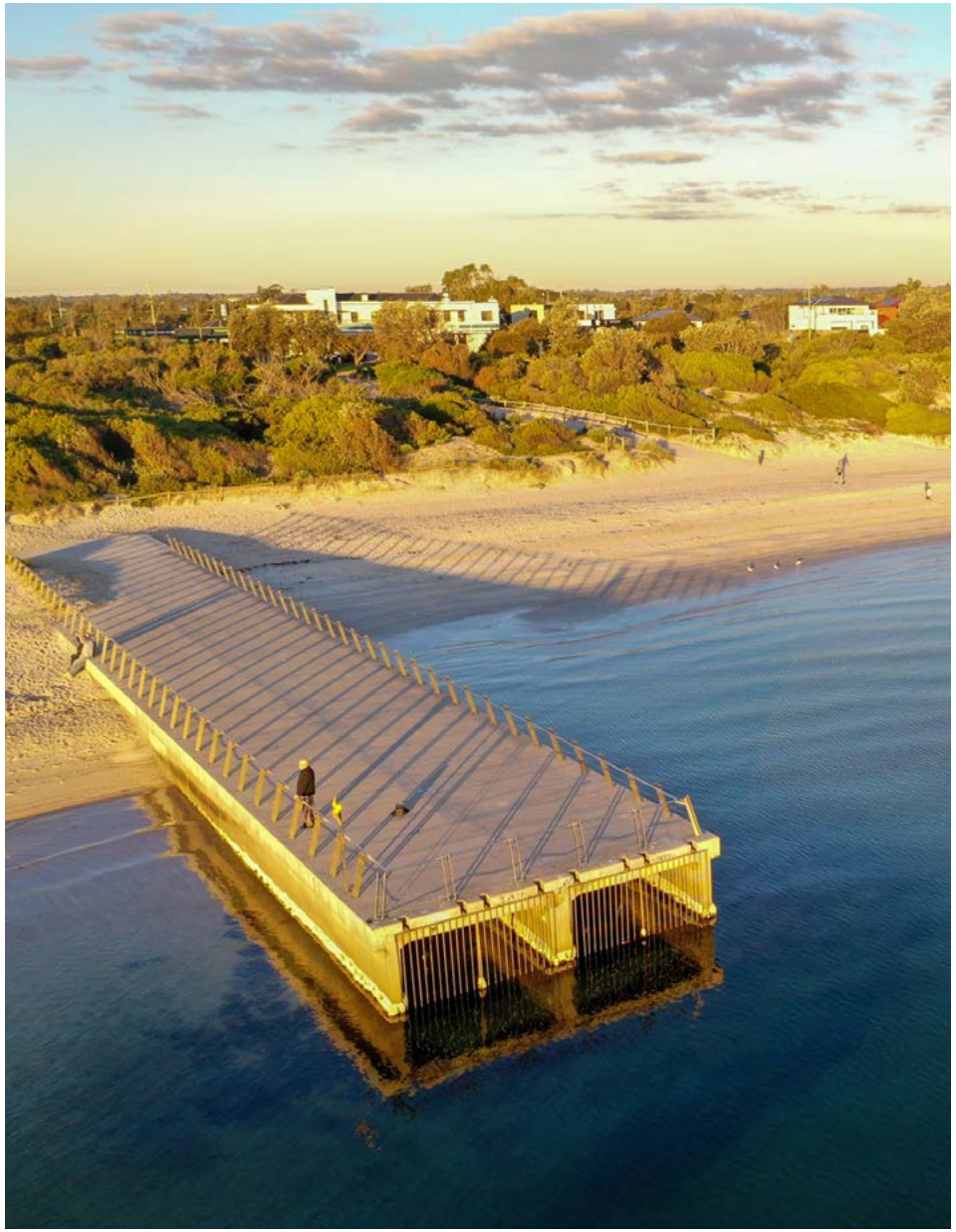


Photo: Frankston City Council

1.5. Barriers and enablers

The AVA project faced few barriers, and those that did arise were overcome through several enablers to ensure the commencement and eventual completion of the project. Staff prioritising the required time, commitment from all key stakeholders, clear terms of reference for the project, and sound planning all contributed to overcoming barriers.

FUNDING

A lack of significant funding was a key barrier, and SECCCA had to adjust expectations to fit the available budget. Failure to secure Federal or State Government funding required seeking it from the SECCCA councils, and reducing the number and scope of case studies.

Difficulties in securing funding for local governments to invest in infrastructure risk management is not unique to SECCCA. As government funding is difficult to access, the private sector may finance risk assessment projects.

'Green Capital' investors seek projects that address the need to increase climate change resilience and reduce risks to infrastructure, provided the investment is structured in a way that is attractive to investors (SECCCA and ICA 2021). Demonstrating how investment in understanding and reducing the vulnerability of infrastructure results in savings for the local government and the community can help attract government funding (see Box: Successful reduction of physical risk to infrastructure).

KEY MESSAGE

Demonstrating how investment in understanding and reducing the vulnerability of infrastructure results in savings for the local government and the community can help attract government funding.

SUCCESSFUL REDUCTION OF PHYSICAL RISK TO INFRASTRUCTURE

In June 2016, Launceston, Tasmania, experienced severe flooding. The Bushfire and Natural Hazards Cooperative Research Centre (BNH CRC) examined whether investing in a flood levee was worthwhile (SECCCA and ICA 2021).

BNH CRC (2017) showed that upgrading the levee system in 2014, for $58 million, resulted in avoided losses of about $216 million (had the original levees failed); that is, the levee upgrade prevented flood losses costing approximately 4 times the investment. Moreover, the levee upgrade brought additional intangible and indirect benefits to the community.

In their assessment of the Launceston levee upgrade, the BNH CRC included the following considerations:

- the avoided damage cost to Launceston during the June 2016 floods
- the number of people that would be displaced due to inundation of homes for flood events ranging from the 20 year Annual Recurrence Interval (ARI) up to the Probable Maximum Flood (PMF) and the expected time for them to return before and after the new mitigation works
- avoided residential and non-residential building damage for flood events ranging from the 20-year ARI up to the PMF
- the long-term cost to Launceston from flood hazard before the levee upgrade
- the long term cost to Launceston from flood hazard following the upgrade
- a cost-benefit analysis of the upgrade.

Photo: Frankston City Council

DATA

Data availability was another barrier, which was made more difficult through the combination of silos in councils and data differences between councils in a consortium.

There was potential risk in not being able to obtain data from asset teams. Some data were subject to commercial confidentiality. There were also difficulties with a variation in data quality, format and completeness. However, these issues were anticipated, so measures were enacted to avoid data availability being a barrier to the project progressing. These measures included varying how features (attributes) of assets were used and using several attributes for an assessment so as not to depend on a single feature of an asset, as well as considering the asset's context to its surrounding environment, and accounting for differing formats.

AWARENESS

Awareness, understanding, education and capacity in climate change science was a potential barrier. Some teams within councils are very familiar with planning based on climate scenarios, while others required help to understand climate-related risks and opportunities, and incorporating climate change information into decision-making.

Many people think only of mitigation and reducing emissions as the role of councils in addressing climate change. But councils also contribute to adaptation and hence require information, data and understanding for strategic adaptation decisions. Addressing adaptation doesn't mean avoiding emissions reduction: both types of responses are required by councils.

UNCERTAINTY

Decision-making based on future climate uncertainty is a capability issue for many asset managers.

Participating councils questioned how to bring the tools and data together to address their needs for making decisions about assets, liability and adaptation. In particular, there was concern about confusion arising from different climate scenarios (for example, finding that rainfall could increase or decrease by 20 per cent, or that models project a range of warming). Such uncertainty can be a barrier to decision-making at a local level, so capability needs to be built to help people understand how the variability of model outputs translates into decision-making for asset adaptation, and for which future to plan. However, it was recognised that uncertainty is inherent in the nature of future climate change, and that the project provided the best available information on which to base risk-management decisions and make a case for funding asset management, noting the uncertainty, as a start in the process of assessing vulnerability.

1.6. Further information

For more information about the SECCCA Asset Vulnerability Assessment project, including the SECCCA Asset Vulnerability Assessment Findings Report, Methods Report and Worked Examples Report, see:

Asset Vulnerability Assessment:
https:// www.seccca.org.au/
Asset Vulnerability Project

To discuss the project, please contact SECCCA at:

Email: enquiries@seccca.org.au

Photo: City of Port Phillip

2

THE BACKGROUND: Climate change in Victoria

Photo: Bass Coast Shire Council

2.1. Global, Australian and Victorian climate change

Human activities add to greenhouse gases in the air, influencing the global temperature and changing the global climate system. This leads to changed, uncertain and variable local weather impacts that are felt at the local scale.

The global concentration of atmospheric carbon dioxide has increased around 50 per cent since 1750, passing 410 parts per million (ppm) in 2019. This is much higher than the natural range of 172 to 300 ppm that existed before the industrial revolution. The world has warmed by 1.1 °C since 1850. Most of the hottest years on record have occurred in the 21st century: 2016 and 2019 were the world's warmest years on record, followed by 2020.

The increasing amounts of greenhouse gases have been the main cause of changes to the world's climate since the 1950s.

Australia has warmed by around 1.4 °C since 1910 when national records began. Australia's warmest year on record was 2019, followed by 2013, 2005, and 2020.

In Victoria, the temperature has increased by just over 1.0 °C since 1910, and the rate of warming has increased since 1960. The climate is drier than in previous decades, with average rainfall declining since the 1950s, especially in autumn (Figure 5). Mean sea level for Melbourne (recorded at Williamstown) has risen by approximately 2 mm per year since 1966 (see Appendix 1: Climate change in Victoria).

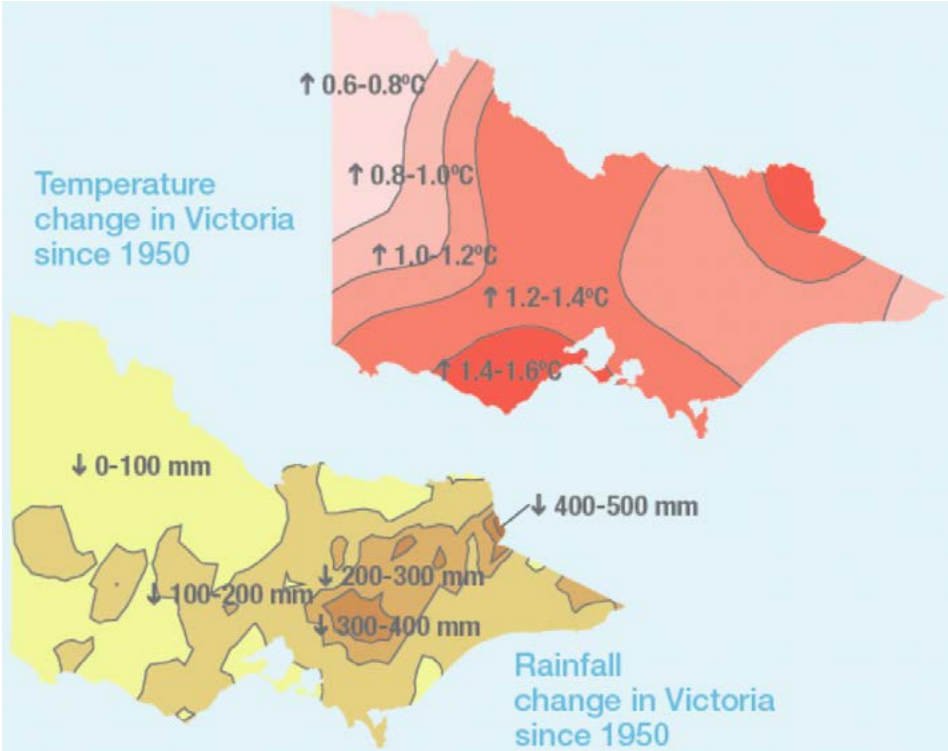


Figure 5: Victoria has warmed and dried since the 1950s (DELWP 2015)

KEY MESSAGE

Climate change is having, and will continue to have, significant impacts on marine life, habitats, ecosystems, landforms, culture, human health and infrastructure – with flow-on effects on society and the economy.

2.2. Climate modelling

Scientists use global climate models (GCMs) to study how the climate may respond to increasing levels of greenhouse gases. Global climate models show that, without significant reductions in greenhouse gas emissions, changes in climate will continue. Regardless of any actions to reduce greenhouse emissions, there will be impacts of climate change throughout this century, due to the long life of greenhouse gases in the atmosphere, and the changes already built into the system.

KEY MESSAGE

Regardless of any actions to reduce greenhouse emissions, there will be impacts of climate change throughout this century.

While greenhouse gases are already affecting the climate (and hence adaptation needs to occur now), the climate of the future will be determined by the amount of greenhouse gases and aerosols in the atmosphere.

The United Nations Intergovernmental Panel on Climate Change (IPCC) developed scenarios that describe plausible future greenhouse gas concentrations in the atmosphere. There are many possible futures, which were summarised as 4 main representative concentration pathways (RCPs). These range from RCP2.6 (where emissions of greenhouse gases are low following extensive global efforts to reduce emissions), to RCP8.5 (where there is little global action to reduce greenhouse gas emissions). In 2021, the IPCC Sixth Assessment Report used new socio-economic and technological descriptions, called shared socioeconomic pathways (SSPs).

As we can't be certain which pathway the world will follow, best practice science recommends that assessments of climate change impacts must consider 2 or more RCPs, the full range of projected changes for each emissions pathway, and natural climate variability when assessing the impacts of climate change.

2.3. Future climate

The world's environment, and how it supports us, will be challenged by dangerous changes if we don't keep global warming below 1.5 to 2 °C.

The IPCC projects a global warming increase by 2100 of between 1 and 5.7 °C (relative to the climate baseline period of 1986 to 2005), depending on the emission scenario.

Under a changing climate, Australia can expect continued warming, more extremely hot days, a decrease in rainfall across the south and east, more time in drought, increased fire risk, more intense rainfall events, and ongoing sea-level rise.

Similarly, Victoria will continue to become warmer and drier in the future. Rainfall will decrease in autumn, winter and spring, but extreme rainfall events are likely to be more intense. By the 2050s, if the current rate of global warming continues, Victoria's average annual temperature could rise by up to 2.4 °C and towns could experience twice the number of very hot days compared with the 1986–2005 average. By the 2090s, Victoria is projected to warm on average by 2.8 to 4.3 °C under a high emissions scenario (see Appendix 1: Climate change in Victoria).

Photo: Simon Torok

2.4. Adapting to the impacts of climate change

Climate change is having, and will continue to have, significant impacts on marine life, habitats, ecosystems, landforms, culture, human health and infrastructure (Figure 6). These have flow-on effects on society and the economy.

Climate adaptation can reduce the risks of damage caused by climate change; however, the success of adaptation measures decreases with increasing global warming.

Adaptation is not an alternative to reducing greenhouse gases (mitigation); we need to adapt to climate change while also undertaking mitigation efforts. Many of the projected impacts due to climate change (such as increased temperatures, higher sea levels, and decreased biodiversity) are already happening, so there are already changes that we must adapt to, as well as further inevitable changes.

See Appendix 1 for more information about observed climate change globally, in Australia, and in Victoria, details about future climate change and its impacts, and options for adaptation.

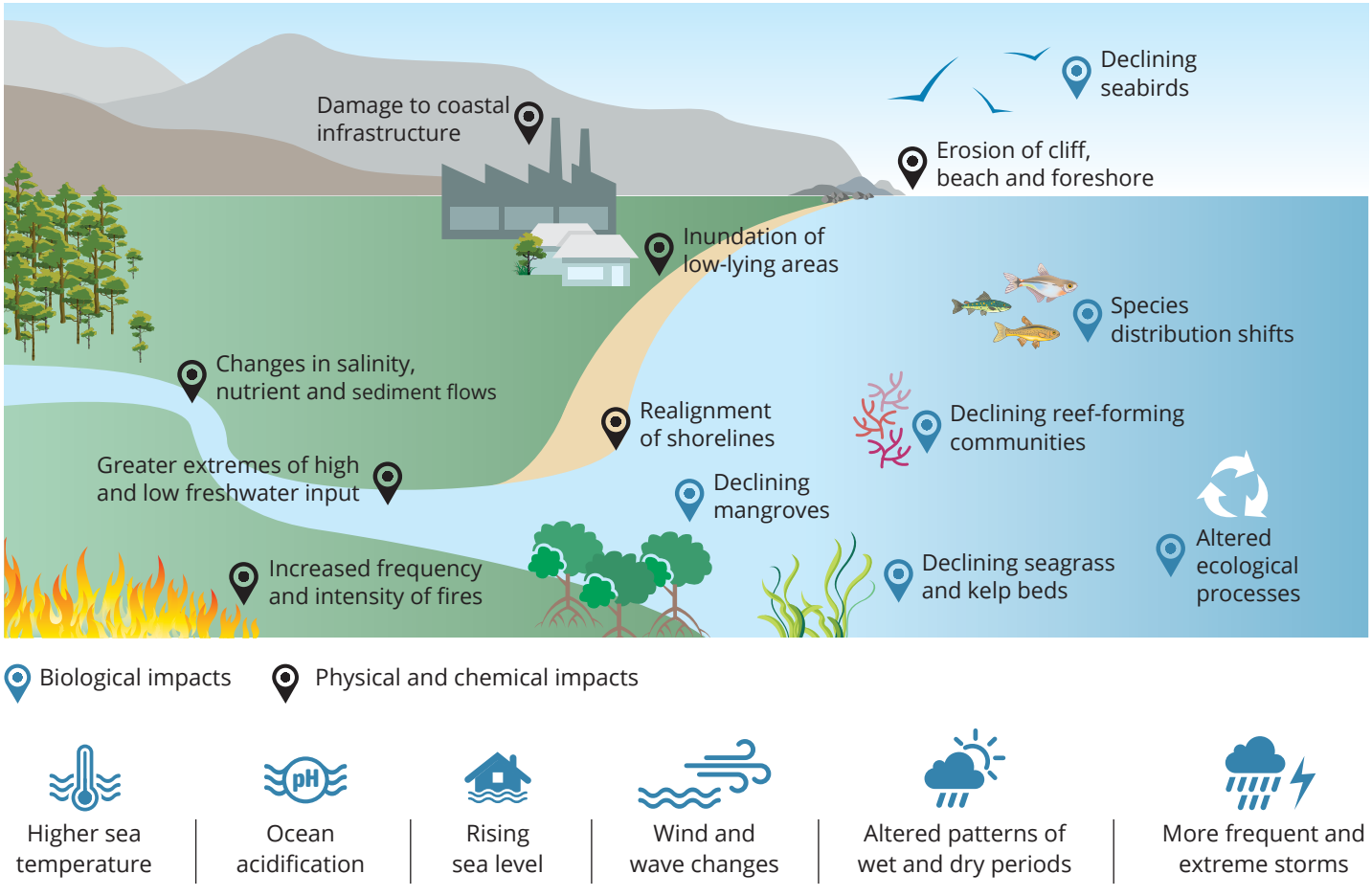


Figure 6: The likely impacts of climate change on Victoria's coastline (Victorian Coastal Council 2018)

KEY MESSAGE

Climate adaptation can reduce the risks of damage caused by climate change.

3 THE OPERATING ENVIRONMENT

Photo: Bass Coast Shire Council

3.1. Understanding the challenge

Councils assessing the vulnerability of their assets to climate change shouldn't underestimate the commitment and amount of work involved in taking on a similar task to the AVA project. Such a strategic undertaking aims to direct council plans for decades. It is in no way a simple tick-a-box exercise.

Commitment is required to stay the course. Those involved in the AVA project reported a need for persistence, tenacity, and vision to keep it going. The project's development took 2 years and required 9 local governments to commit to funding.

As well as understanding this challenge, councils initiating a vulnerability assessment project also need to understand the problem being addressed. The first step is to establish a clear need for the project by defining what the problem is: its nature, causes, links to climate change, and why existing strategies are failing to address it.

The next step is to determine why the council needs to address the problem (for example, due to future impacts on council resources, and failure of other agencies to provide a solution), and to identify and assess options to do so.

Understanding climate scenarios (see section 2.2. Climate modelling) is an important step in considering what is likely to happen in a council's region. For example, consideration should be given to what will happen when sea level or flood level rises to a certain height. Investigating what might happen under a particular scenario will help determine the vulnerability of assets.

Adaptation needs to be viewed as providing benefits, as well as reducing costs. Consideration should be given not only to avoided costs (achieved through adapting to avoid harm caused by climate change) but also to potential benefits (including opportunities identified through strategic planning).

Once the problem is defined, and the role of the council in addressing it is clear, a brief needs to be developed. For the AVA project, SECCCA undertook a reverse brief approach – that is, the outcome of the project was provided to potential suppliers for them to determine the best way of achieving it. This approach was a crucial element, as it led to the adopted project methodology, kept the project aligned to the outcomes SECCCA had sought, and produced a robust outcome. However, undertaking a reverse brief required technical capability to assess submitted proposals, and it was a lengthy and involved process from the initial call for consultants to their appointment and subsequent project commencement. This approach also led to a reduction in the scope of the project, as the initial list of planned outcomes could not be met within the established budget.

A very important step at the start of the project was to develop the project's detailed approach: the 'project logic' (Table 1). A lot of time and consideration went into what were the short, medium and long term outcomes of the project, the desired outputs, and the stakeholders. This very detailed process informed the reverse brief, and guided the work throughout the project.

GOVERNANCE LESSON:

EXPLAIN THE PROJECT'S IMPORTANCE TO COUNCIL DECISION-MAKERS FROM THE START

Consider how to clearly communicate the message internally about the importance of asset vulnerability assessment to key decision-makers across the organisation. The message should be about obtaining essential information on which to base decisions to protect the council's interests and deliver community services.

Asset Vulnerability Assessment Project – example project logic

INPUTS	PARTICIPATION	OUTPUTS (dependent on budget)		OUTCOMES / IMPACT (dependent on budget)		
		ACTIVITIES	TANGIBLES	SHORT	MEDIUM	LONG
SECCCA Council Member funding SECCCA Member Council staff resources SECCCA staff resources Stakeholder resources Council current asset plans Council assets data Council software tools Climate change data sets Established methodologies and software tools (to be provided by engaged consultants)	1. Project Working Group – membership reps from each council's assets teams 2. Technical Reference Group - membership reps from DELWP, CSIRO, ICA, Councils Assets and Environment teams 3. Project Control Group – SECCCA staff, Project Control Group and Council members 4. Project management, SECCCA project manager and Exec. Officer 5. External stakeholders as required, e.g.: • Water Authorities, Vic Treasury, Measurement Standards Board • Councillors, intra and interstate councils, other climate change alliances, Resilient Investment Taskforce, finance sector (banks) 6. Project Evaluator	Data collection from each participating council Workshops, analyses including: **How will climate variables impact specific areas and the council assets located in these areas?** On council assets (e.g. roads, drains and buildings, TBC); under various scenarios (RCP 4.5 and 8.5); across time slices (TBC) and to climate variables (TBC) **How vulnerable are the council assets that have been identified as impacted by the climate variables?** On assets (TBC); various scenarios (RCP 4.5 and 8.5); time slices (TBC) and climate variables (TBC) **What are the cost implications?** Financial Impact Assessment **What are the options to avoid identified impacts?** Adaptation options and financial analysis on identified assets, and cost benefit analysis	Tools developed to assist with decision making. Possibly could include: decision matrix, a financial model or software tool (not an exhaustive list), data layers to be imported into existing asset management systems	1. Each council is able to identify: a) how climate change will impact buildings, roads and drains b) the vulnerability of priority assets to different climate impacts c) financial implications of Business-as-Usual for priority assets (buildings, roads and drainages) d) identify adaptation opportunities for priority assets 2. Each council will understand how climate change will impact their expenditure and income and therefore budgets 3. Recommendations of the governance and leadership needed internally to embed assessment of climate change risk into decision making	Ability to undertake ongoing review of adaptation options using developed tools and/or processes To then be used to inform decision making and create prioritised, costed works plans to make the prioritised asset more resilient to climate change Ability to learn from these outcomes to improve asset planning decision making	Asset resilience improved to mitigate future impacts of climate change. Including impact of extreme weather events and the new normal of changes in climate on assets

Addressed by AVA project – successful delivery of the AVA tool will deliver these short-term outcomes.

Addressed by the case studies requiring further focus by each Council to fully achieve the outcomes.

Not explicitly addressed by the AVA project. Further focus required once the AVA tool is in place.

Table 1 shows an example of a Project Logic. This was the original one used in the AVA project as part of the formulative evaluation. Having a project logic enabled clarity and focus on the priorities during the procurement process, especially when assessing the reverse briefs, and was also the basis for ongoing evaluation. The table highlights the short-, medium- and long-term outcomes that could be met directly by a successful AVA project, and those requiring further investment and/or attention in future.

3.2. Legislative and policy contexts

Victoria's *Climate Change Act 2017* provides a long-term framework for mitigation and adaptation action on climate change. It sets out a pathway to zero net carbon emissions by 2050, in line with the Paris Agreement to keep global temperature rise well below 2 °C above pre-industrial levels. The Act requires decision-makers to consider climate change for specific decisions and actions, and encourages pledges for emission reductions.

The *Local Government Act 2020* sets out the broad roles and responsibilities for local government. It provides the primary legislative authority for local government in Victoria, with overarching governance principles that are compulsory obligations (DELWP 2020).

Several of these overarching governance principles create obligations for councils in the context of climate change. Under section 9 (2), councils are required to promote the economic, social and environmental sustainability of the municipality, including mitigation and planning for climate change risks. The section also requires councils to give priority to achieving the best outcomes for the municipal community, including future generations, and to consider climate change in their public health and wellbeing plans.

Section 9 (2) requires councils to take regional, state, and national plans and policies into account during their strategic planning, with decisions, actions, and information being transparent. This means that strategic planning and other decisions must incorporate climate change considerations, including those relating to bushfires, flooding, heatwaves, sea-level rise, and storm surges. As noted in DELWP's guidance for local government decision-makers (DELWP 2020), 'there is now a clear expectation that decision-making is supported by robust and transparent practices, and that the long-term adverse consequences of climate change for future generations are incorporated into council planning, decisions and actions.'

KEY MESSAGE

Victoria's *Climate Change Act 2017* provides a long-term framework for mitigation and adaptation action on climate change.

MANAGEMENT LESSON:

AN AVA TOOL WILL HELP YOU MANAGE FUTURE RISK

Despite the challenges, learning from these lessons and embarking on an AVA will provide you with a tool to enable management of future climate risk, and achieve climate-resilient assets, based on the best available science. The information provided by an AVA tool empowers staff to make informed decisions. Such knowledge can be embedded into state or national processes or frameworks for planning.

Photo: Kingston City Council

3.3. Roles and responsibilities of councils

Other imperatives highlight the responsibilities councils have to understand the impact of climate change on their business:

- damage associated with an increase in extreme weather events due to climate change will affect council budgets
- governments, including local councils, are declaring a 'Climate Emergency'
- there are strengthening requirements to disclose climate risks in annual reporting (see section 3.4. Implications for councils of the Task Force on Climate-related Financial Disclosures)
- councils have a legal liability to disclose known risks or risks they should know to protect the community.

Individual councils decide how to manage their risks. Local governments in Victoria are responsible for a range of assets and infrastructure, including over $100 billion worth of community buildings, local roads and bridges, drainage systems and open spaces (Victorian Auditor-General 2019). These need to be protected from the impacts of climate change and made more resilient to climate change. Without adequate investment in understanding and managing the risks to assets and infrastructure, the financial viability of councils, and community wellbeing, will be affected.

DELWP (2020) notes 3 fundamental messages relating to risk and liability management: (1) statutory authorities, including local government, have a duty of care to manage foreseeable risks; (2) climate change hazards and risks are significant and foreseeable, so decision-makers are accountable for considering them; and (3) good decision-making is enabled by acting as a 'reasonable person' in making decisions guided by law. To do this effectively, councils need to:

Photo: Bass Coast Shire Council

- be alert to the decisions they make where a duty of care will arise
- ensure robust and transparent processes when they make these decisions
- undertake effective consultation with experts and the community about specific decisions being made
- ensure appropriate record-keeping and risk-management processes are in place
- ensure the information that has led to a decision is made publicly available where possible.

3.4. Implications for councils of the Task Force on Climate-related Financial Disclosures

In 2015, the Financial Stability Board, an international body that monitors and makes recommendations about the global financial system, launched the Task Force on Climate-related Financial Disclosures (TCFD). The TCFD was created to develop voluntary recommended disclosures that companies could use when providing information to investors, lenders and insurance underwriters about the climate-related financial risks that companies face. These recommendations are considered international best practice for climate-related financial reporting and are being used by companies in Australia.

The TCFD identified 2 major categories of climate-related risks:

- the risks related to physical impacts of climate change
  - > Physical climate change risks result from the interaction of the natural hazards caused by climate change (e.g. extreme heat events, or flooding), the exposure to the effects of climate change (e.g. to heat in urban areas, or inundation in low-lying coastal areas), and the vulnerability of communities and infrastructure to the impacts (e.g. elderly people susceptible to heat stress, or inability of stormwater systems to cope with flooding).
- the risks related to a transition to a low-carbon economy
  - > Transitional risks result from adjustments as society moves to reduce carbon emissions through regulation, incentives, market changes, technological advances, and other changes. Transitional risks include financial and market risks (e.g. stranded assets, the cost of upgrading to new technology), policy and legal risks (e.g. those associated with planning decisions, litigation for failure to adapt to climate change), and reputational risks (e.g. changing community perceptions of an organisation's contribution to climate change solutions).

Photo: Edithvale Water Sensitive Urban Design, City of Kingston

The TCFD's recommendations (TCFD 2017) encourage organisations to evaluate and disclose, as part of their annual reporting, the climate-related risks and opportunities relevant to their operations if these have a material impact on the organisation and a qualitative impact on stakeholders.

In November 2021, at the 26th Conference of the Parties in Glasgow, the International Sustainability Standards Board proposed a new global disclosure standard, based on the TCFD. With standards evolving, councils will need to monitor how this will influence local government responses and state government directions on how to respond.

The TCFD guidance means that auditors will be asking councils how climate-related risk has been considered, whether the risk is material and what disclosures have been made. To be consistent with TCFD recommendations, future disclosure requirements, and the policy, planning and regulatory environment, councils need to draw on information from activities such as an asset vulnerability assessment to identify and report on climate risks to assets.

KEY MESSAGE

An AVA tool will help manage future risk and achieve climate-resilient council assets. It is based on the best available climate change evidence and has been tailored to the needs of councils planning for climate-resilient assets. It has been tried and tested by councils at the frontline.

3.5. Alignment with the Climate Measurement Standards Initiative

The TCFD guidance on how to assess and disclose climate-related risk is broad, potentially leading to disclosures that are not aligned with Australian practice or council needs. The Climate Measurement Standards Initiative (CMSI) helps asset owners in Australia and institutions whose role it is to oversee financial and community stability. It is a first step to providing Australian organisations with a common understanding of financial disclosures regarding potential damage to residential and commercial property from climate change.

The overarching principles of the CMSI include using credible scientific sources and research published in the peer-reviewed scientific literature; multiple lines of evidence to assess risk; results from multiple global climate models; and appropriately communicating uncertainty (CMSI 2021).

The AVA project aligned with climate risk methodologies and standards of the CMSI in principles, concepts and definitions. However, as CMSI requires consideration of RCP 2.6, and as this low emissions scenario is unlikely (even the Paris target surpasses this), the AVA project only included this scenario where possible, in which case they downscaled data from RCP 4.5 to RCP 2.6.

Photo: Frankston City Council

4 THE HOW

Photo: Bass Coast Shire Council

4.1. Implementation of the AVA project

In summary, the project involved:

1. set up, including establishing project governance arrangements
2. accessing and standardising the data and processes
3. working through council data on climate change and impacts, conducting a high-level climate impact assessment and a general vulnerability assessment on a large scale
4. selecting a small number of case studies on which to do detailed vulnerability assessments, identifying adaptation options, and undertaking economic analyses
5. visualising the outputs and using mentoring and online videos to build council capacity in implementing the results
6. Creating a community of practice among asset managers.

MANAGEMENT LESSON:

AN AVA PROJECT WILL TAKE LONGER THAN YOU THINK IT WILL

Add time for contingencies. If there are multiple partners, consider that their ability to provide input and feedback promptly will hinge on their capacity to do so, not your deadlines. COVID working-from-home requirements were implemented once the AVA project commenced. The resulting online environment enabled more engagement in meetings and more frequent communication between the PCG members and the project management. This in turn enabled faster and more considered decision-making. Without online meetings, this would have become a 2-year project. The second (case study) phase of the project emphasised that such projects take longer than expected, as assessing adaptation options using case studies is a very time-consuming exercise.

GOVERNANCE LESSON:

A DETAILED PROJECT LOGIC IS REQUIRED TO GUIDE THE PROJECT

A crucial step at the start of the project was to develop the project's detailed approach: the 'project logic'. Much time and consideration went into deciding and clarifying the short-, medium- and long-term outcomes of the project, the desired outputs, and the stakeholders. This detailed process informed the reverse brief, and guided the work throughout the project.

MANAGEMENT LESSON:

AVA PROJECTS NEED COUNCIL CHAMPIONS

Internal council champions are essential. Having someone championing the input and uptake of the project by councils throughout the project is essential, as is having support from the council. The champions have an important role in the inception and conduct of the project, as well as in subsequent delivery. They should be at the interface level; people with operational roles to drive the change and enough seniority to leverage support.

MANAGEMENT LESSON:

A REVERSE BRIEF APPROACH ALLOWED THE MARKET TO RESPOND WITH UP-TO-DATE METHODOLOGIES

For a new type of project like this one, having a reverse brief worked well. This involved providing the scope and final outcome of the project to potential suppliers, requiring them to determine what would be the best methodology to employ. In the rapidly emerging area of analysing and preparing for climate impacts, this enables councils to capitalise on new approaches and technical advances.

4.2. How the project was managed

An effective governance structure and a dedicated project manager were key to the success of the asset vulnerability assessment project, especially as it involved multiple project partners across a large geographic area.

The project's governance structure included (Figure 7):

- The SECCCA management committee: this provided overall project oversight. It met every 6 weeks.
- A project control group: this was responsible for direct project oversight and decisions to ensure the project was delivered. It comprised some members of the SECCCA projects subcommittee. It met every 2 weeks and more frequently if large decisions were required.
- A technical reference group: this provided expert advice on the project and ensured technical issues were clarified. It comprised SECCCA staff, and one representative from a participating council's asset team, the Insurance Council of Australia (ICA), DELWP and CSIRO. It met when required.
- A project working group: this coordinated data gathering for each council, helped liaison with SECCCA and the consultants, and was the conduit for information sharing within councils. It included a member from each participating council's asset team. It met as needed.

The consultants were Spatial Vision (for the modelling and technical activity), Marsden Jacob Associates (to analyse the financial implications), *Science into Action* (to evaluate the project) and Scientell (to communicate the process as a guide for other councils).

The project was supported by a Project Manager employed by SECCCA to coordinate and administer the project.

KEY MESSAGE

An effective governance structure and a dedicated project manager were key to the success of an asset vulnerability assessment project of this scale.

GOVERNANCE LESSON:

STRONG PROJECT MANAGEMENT AND GOVERNANCE ARE ESSENTIAL

A clear governance structure, ways of working, and clear expectations of commitment should be established from the start. The governance structure for this project may appear unwieldy, but it was important and worked well. The governance groups need to be flexible, meet regularly, be constant in their membership, and focus on risks and objectives. Accountabilities and role clarity are essential for the various groups. Diversity in participants is also essential; for example, the external input of ICA and DELWP added great value to the project. Support is required from engineers who have practical, new adaptation options.

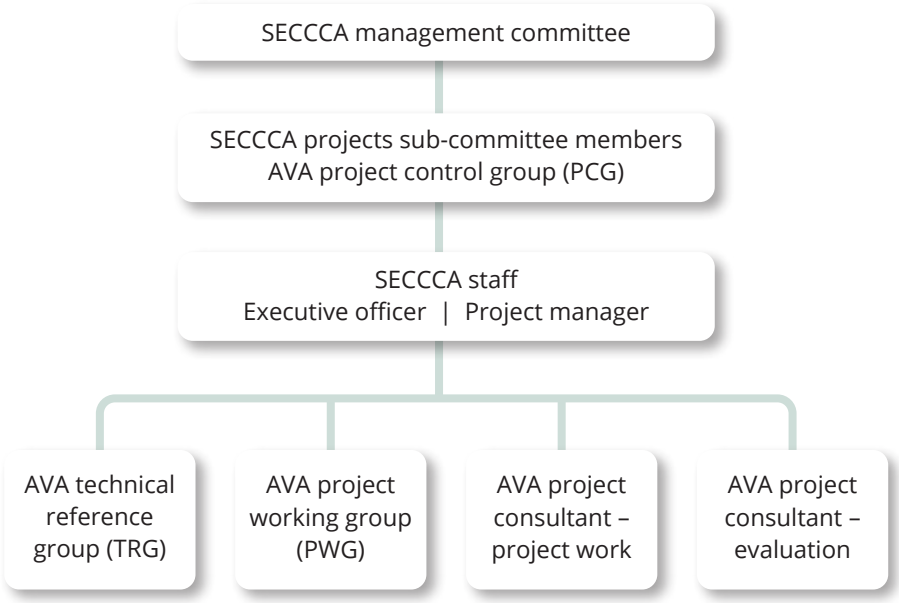


Figure 7: the AVA project governance structure

GOVERNANCE LESSON:

A LEAD ENTITY AND DEDICATED PROJECT MANAGER ARE IMPORTANT

In the case of a consortium of councils, having a lead body such as SECCCA to drive the project is essential. A dedicated project manager to manage a clearly phased approach is essential, as is clear project planning that is communicated well.

GOVERNANCE LESSON:

THE PCG NEEDS TO CONSTANTLY BE CONSIDERING THE WHOLE OF THE PROJECT, INCLUDING THE NEXT STEPS, NOT JUST THE CURRENT POINT

The SECCCA and PCG teams maintained a close check on items coming up in the project, as well as what would need to occur after project completion to ensure the use of the data. Such foresight has been essential and will continue to be so for the translation of the project results into action by councils. Examples of issues addressed include: What are the ongoing costs likely to be for operational maintenance and upgrades of the tool? Who contributes, holds and spends that budget? What and where is the ongoing home for the project product? What is the intellectual property status for the ongoing model inputs (and hence project outputs)? How does intellectual property relate to the home for the project outputs?

Surveyed project participants noted that the strong governance structure, regular meetings of the groups, the number of members of the groups, and the good working relationships within the groups were important to keeping the project on track. The autonomy given to the PCG by the management committee was regarded as important, and the inclusion of asset managers in the PWG was seen as crucial. Regular (weekly) meetings with the consultants were vital to maintaining conversations, raising issues immediately, and dealing with any problems. There were also strong lines of communication to the councils by having people with the right expertise and commitment involved from each council. It was important to have the evaluator participate in meetings to ask knowledgeable but independent questions.

The governance structure did result in a large time commitment from participants. Such an undertaking requires people to take the time to do the work required at a detailed level. Members of the groups, especially the PCG, had to spend time to investigate, understand and make crucial decisions. Such a governance structure may not be necessary for a smaller project involving a single council, but managing such a project should still include external participants who understand the technical details.

In addition to the expertise and commitment from the governance groups, project participants noted the importance of having a dedicated project manager with allocated time to keep the project on track.

MANAGEMENT LESSON:

COUNCIL OFFICERS NEED TO BE COMMITTED AND HAVE RELEVANT EXPERTISE

Having the right people with relevant expertise involved is essential. This includes data, GIS, assets, risk management, strategic and statutory planning, finance, and environmental experts, as well as those with strong skills in project governance and administration. Preferably, there should be consistency in the people involved, although this is a challenge for long projects if there is staff turnover. The initial consultation period is when the widest engagement across types of asset managers is needed. Once the case studies are decided, the expertise of the council representatives is potentially less important, but their ability to connect internally with their colleagues may be more important. It was vital to have the right technical experts involved through the TRG to enable peer review and alignment to the latest science.

MANAGEMENT LESSON:

CONTRACTORS NEED TO HAVE THE REQUIRED COMPETENCE

A project like this relies on using experienced and capable consultants who are responsive, energetic and enthusiastic.

MANAGEMENT LESSON:

ALLOW TIME FOR CONSIDERED DECISIONS

New information needed for decisions must be available before the decisions are made. All decisions and requests should be in writing to ensure roles and responsibilities are understood, and to enable transparency and accountability.

Photo: Cardinia Shire Council

4.3. Impact and vulnerability assessment

Data were key to the project, as the inputs to the assessment influenced the outputs. However, data access and standardisation was a significant undertaking. Across the 9 councils there are almost 6,000 buildings, more than 51,000 roads, almost a million drainage pits and pipes, and over 6,000 open spaces and parks. Attributes for these assets included their construction materials, age, condition, use and maintenance. Councils have different asset management processes, so standardising the inputs into a consistent form was important.

The asset vulnerability assessment approach used Victorian coastal inundation datasets, councils' own internal flood modelling data (where possible), and the most recent climate projections for Victoria (Victorian Government/ CSIRO Victorian Climate Projections 2019). The projections included dynamically downscaled 5 km x 5 km state-wide projections from 6 GCMs from the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report. The consultant used 3 GCMs representing (1) maximum consensus future climate based on the 6 GCMs used for the Victorian Climate Projections 2019 (the CSIRO and Bureau of Meteorology's ACCESS 1.0 model); (2) a hotter and drier future climate (the UK Hadley Centre's HadGEM2-CC model); and (3) a warmer and wetter future climate (the Norwegian Climate Centre's NorESM1-M model).

The consultant used a range of timescales for the projections (2030, 2050, 2070 and 2090, compared with 1981-2010), a range of emissions scenarios (low RCP 2.6, moderate RCP 4.5 and high RCP 8.5) and a suite of climate variables (maximum and minimum temperature, rainfall, and sea-level rise, and extremes including heatwaves and flooding) to examine the vulnerability of council assets. The results of the impact and vulnerability assessment were represented spatially using a GIS application (QGIS) to enable councils to view and work with the outcomes and continue to update data and asset information on an ongoing basis (Figure 8).

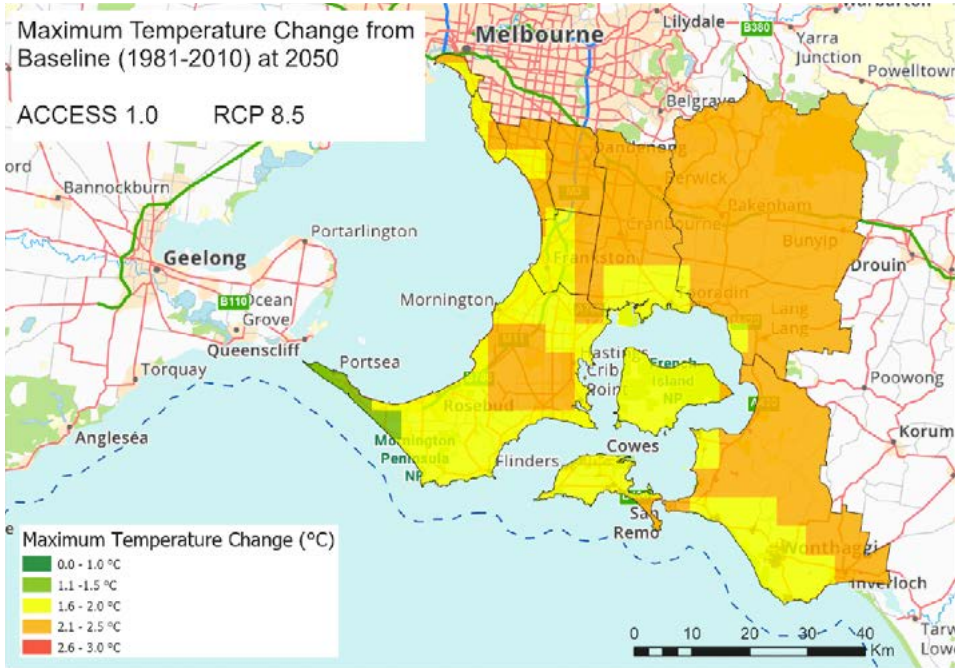


Figure 8: An example of the modelled changes in temperatures (Spatial Vision)

KEY MESSAGE

Data were key to the project, as the inputs to the assessment influenced the outputs.

4.4. Case studies

There was a more detailed vulnerability assessment undertaken for 3 case studies relating to (1) coastal inundation, (2) flooding and (3) bushfire risk. These studies explored the costs of climate change impacts. They aimed to help councils identify vulnerabilities and impacts on the council and community, and to assess adaptation and asset replacement options, to understand the costs and benefits of action.

The case studies identified how council expenditure is likely to be affected by climate change and will guide how councils can plan for, and reduce costs of, the changes. The case studies help council asset and sustainability managers use the tool for adaptation action planning and development of a business case for action.

The process to select the case studies involved:

- developing selection criteria for the case studies and testing these with SECCCA councils
- identifying potential case studies in each council and nominating these at the February workshop (see section 4.5. Workshops and mentoring)
- short-listing case studies, leading to conversations with councils about data, scope and capacity
- selection of final case studies, supported by vulnerability assessments to highlight their priority
- final scoping, resourcing and capacity assessments.

The team ensured that at least one of the 3 case studies was relevant to each participating council.

KEY MESSAGE

The case studies identified how council expenditure is likely to be affected by climate change and will guide how councils can plan for, and reduce costs of, the changes.

For each case study, costs and benefits of proposed adaptation options were assessed relative to a baseline case, typically Business-as-Usual (the outcome that could be expected to occur in future in the absence of adaptation action). To compare benefits and costs over time, the analysis took into account discounting and Net Present Value (NPV), which is the value of discounted future benefits minus the discounted future costs.

The main steps taken and questions considered in the analyses for each case study included:

- What adaptation options are available to Council?
  - > For example, structural works, statutory planning, research and knowledge-building, education and awareness-raising.
- How can options be sequenced over time (pathways and triggers)?
  - > Before assessing identified options, consider if different options are mutually exclusive, or complementary, and can be sequenced – and if they can be sequenced, what are the potential triggers for implementing an option, the pathways for adaptation (to help focus on short term or long-term options).
- What are the key costs and benefits associated with each option?
  - > Financial costs (such as upgrades to assets), financial benefits (such as reduced operating costs), and social benefits (such as improved community resilience).
- How to quantify the benefits (avoided costs) of adaptation?
- How to value social and environmental benefits?

The analyses took into account the future impacts of climate change, including uncertainties in future impacts and associated costs, and valued intangible social and environmental costs and benefits.

The case studies focused on council assets, so adaptation options centred on design and structural works, but had broader objectives, such as enhancing community resilience, to meet council objectives and broader community objectives.

The selected case studies provided the basis of mentoring sessions that developed council capability in planning for anticipated climate change and assessing adaptation options (see section 4.5. Workshops and mentoring) and provided practical examples for future reference by councils when undertaking assessments of adaptation options.

DATA LESSON:

NOT ALL CLIMATE DATA ARE FREELY AVAILABLE

Scope available data thoroughly before the project, and plan for data that may need to be purchased.

DATA LESSON:

INVESTIGATE ASSET DATA GAPS

Look into any gaps in available asset data well before the commencement of case studies, and allow time for collation.

DATA LESSON:

REVISE THE SCHEDULE FOR ONGOING ASSET DATA COLLATION

Develop or revise the schedule for ongoing asset data collation for future vulnerability assessments.

DATA LESSON:

PREPARE FOR DATA TO BE DISPARATE AND REQUIRE WORK

Data requirements and guidance need to be clear from the start. Data problems fit into 4 categories:

- data quality (for example, having the wrong numbers)
- lack of clarity about data criteria (i.e. explanation of a category's data – for example, is my 'small road' your 'small road'?)
- missing data, including gaps in council-owned data, and data not owned by councils but in the same category as those owned by councils (for example, roads by VicRoads, drains by Melbourne Water, or parkland by DELWP)
- new data types and sources and how to incorporate these into the analysis and later models without scope creep.

Each of these data issues requires attention. Assumptions, corrections, gap-filling and massaging of asset and other data need to be documented to ensure repeatability. There may need to be implementation of a 'minimum viable data availability threshold' to avoid too many data proxies affecting the robustness of the outputs. The case studies in particular emphasised the work required on data: undertaking the case study analysis was a data-intensive process, with the data required to be more in-depth and broader than the data used in the initial AVA. Hence, there is a need to have a contractor experienced in working with messy and incomplete datasets and collecting missing information.

4.5. Workshops and mentoring

The consultants presented the project status and outputs at 3 AVA project workshops, which generated discussion and feedback from asset and sustainability representatives from each participating council.

The first workshop, held in November 2020 (close to the start of the project), outlined the scope of the asset vulnerability assessment and the consultant's proposed approach. Participants explored climate change projections and discussed the role of case studies (see section 4.4. Case studies). The workshop also sought to confirm available asset and climate-related data and key studies.

Each council gave brief presentations about the extreme weather events and assets of concern. They include heavy rainfall and flooding, sea-level rise and storm surge, and heatwaves. Assets of concern include roads, train lines, drainage and stormwater network, coastal structures, foreshore properties, piers and jetties, sand dunes, bathing boxes and open spaces. The consultant used these findings for further discussions regarding project direction.

At the second workshop, held in February 2021, the consultant presented preliminary results of Part 1 of the project: the overall asset vulnerability assessment. Each council nominated case studies to be considered for Part 2 of the project, including the rationale for the nomination, including the priority of the extreme weather issue, the availability of data to support a vulnerability assessment, representation of the council's geography, and availability of staff to support the development of the case study.

The third workshop, held in May 2021, involved the consultant presenting the final results of the overall asset vulnerability assessment and a discussion of how councils might use these outputs. Participants discussed the case studies being pursued (and why), and adaptation options for the case studies.

The vulnerability of an asset is highly dependent on attributes such as the asset's age, materiality, level of service and use. In addition to the 3 workshops summarised above, working group members identified the main attributes of assets to assess their vulnerability, as well as the assets' sensitivity to climate change, and their adaptive capacity. A workshop was held for each of the assets of interest (roads, drains, and buildings) to ensure local knowledge was captured in the process.

As well as the workshops guiding councils through the asset vulnerability process, the consultant provided 2-hour mentoring sessions for individual councils to explore how the asset vulnerability tool and what it visually represents can support council planning. The mentoring familiarised council staff with the data, thereby building internal capacity. Participants used worked examples with the outputs generated by the tool to exemplify how it can assist decision-making and planning.

Once people are trained, the AVA tool is easy to use. The mentoring sessions enabled council staff to develop an understanding of how to apply the outputs of the project to their business processes and decision-making. It will help empower council staff to make informed decisions for climate-resilient assets based on evidence, to better manage future risk.

KEY MESSAGE

Once people are trained, the AVA tool is easy to use. It will help empower council staff to make informed decisions for climate-resilient assets based on evidence, to better manage future risk.

COMMUNICATION LESSON:

TRAINING AND MENTORING MUST BE TARGETED TO THE NEEDS OF THE COUNCIL OFFICERS

Plan training and mentoring sessions early, and engage with the users of the information (council officers) to identify and target their needs. Define the learning outcomes in order to effectively design training sessions and measure capacity building. Client workshops require a specialist facilitator to maximise outcomes and capability building.

5 AUDIENCES AND ENGAGEMENT

Photo: Kingston City Council

5.1. Communication

It is important to establish processes and expectations for communication from the start of the project. This includes communication within the project (between the client and consultants), and with key stakeholders (including funders and partners). For this project, internal audiences (including Spatial Vision, Marsden Jacob Associates, and the councils) were collaborative and engaged, while the funders and partners were strongly interested. Furthermore, the project's governance structure, the dedicated project manager, and weekly update emails enabled consistent messaging, open lines of communication, and frequent, efficient communication.

External communication plans also need discussion early in the project, and evaluated at the end of the project. The project manager or lead organisation should clarify who the stakeholders and audiences are (for example, communities affected by decisions and results), a range of processes to reach them (for example, fact sheets and council newsletter stories summarising the project and results), and the aims of communication activity. Following the project's completion, communication with the community may become more important.

Given the challenges of adapting to climate change, and the urgency, the communication and engagement about the AVA project need a courageous posture that requires language aligning to that need. At times it will mean being courageous in the face of some not liking what is being said. All communication should just tell it how it is, without jargon or 'weasel' words or phrases. The ultimate objective is action, not to make people feel good. Support to do this may be important for parts of some councils that may be concerned about how to deliver 'bad' news to their community.

Consider pre-prepared media statements and a media-trained spokesperson to manage any media interest in the project.

The final report for such a project may be long and technical, and hence should be tailored for the audience, with consideration given to the development of a non-technical summary brochure.

The audience for the project outputs was engaged and interested in the content. This included mainly council officers who are technically literate but non-specialist in climate change matters. Hence there was a need to define new terms, ensure clarity, be concise, remove unambiguity, keep things simple, and establish rules on language use.

KEY MESSAGE

It is important to establish processes and expectations for communication from the start of the project.

COMMUNICATION LESSON:

COMMUNICATE EARLY AND OFTEN: DEVELOP A COMMUNICATION AND ENGAGEMENT PLAN EARLY IN THE PROJECT

The main objectives of communication and engagement need to be established early. These can then drive the approach taken by the project's contractors. The project logic is helpful in communication and engagement planning (it enables decisions about the main audiences likely to be influenced by the results, which helps achieve the medium-term outcomes) but a targeted discussion about communication is required.

5.2. Language

COMMUNICATION LESSON:

ENGAGEMENT AND BROAD COMMUNICATION ARE ESSENTIAL

Engagement and general communication have been essential and were managed by SECCCA. Consideration of communication products and preparation of a communication plan were part of the project. Media management may be helpful – an assessment can be made whether project sponsors require pre-prepared media statements and a spokesperson ready in case there is external interest in the project. After the project's completion, communication may become more important – so how communication has been delivered by the project group, and internally at different councils, should be evaluated.

The TRG identified language as an issue to address, leading to a communication-focussed workshop. Members of the project teams met to make decisions about clear language use and develop a set of simple rules about language use. This session, which aimed to make the project outputs more readable, was crucial. It resulted in a set of principles for communicating technical terms, decisions about language use for the project, and a glossary (see Appendix 2).

COMMUNICATION LESSON:

LANGUAGE CLARITY IS FUNDAMENTAL

Through the drafting process of the first report, the workshop process, and feedback from the TRG, it became clear that having a set of simple rules about language use is important, given the large amount of technical expertise held by those directly involved, and the project's complexity and technical nature. Having time dedicated to clarifying language to make products more readable was crucial and resulted in a set of principles and some decisions about language use for the project (see section 5.2. Language). The outputs cover 3 models, 2 RCPs and 4 timeframes, so there needs to be work done on how to communicate model outputs so the context and language are clear. This will help achieve clarity in communicating with a non-technical audience. AVA project proposals must include provision for all workshop contents and project outputs to be reviewed by communication experts for consistency and plain language, with communication a capability requirement for potential contractors.

Particular terms and topics that required discussion were:

- instead of 'chronic' and 'acute', use the terms 'climate extremes' and 'climate averages' and explain that chronic means gradually emerging aspects of climate risk (including temperature rise, rainfall changes and sea-level rise), and acute refers to extreme weather events (such as extreme rainfall, bushfires, and flooding)
- when discussing probability and extreme event return intervals, use words rather than statistics, such as frequency, intensity or chance of an event happening (for example, if a 1-in-100-year historical event becomes a 1-in-20-year event, refer to the increase in frequency rather than a percentage)
- agreement between global climate models: rather than referring to maximum consensus, explain where the models agree the most, or where they disagree, and the most likely model outcome
- avoid using the word scenario and, where its use is essential, describe the context (for example, emissions scenario, climate scenario), or refer to RCPs with their definition in a glossary or box (see section 2.2. Climate modelling)
- ensure important terms are defined, including vulnerability, sensitivity, adaptive capacity, impact and exposure
- when communicating uncertainty, define what it means in this context (as it has a different meaning in plain English): uncertainty of climate projections depends on the range of climate projections, the climate sensitivity of models, and the availability of data
- mitigation refers to emissions reduction, but the term can be confused with avoiding climate impacts through adaptation, so be cautious with its use
- explain that adaptation is not an alternative to mitigation, clarify adaptation options, address transformational strategic change rather than autonomous (reactive) adaptation, and frame adaptation options as beneficial.

COMMUNICATION LESSON:

COMMUNICATING ABOUT UNCERTAINTY AND RISK IS ESSENTIAL

Asset managers need to deal with decision-making in the face of uncertainty. The number of significant figures and relevant decimal places needs to reflect the precision in results such as the vulnerability asset score. Understanding uncertainty and risk is an important component of the project.

COMMUNICATION LESSON:

FRAME ADAPTATION OPTIONS AS BENEFICIAL, AS OPPOSED TO JUST COST MINIMISATION

Adaptation is often considered as being required to avoid the costs of climate change, but it needs to be viewed as a benefit and value creator. Engineers, asset managers and service providers need to be part of the adaptation discussions. Consider the services that assets supply, not just the assets when considering the benefits of adaptation.

5.3. Decision-making principles

A good decision-making process provides the foundation for effective climate change adaptation. To facilitate decision-making during the AVA project, representatives of all 9 SECCCA councils agreed on a set of principles for the SECCCA team, the PCG and the contractors. The applied principles were useful at crucial points where judgement or rapid decision-making was required, or the criteria for a decision were not clear, or where outcomes produced conflicting benefits, or other circumstances when there were uncertain decision-making moments.

The teams decided that decisions made during the project should be:

- evidenced-based
  > there is strong evidence accessible to all that underpins the decision
- focused on outcomes
  > the decision is based on the priority project outcomes
- transparent and understood
  > assumptions are clear to decision-makers and stakeholders
- COVID-safe
  > to keep participants safe from exposure to COVID
- within scope and budget
  > to deliver the AVA project at the agreed cost
- inclusive of the right people at the right time
  > to ensure that the right people were engaged at the right time to achieve the desired result
- made once
  > so there is a bias to progress in the project, and it is not delayed by slow decision-making.

In terms of assessment of adaptation options, this should be seen as part of a broader adaptation decision-making process (Figure 9), which involves:

- defining the problem
- assessing hazards and risks
- clarifying responsibilities
- establishing objective
- identifying options
- identifying suitable triggers/timing
- assessing option(s)
- assessing uncertainty
- selecting options, funding and implementation pathway
- evaluating and monitoring.

Photo: Cardinia Shire Council

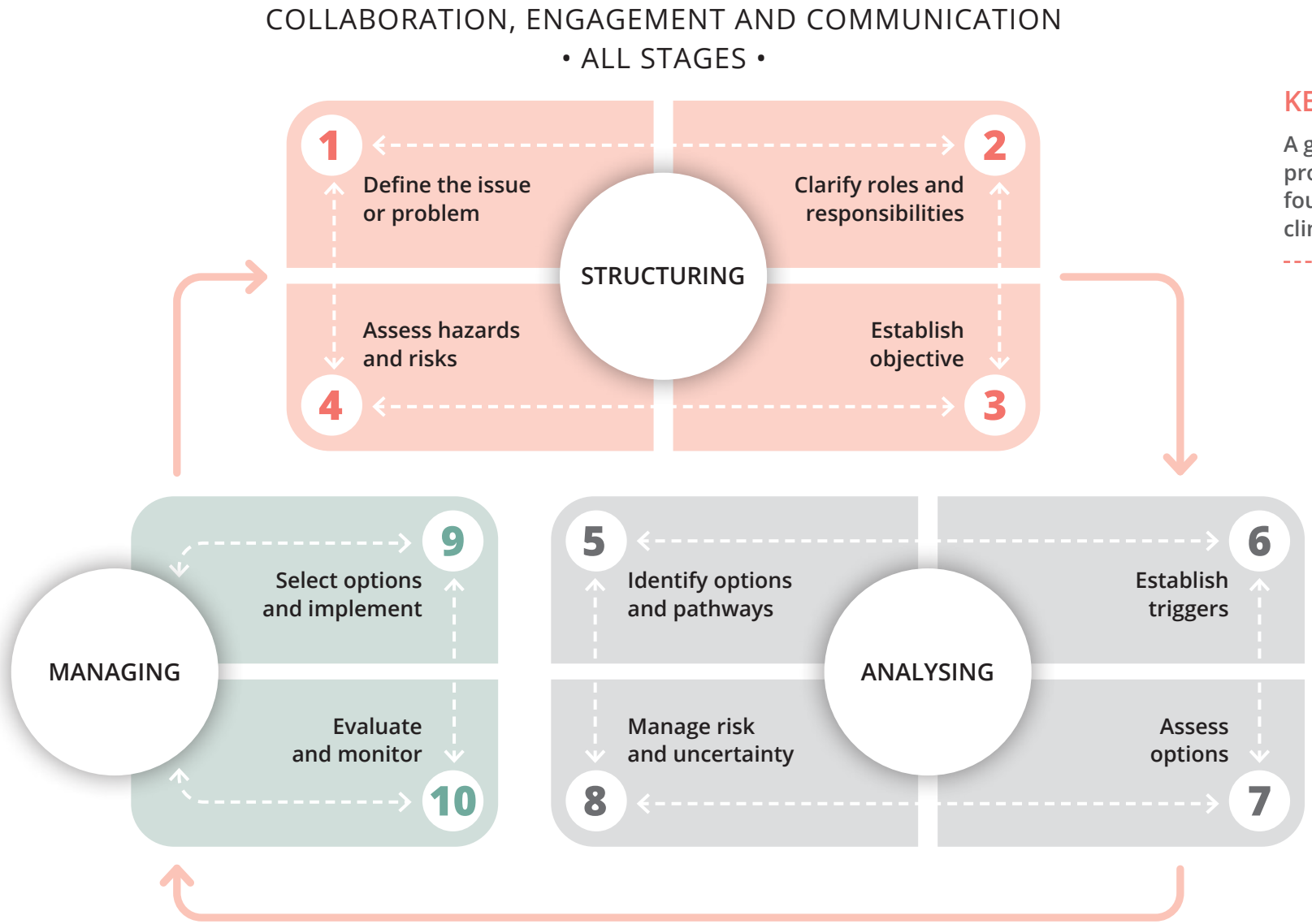


Figure 9: Stages in a good-practice decision-making process in assessing adaptation options (based on Marsden Jacob Associates)

KEY MESSAGE

A good decision-making process provides the foundation for effective climate change adaptation.

6 THE LESSONS LEARNED

Photo: Ryan Eckersley

6.1. Evaluation

Evaluation is an important process in a project of this scale and complexity. For this AVA project, an evaluator was embedded as an independent member of the project team. As there is a need for evaluation to occur, even if the size of the project and the allocated budget does not allow for a formal evaluation consultant to be engaged throughout the entire project, establishing some sort of evaluation process (such as online surveys) early in the project will ensure objectives can be checked on.

Science into Action was the embedded evaluator, preparing a report summarising the evaluation process and evaluating the project. The report included recommendations for activities to maximise the value of the AVA project.

The evaluation process involved the evaluator remaining independent from the AVA project, attending all PCG meetings, and using a dynamic evaluation matrix as a process for regular check-ins. This enabled the PCG to assess if the project was achieving the objectives in real-time and intervene if needed. When required, the project was adapted to focus on desired outcomes. The evaluator produced an interim report approximately mid-way during the project with an assessment of alignment to the objectives to date and some recommendations to maximise success of the final project.

Evaluation data were collected 3 ways during the project:

- formal online surveys during workshops
- informal questioning and data gathering during meetings, including baseline data from most of the groups in the governance structure
- final structured interviews with key participants split into 5 groups (SECCCA, PCG, councils directly involved in a case study, councils not directly involved in a case study, and the consultants who delivered the AVA), drawn from different functions including sustainability, asset management and planning and spatial data teams.

Science into Action collated information from the interviews, extracted patterns, and added the informal data gathering during the project and from the online surveys. The evaluation concluded that the project delivered on the planned objectives, with some significant areas of ongoing work to look in more detail at impacts and adaptation options at the council level.

COMMUNICATION LESSON:

EVALUATION IS NEEDED

Evaluation is an important process in a project of this scale and complexity. For this AVA project, an evaluator was embedded as an independent member of the project team. As there is a need for evaluation to occur, even if the size of the project and the allocated budget does not allow for a formal evaluation consultant to be engaged throughout the entire project, establishing some sort of evaluation process (such as online surveys) early in the project will ensure objectives can be checked on.

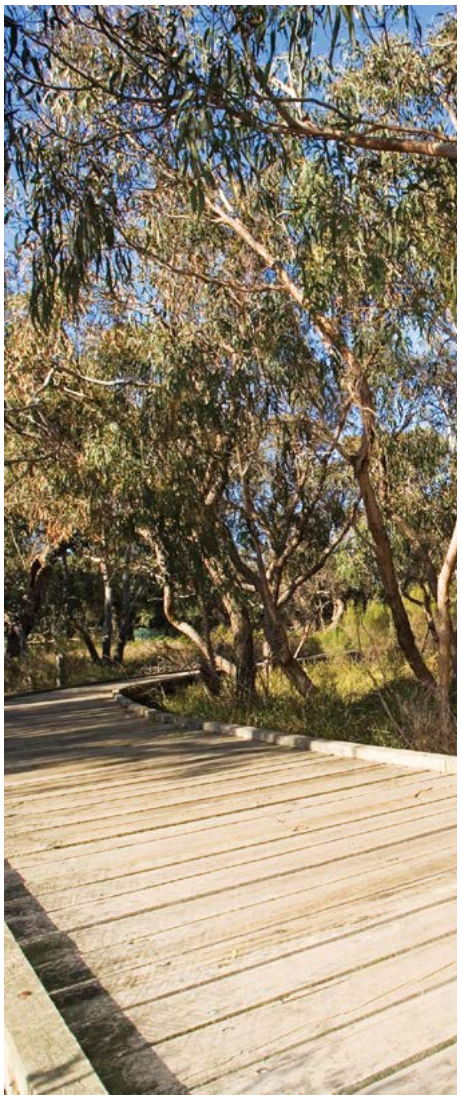


Photo: Bayside City Council

6.2. Next steps

Recognising that this project is the start of asset adaptation for some SECCCA councils, following the completion of the AVA project there are further activities needed to maximise the uptake and enable implementation of the project outputs.

SECCCA can help share information, drive council uptake of the AVA tools (for example, by coordinating training), and normalise the use of the AVA tools in councils' business processes, policies and practices.

This can be facilitated by the detailed communication and engagement plan developed for the AVA project. SECCCA should draw on this to communicate about the project, its outputs and the next steps needed to realise the full project outcomes. This will support council officers to conduct briefings for council CEOs and councillors about the existence and power of the AVA tool.

SECCCA should continue to evaluate the effectiveness of the project over the next year, which should be enough time for councils to develop a regular pattern of tool use.

In future, the project could be extended to include residential houses: if councils know the risk to their own assets, they will be aware that there are similar risks to exposed and vulnerable privately owned assets.

In the longer term, there are opportunities to improve the tool and the availability of data.

Individual councils, as the intended end-users of the AVA tool, have an opportunity to change how risk is managed in relation to the adaptation of assets. They should build awareness of the tools (with the help of a council champion of the project), communicate their value (especially to decision-makers), and increase the capability for using tools such as the QGIS viewer. The AVA tool should be embedded into internal council processes and policies, and aligned to the next council planning and budgeting cycle.

Planning for adaptation, and doing the research into adapting council assets for climate resilience, is better delivered in partnership with other organisations and agencies. Evaluation of the project highlighted the potential roles of various peak bodies and supporting partner organisations, from public utilities to government departments and sector representative bodies.

For example, there needs to be clarity on councils' roles and responsibilities about legal disclosure of known, or suspected, impacts from climate change, especially as it relates to disclosures that highlight, or otherwise indicate impacts to private assets. Councils need to be empowered to act without the fear of litigation exposure from running an AVA project that is effectively doing due diligence and proper governance. It should not be the role of individual councils to reach an understanding on this complex legal and insurance issue – State or Federal Governments could set a standard, provide clear guidance or even clarify who has the liability for disclosure. There is also a need for stronger guidance about which climate scenarios to use for asset planning and management.

GOVERNANCE LESSON:

AN AVA PROJECT IS JUST THE START

A project like this is the starting point. More work will need to be undertaken by anyone doing a project like the AVA to ensure ongoing use of the data and that information is used for other analyses.

6.3. Lessons learned

Throughout the AVA project, many lessons were learned about different elements of an asset vulnerability assessment (Figure 2). Understanding these will help other councils run projects effectively. In addition, participants were surveyed on their view of the most important things that contribute to the successful commencement of an AVA project (Figure 10).

These can be found throughout the guide, where the lessons are expanded further. In summary, the lessons are:

MANAGEMENT

- An AVA tool will help you manage future risk
- AVA projects need council champions
- An AVA project will take longer than you think it will
- Scope creep needs to be managed
- Council officers need to be committed and have relevant expertise
- Contractors need to have the required competence
- Obtaining the funding is key, with the scope of project matched to available funding
- A reverse brief approach allowed the market to respond with up-to-date methodologies
- Allow time for considered decisions

GOVERNANCE

- A lead entity and dedicated project manager are important
- A detailed project logic is required to guide the project
- Strong project management and governance are essential
- The PCG needs to constantly be considering the whole of the project, including the next steps, not just the current point
- Explain the project's importance to council decision-makers from the start
- An AVA project is just the start

DATA

- Prepare for data to be disparate, unavailable, and requiring time to collate
- Not all climate data are freely available
- Investigate asset data gaps well before case study commencement
- Revise the schedule for ongoing asset data collation for future vulnerability assessments

COMMUNICATION

- Communicate early and often: develop a communication and engagement plan early in the project
- Engagement and broad communication are essential
- Language clarity is fundamental
- Communicating about uncertainty and risk is essential
- Frame adaptation options as beneficial, as opposed to just cost minimisation
- Training and mentoring must be targeted to the needs of the council officers
- Evaluation is needed

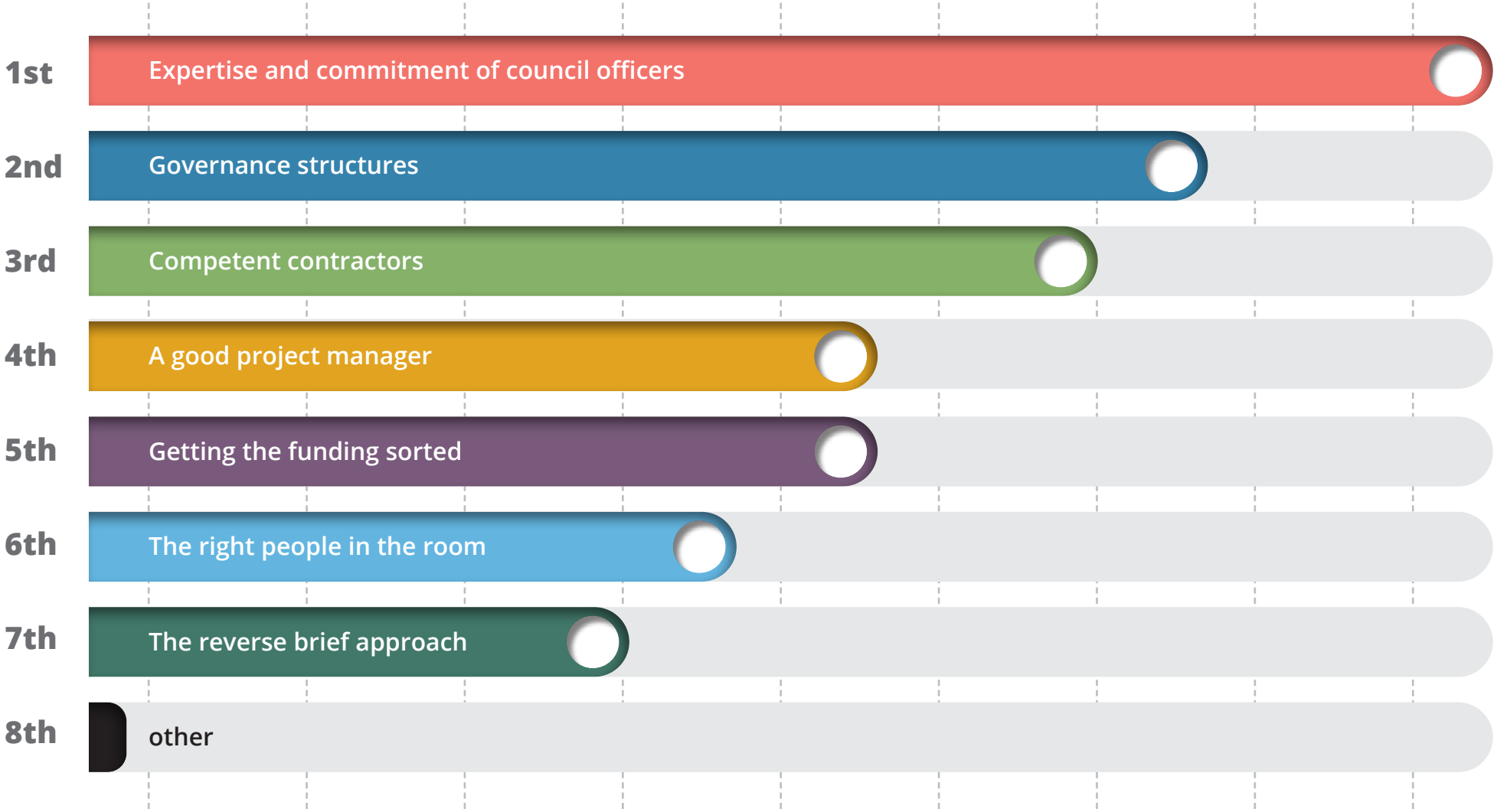


Figure 10: Participants' view of what's most important to the successful commencement of an AVA project (*Science into Action*)

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APPENDIX 1

Climate change in Victoria

Photo: Bass Coast Shire Council

A1.1. Global climate change

Human activities add to greenhouse gases in the air, influencing the global temperature and changing the global climate system. This leads to changed, uncertain and variable local weather impacts that are felt at the local scale.

The global concentration of atmospheric carbon dioxide has increased around 50 per cent since 1750, passing 410 parts per million (ppm) in 2019. This is much higher than the natural range of 172 to 300 ppm that existed for hundreds of thousands of years before the industrial revolution, and is the highest level observed on Earth in at least 2 million years (CSIRO and Bureau of Meteorology 2020).

The increase in carbon dioxide has contributed to increasing global warming and subsequent changes to the climate. The world has warmed by 1.1 °C since 1850, and there is no record of temperature having increased as rapidly as it has over the past century.

The increasing amounts of greenhouse gases have been the main cause of changes to the world's climate since the 1950s. Most of the hottest years on record have occurred in the 21st century: 2016 and 2019 were the world's warmest years on record, followed by 2020. As well as air temperatures increasing, there have been changes to the intensity and frequency of extreme weather events.

Photo: Kingston City Council

A1.2. Changes in Victoria's climate

Australia has warmed by around 1.4 °C since 1910 when national records began. Australia's warmest year on record was 2019, followed by 2013, 2005, and 2020 (Bureau of Meteorology 2021).

Oceans around Australia are acidifying as they absorb increasing amounts of carbon dioxide from the air. The ocean has warmed by around 1 °C since 1910, contributing to longer and more frequent marine heatwaves. The global mean sea level has risen by around 25 cm since 1880, and the rate of rise is accelerating. Sea-level rise amplifies the effects of high tides and storm surges.

In Victoria, the temperature has increased by just over 1.0 °C since 1910, and the rate of warming has increased since 1960. The climate is drier than in previous decades, with average rainfall declining since the 1950s, especially in autumn. Mean sea level for Melbourne (recorded at Williamstown) has risen by approximately 2 mm per year since 1966 (DELWP 2019).

A1.3. Climate modelling

Scientists use computer-based, mathematical representations of the Earth system – after careful testing and comparison with historical climate – to simulate likely future changes in the climate, based on various greenhouse gas emission scenarios. These global climate models (GCMs) are sophisticated computer models that use the physical laws that govern the way the world's climate works to simulate all aspects of the Earth system (from high in the atmosphere to the depths of the oceans). Model simulation allows us to study how the climate may respond to increasing levels of greenhouse gases.

The models run on powerful supercomputers, and successfully represent the important features of both current and past climate. Climate projections are not long-range weather forecasts. Weather forecasts aim to predict a sequence of events for the very near future. Climate projections do not aim to predict a particular sequence of events but rather to simulate how

A1.4. Future scenarios

the entire climate system responds to change, and so provide a plausible range of future climate conditions.

Global climate models show that, without significant reductions in greenhouse gas emissions, changes in climate will continue. Regardless of any actions to reduce greenhouse emissions, there will be impacts of climate change throughout this century, due to the long life of greenhouse gases in the atmosphere, and the changes already built into the system.

Climate change projections model the response of climate to a set of greenhouse gas, aerosol and land-use scenarios that relate to how the future may evolve based on population growth, energy use, economic changes and technology.

While greenhouse gases are already affecting the climate (and hence adaptation needs to occur now), the climate of the future will be determined by the amount of greenhouse gases and aerosols in the atmosphere. The atmospheric concentrations represent the balance between what is emitted by human and natural actions, and what is absorbed by the oceans and the land.

The United Nations Intergovernmental Panel on Climate Change (IPCC) developed scenarios that describe plausible future greenhouse gas concentrations in the atmosphere. There are many possible futures, which were summarised as 4 main representative concentration pathways (RCPs).

These range from RCP2.6 (where emissions of greenhouse gases are low following extensive global efforts to reduce emissions), which would lead to around 2 °C of global warming, to RCP8.5 (where there is little global action to reduce greenhouse gas emissions), which would see global temperature rise by 4 to 6 °C (IPCC 2013).

In 2021, the IPCC Sixth Assessment Report used new descriptions for future greenhouse trajectories. The shared socioeconomic pathways (SSPs) are 5 socio-economic and technological trajectories that the world could follow this century. The SSPs can be linked to climate policies to generate different outcomes for the end of the century (analogous to RCPs).

IPCC (2021) projects a global warming increase by 2100 of between 1 and 5.7 °C (relative to the climate baseline period of 1986 to 2005), depending on the emission scenario. Specifically, the planet is likely to warm by between 1 °C and 1.8 °C for a scenario where emissions of greenhouse gases are low following extensive global efforts to reduce emissions. Or global warming could be between 3.3 °C and 5.7 °C if there is little global action to reduce greenhouse gas emissions and the world follows the very high emission scenario.

As we can't be certain which pathway the world will follow, best practice science recommends that assessments of climate change impacts must consider 2 or more RCPs, the full range of projected changes for each emissions pathway, and natural climate variability when assessing the impacts of climate change.

A1.5. Projected changes in climate

The world's environment, and how it supports us, will be challenged by dangerous changes if we don't keep global warming below 1.5 to 2 °C.

Under a changing climate Australia can expect (CSIRO and Bureau of Meteorology 2020):

- continued warming, with more extremely hot days and fewer extremely cool days
- a decrease in cool season rainfall across many regions of the south and east
- more time in drought
- a longer fire season for the south and east and an increase in the number of dangerous fire weather days
- more intense short-duration heavy rainfall events
- fewer tropical cyclones, but more high-intensity ones
- continued warming and acidification of surrounding oceans
- ongoing sea-level rise.

Similarly, Victoria will continue to become warmer and drier in the future (DELWP 2019). Rainfall will decrease in autumn, winter and spring, but extreme rainfall events are likely to be more intense. By the 2050s, if the current rate of global warming continues, Victoria's average annual temperature could rise by up to 2.4 °C and towns could experience twice the number of very hot days compared with the 1986–2005 average. By the 2090s, Victoria is projected to warm on average by 2.8 to 4.3 °C under a high emissions scenario.

These changes will play out against a backdrop of high variability from year to year through the action of large-scale climate drivers such as the El Niño – Southern Oscillation and Indian Ocean Dipole, so cooler periods and wet years will still occur.

A1.6. Impacts of climate change

Climate change is having, and will continue to have, significant impacts on marine life, habitats, ecosystems, landforms, culture, human health and infrastructure. These have flow-on effects on society and the economy. High temperatures and extreme weather events such as flash flooding or tropical cyclones can result in changes to, or loss of, biodiversity and can damage infrastructure. A greater frequency of extreme events such as floods, fires and high winds would harm the built environment. Impacts of sea-level rise are likely to include more frequent and extensive inundation of low-lying areas, and erosion of cliffs, beaches and foreshores, as well as damage to infrastructure.

The impacts of climate do not always occur gradually. There are many past examples of rapid warming. Rather than being linear and somewhat predictable, such 'tipping points' to the climate system can be large step changes and can be a surprise.

A1.7. Adapting to change

Climate adaptation can reduce the risks of damage caused by climate change; however, the success of adaptation measures decreases with increasing global warming.

Adaptation can be autonomous, as has generally happened in response to short-term climate variability in the past. Alternatively, it can be planned, with strategic, long-term decisions made at a government-wide level. Adaptation could also be incremental, to maintain the essence and integrity of a system or process, or transformational, where changes are made to the fundamental attributes of a system in response to climate change. Planned adaptation, particularly for transformational change, requires knowledge about likely climate change.

Adaptation is not an alternative to reducing greenhouse gases (mitigation); we need to adapt to climate change while also undertaking mitigation efforts. Many of the projected impacts due to climate change (such as increased temperatures, higher sea levels, and decreased biodiversity) are already happening, so there are already changes that we must adapt to, as well as further inevitable changes.

APPENDIX 2

Asset vulnerability assessment example

Photo: Ryan Eckersley

A2.1. Description

Spatial Vision used climate modelling prepared by CSIRO for the IPCC 5th Assessment Report and provided through the Victorian Climate Projections 2019 Project. The data include downscaled modelling to a resolution of 5 km x 5 km Victoria-wide, within the Coupled Model Inter-comparison Project phase 5 (CMIP5) suite of projections. These have been updated based on new understanding and modelling techniques and were available for the study area.

The vulnerability assessment method incorporates various climate scenarios and estimates the sensitivity and adaptive capacity of assets to these climate changes to assess vulnerabilities.

This approach generates an impact rating based on the assessed sensitivity of an asset to different climate change scenarios.

The adaptive capacity of assets to impacts is also assessed and used to assign asset vulnerability, where adaptive capacity relates to asset condition and context (see Figure 11). This included ground-truthing so there was consistency in the categories for adaptive capacity and sensitivity across councils.

The approach involves:

- Vulnerability assessment rating for assets where there is sufficient information at the individual asset level to complete this assessment. Where there is insufficient information to support a vulnerability rating, an impact assessment at the asset group level is undertaken. This impact assessment assists in understanding the climate parameters that are driving the assessed vulnerability rating in that it reflects how the anticipated broader climate change under each climate change scenario (using the latest CSIRO climate projections) is likely to broadly affect each asset group.
- Inundation and erosion impact assessment will be applied to all agreed council assets incorporating detailed spatial data for inundation (from anticipated sea rise and flooding scenarios) and coastal erosion (from local coastal hazard assessments and other sources).

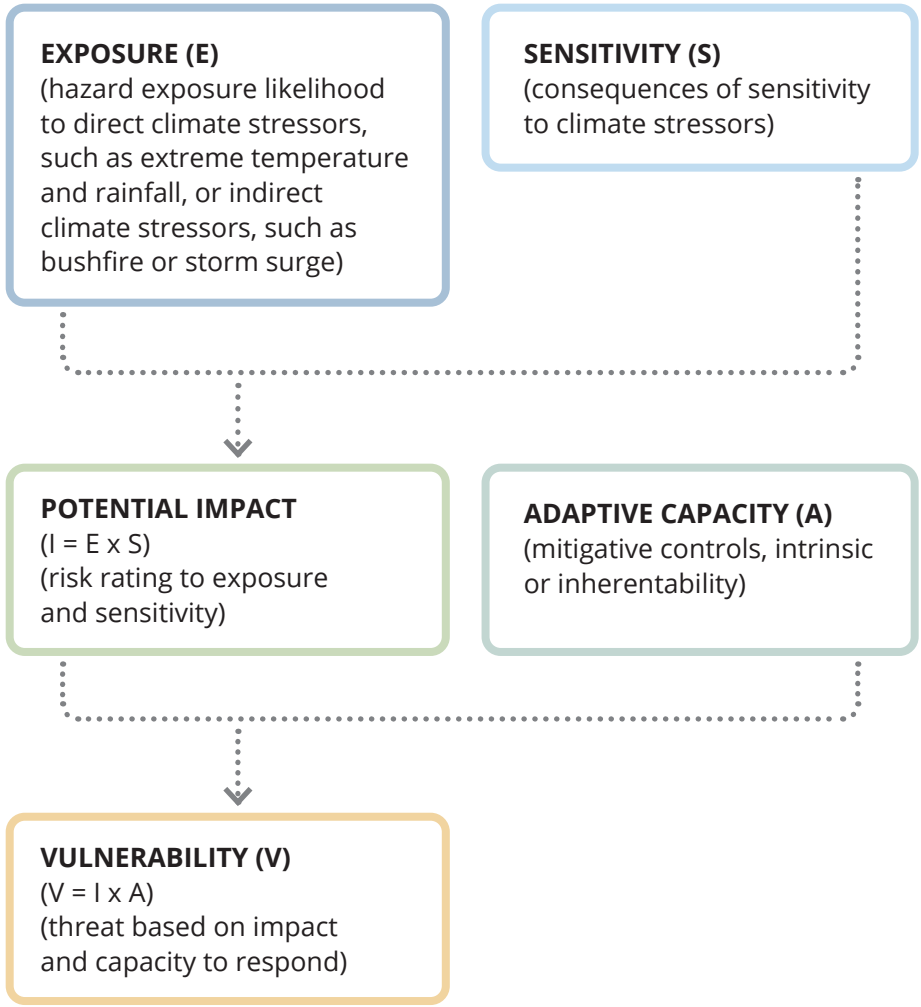

Figure 11: Vulnerability Assessment Framework (based on Spatial Vision)

A2.2. Example

This example shows asset vulnerability assessment applied to each asset depicted in a spatial dataset. Figure 12 presents a representative area of Melbourne, showing the vulnerability rating assigned to individual open space for a scenario for 2050 and RCP 8.5. The view shows how open space transitions from lower to higher vulnerability ratings over time.

In this example, the open space area on the left marked in red is assessed to have less tree canopy than the open space area in the top left of Figure 12 that is identified in yellow.

The factors determining the vulnerability rating include exposure (high maximum temperatures, extreme heat days, heat waves, reduced rainfall, extreme rain events, and high wind), sensitivity (use or type of park, level of service, and size) and adaptive capacity (risk, proximity to water bodies, proximity to surrounding buildings, proximity to busy roads, and percentage coverage of tree canopy and shrub beds).

Figure 12: Open Space – Vulnerability ratings (2050 – RCP8.5) where yellow represents a moderate rating; and red a high rating (Spatial Vision)

A2.3. Visualisation

Spatial Vision has packaged the data outputs from the first pass assessment process into a spatial data viewer, QGIS, a free and open-source geographic information system. The council-specific QGIS viewer presents the inundation profile and vulnerability analysis outputs.

The data outputs help asset managers better understand the likely changes under various climate futures, and the likely impacts.

The data are packaged into 2 separate viewers:

- a climate viewer that displays climate projections information prepared by CSIRO (and sponsored by DELWP under the Victorian Climate Futures Project 2019) and historical climate observation data
- a council AVA viewer that presents the inputs and outputs from the first pass asset vulnerability assessment for buildings, roads and drains. This includes both the inundation profile for assets under various inundations scenarios, and the full vulnerability assessment for assets based on 3 different climate models and futures, 2 emission scenarios, and 4 different time points

In the climate viewer (Figure 13), climate variables (for example, maximum temperature, and rainfall days above 10 mm) are presented and symbolised for the baseline data, the projected data (for all models, RCP 4.5 and RCP 8.5, and all timeframes) and the historical data. For the climate future data, a consistent portrayal of results across all climate future models, RCPs and timeframes allows for a visual comparison of these different factors to assist decision-making.

The council AVA viewer (Figure 14) can be used to investigate, for example, if an asset will be affected by different inundation scenarios. Users identify the asset of interest and select features and inundation scenarios (for example, 82 cm sea-level rise and an associated storm surge) to see whether the asset is affected.

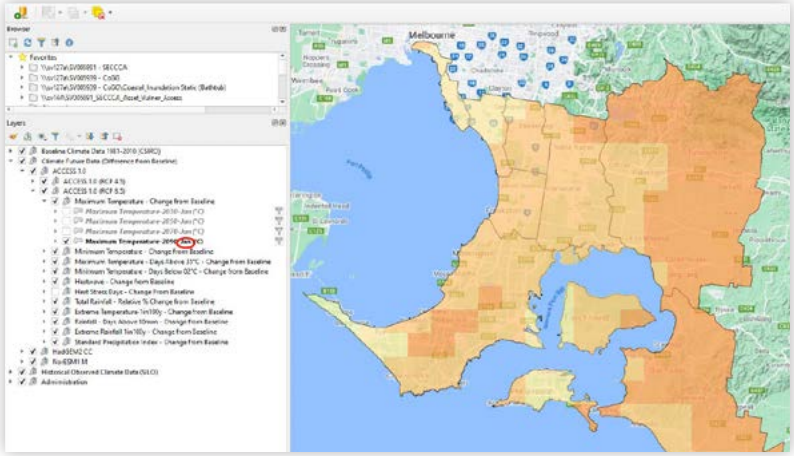

Figure 13: An example of the data presented in the QGIS climate viewer (Spatial Vision)

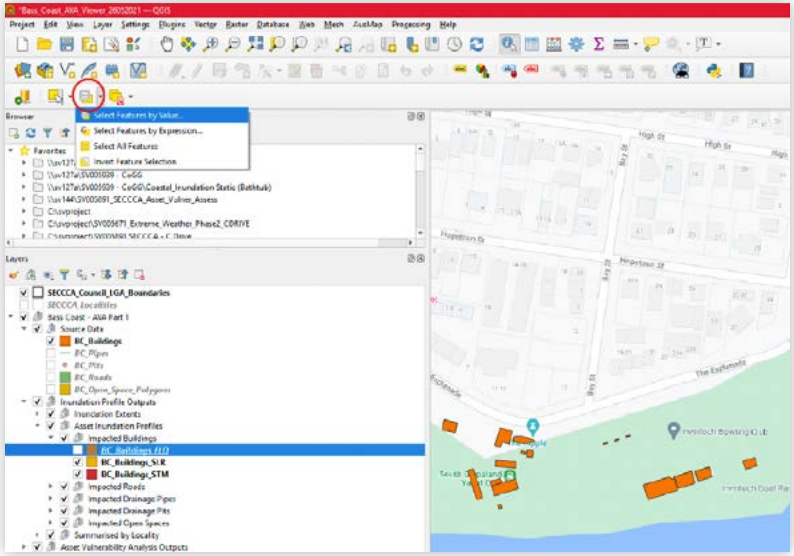

Figure 14: An example of the council AVA viewer interface (Spatial Vision)

APPENDIX 3

Glossary and abbreviations

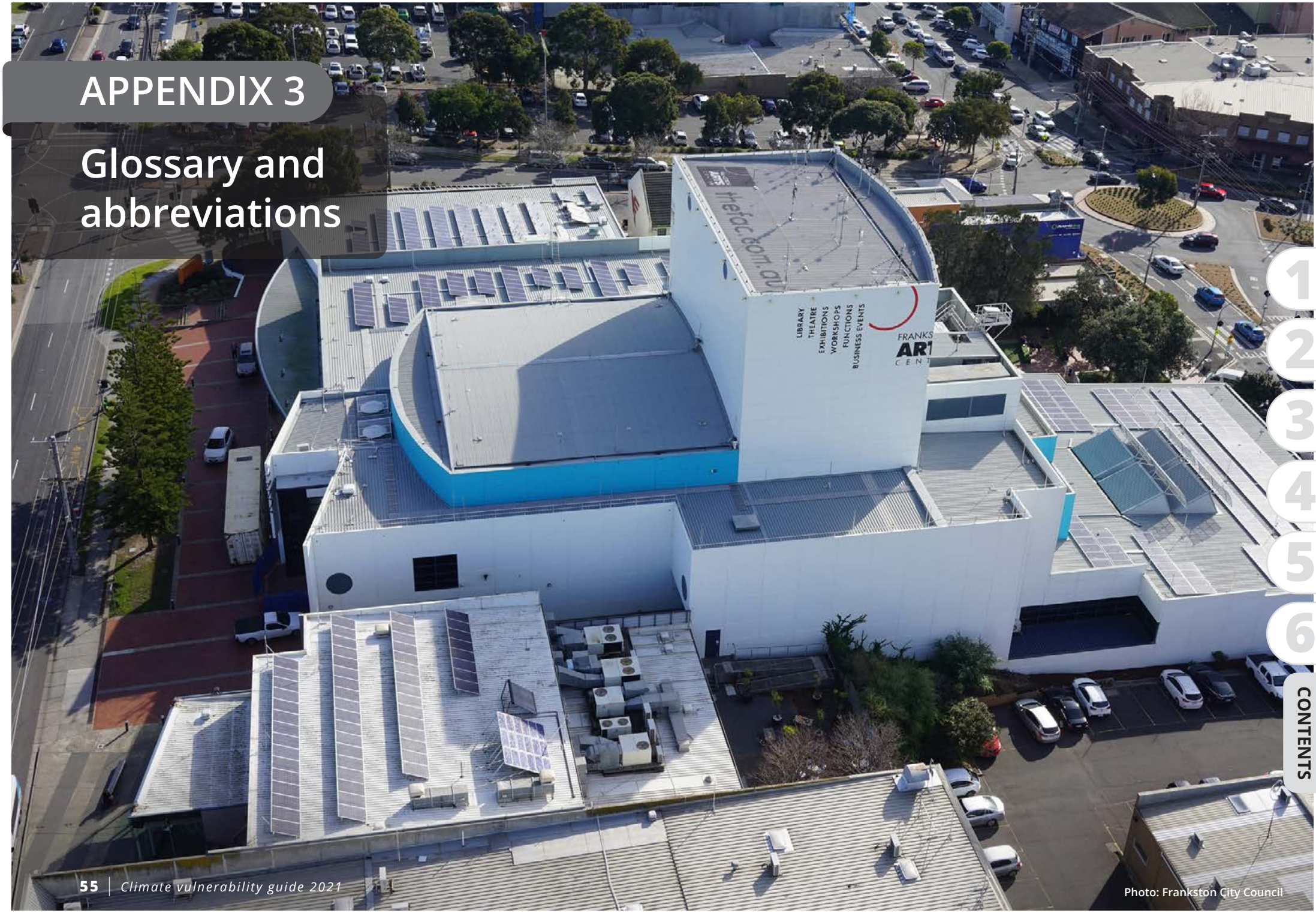

Photo: Frankston City Council

Abbreviations used in this guide

AEP	Annual Exceedance Probability
ARI	Annual Recurrence Interval
AVA	Asset Vulnerability Assessment
BNH CRC	Bushfire and Natural Hazards Cooperative Research Centre
CMIP5	Coupled Model Intercomparison Project phase 5
CMSI	Climate Measurement Standards Initiative
DELWP	Department of Environment, Land, Water and Planning
GCM	global climate model
ICA	Insurance Council of Australia
IPCC	Intergovernmental Panel on Climate Change
NPV	Net Present Value
PCG	project control group
PMF	Probable Maximum Flood
PWG	project working group
RCP	representative concentration pathway
SECCCA	South East Councils Climate Change Alliance
SSP	shared socioeconomic pathway
TCFD	Task Force on Climate-related Financial Disclosures
TRG	technical reference group

Glossary used in the project

The definitions below are based on those included in the Spatial Vision final report that were used throughout the project. These were discussed during a session focusing on communication and language, and draw significantly on IPCC (2007) definitions.

ACUTE: Climate change events or variables that have a short time frame and sharp response. Can relate more to extremes in climate or flooding/ storm events, the extreme 1 per cent Annual Exceedance Probability (AEP) events or 1-in-100-year events.

ADAPTATION: Adjustment in natural or human systems in response to actual or expected climatic variables or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

- **Anticipatory adaptation** – Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
- **Autonomous adaptation** – Adaptation that does not constitute a conscious response to climatic variables but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
- **Planned adaptation** – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

ADAPTIVE CAPACITY: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The adaptive capacity of a system or society describes its ability to modify its characteristics or behaviour to cope better with changes in external conditions. The more adaptive a system, the less vulnerable it is. It is also defined as the property of a system to adjust its characteristics or behaviour to expand its coping range under existing climate variability or future climate conditions. For this project, adaptive capacity relates to the ability of the asset to adjust to climate variables based on its current state.

ATTRIBUTES: Parameters or features of an asset that are described in database fields. These range from the materials from which the asset is built, to the maintenance schedule for an asset.

CHRONIC: Long-term climate change events or variables, such as temperature rise.

EXPOSURE: The influences or stimuli that affect a system. Exposure is a measure of the predicted changes in the climate for the scenario assessed. It includes both direct variables (such as increased temperature), and indirect variables or related events.

HAZARD: A process, natural or otherwise, that has the potential to affect a given area to a degree that assets may be at risk. In coastal areas, these hazards are primarily naturally driven and can include processes such as storms and sea-level rise. However, anthropogenic influences on these processes may be indirectly increasing the impact of the hazards.

IMPACT: The effect on the natural or built environment to particular hazards, including extreme events such as storms and other climate events. It relates to the exposure of an asset to a particular hazard and the sensitivity of that asset to that exposure.

MITIGATION: Human interventions to reduce the amount of greenhouse gases entering, or in, the atmosphere; this includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.

RESILIENCE: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.

RISK: The potential of losing or gaining something of value based on particular actions or inaction. A risk assessment evaluates potential risks, and the projected consequences are defined based on actions or inaction.

SENSITIVITY: The responsiveness of a system to climatic variables, and the degree to which changing climate might affect that system. Sensitive systems are highly responsive to climate and can be significantly affected by small changes. This term is often used interchangeably with the term susceptibility.

SPATIAL VIEW: An online or hardcopy map view of spatial data.

VULNERABILITY: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, the system's sensitivity and its adaptive capacity.

To discuss the project, please contact SECCCA

Email: enquiries@seccca.org.au

SECCCA
South East Councils
Climate Change Alliance

Photo: Bayside City Council