Spatial Vision

SECCCA Enhancing Community Resilience to Climate Change

Definitions and Approaches

Paper 1

Final

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About this document

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Cover photo: Storm damage in suburban Melbourne

SECCCA and Spatial Vision respectfully acknowledge the Traditional Owners of the lands on which we work, and pay respect to their Elders, past, present and future. We appreciate and acknowledge the advice and guidance of the Bunurong Land Council in assisting with the consideration of potential climate change impacts on First Nations communities, which for this study began with a focus on the Frankston Local Government Area.

Thanks to the Minderoo Foundation for supporting this project.

Contents

1 Introduction

The Enhancing Community Resilience project aims to help prepare communities in the South East Councils Climate Change Alliance (SECCCA) region for climate by applying practical actions and developing tools and resources. The project is focused on empowering project participants with access to new or improved information and services, enabling them to make individual decisions to prepare for climate change.

The participating councils include:

- Bayside
- Port Phillip
- Kingston
- Greater Dandenong
- Cardinia
- Casey
- Bass Coast
- Mornington Peninsula
- Frankston.

This report relates to initial background activities undertaken to select communities, and to then assess the vulnerability of specific groups within these communities to climate change.

This assessment of vulnerability constitutes Stage 2 of the Enhancing Community Resilience project. It involved a SECCCA-wide evaluation and four focused case studies that apply the SECCCA-wide information at a more detailed level.

2 Document purpose

This document outlines the key terms and definitions adopted in the Enhancing Community Resilience project, which was undertaken in partnership by SECCCA and SECCCA-member councils.

The document also describes the conceptual framework by which community vulnerability and resilience to climate change were assessed.

This document, referenced as Paper 1, should be read in conjunction with the SECCCA-wide outputs that are provided in the form of Microsoft (MS) Excel tables, PDF maps, and spatial data, as well as the additional papers developed as part of this project to gain deeper understandings of the various components of the project:

Paper 2 – *Vulnerable Populations*: Describes the vulnerable groups within the community, identified by SECCCA councils, to be of concern in relation to the likely impacts of climate change.

Paper 3 – *Methods and Application*: Outlines the process used to identify and assess the vulnerability of sub-populations in the community to climate change. This report provides a detailed explanation of how inputs into the vulnerability assessment method, such as the role of community assets, can be used as an entry point for the building of community resilience.

Paper 4 – *SECCCA-wide Outputs, Findings and Guidance:* Provides an overview of the outputs prepared and findings drawn from the SECCCA-wide evaluation. This report includes high-level guidance on how the outputs can be used to identify where there are likely to be groups or sub-populations in the community that are more vulnerable to climate-related events.

Paper 5 – *Case Studies*: Presents the findings of four case studies that apply the SECCCA-wide information for four separate geographic areas, where each case study considers a different climate-change-related event.

3 Project background

Climate change is significantly increasing risks such as fires, floods, coastal erosion, and heatwaves to local communities throughout Australia. Preparing communities for current and future changes to the climate is a critical task and requires protection of life, property, and wellbeing. Proactively preparing communities to act prior to, during and after disasters builds community resilience to future impacts and minimises risks and their consequences.

The Enhancing Community Resilience Project will help prepare communities in the SECCCA region for current and future changes to the climate, by improving community preparedness through practical actions, tools, and resources. Project participants will be empowered with information and access to new or improved services, enabling them to make individual decisions to prepare for climate change.

Leveraging the outputs of the SECCCA Asset Vulnerability Assessment (AVA) project, the project will also assess the vulnerability of the SECCCA region's community to climate change.

Working with SECCCA council members and climate science experts, the project will identify and visualise the community services, demographics, locations, and communities that are exposed to the impacts of climate change. Councils' community planners are integral in understanding vulnerability across communities, including cohorts such as aged care, disability, those with non-English-speaking backgrounds (NESB) and youth.

A further stage of the project will develop, deliver, and evaluate interventions to build community resilience to climate risk by working with expert community development practitioners, councils, emergency services, and communities.

The project outcomes and approach will be converted into a practical Toolkit for councils and communities that can be applied in other regions throughout Australia to build community resilience to climate change in these areas. This Toolkit was developed using a parallel evaluation and collation of lessons learned throughout the project.

For further background information on this project, refer to Appendix A.

4 Resilience and resilience assessment frameworks

4.1 Resilience

In the past few years, resilience has had significant attention in the context of climate change adaptation, disaster risk reduction and development co-operation.

Resilience is applied very differently in different disciplines. From a climate change perspective, an integrated social-ecological understanding of resilience is most appropriate. Following this line of thought, our environment is constituted by social-ecological systems (SES), which encompass five main dimensions: social, ecological, economic, physical, and institutional. The concept of resilience considers systems on various levels (e.g. households, communities, countries) as well as the interdependencies between these systems. Moreover, it regards risk, uncertainty and change as normal features of every SES.

In the broadest sense, resilience can be understood as the ability of an SES to deal with shocks and stressors. This ability depends on its capacity to absorb, adapt, and transform in the face of stressors threatening the system. Hence, it does not only include the responsive capacity to already known threats but also considers innovation, learning and anticipation to be prepared for projected impacts of a changing climate.

Resilience possesses many commonalities with the concept of vulnerability. However, there is no consensus yet on the exact relationship between the two terms.

To assess and monitor climate resilience in practice, a better understanding and clear definition of the term is needed. However, due to the complexity and multiple interpretations of resilience theory, there is still no consensus on factors leading to climate resilience. Similarly, there is no consensus on the variables that should be used to assess and quantify progress in becoming more resilient. Against this backdrop, a practice-oriented explanation of the central pillars of resilience is provided below. These pillars constitute the basis for assessing and monitoring climate resilience.

Building on these general considerations, climate resilience is defined as the ability of SES to absorb and recover from climatic shocks and stressors, while positively adapting and transforming their structures and means for living in the face of long-term change and uncertainty.

Key definitions

This project has adopted the following definitions, which provide a common understanding of how the project defines and measures concepts of resilience and vulnerability as they relate to climate change and stressors. Several terms will be introduced here and will be expanded on in the course of this discussion paper.

Vulnerability:

'The degree to which a system is susceptible to, or unable to cope with shocks and stressors. Vulnerability is a function of the character and magnitude of shocks and stressors to which a system is exposed, its sensitivity, and its adaptive capacity.'

Resilience:

'The ability of a system to deal with shocks and stressors, while retaining the same basic structure and function, the capacity for self-organisation, and the capacity to adapt to stress and change.'

Climate resilience:

'The ability of a system to absorb and recover from climatic shocks and stressors, while positively adapting and transforming their structures and means for living in the face of long-term change and uncertainty.'

Additional terms that build on and relate to the vulnerability or resilience of a system are included below. These terms link back to concepts relating to the capacity of a system to deal with climatic shocks and stressors. These have been used in many different forms across a multitude of papers and projects. Here we broadly apply three definitions for these capacities:

Mitigation/Absorptive capacity:

'The ability of a system to prepare for, mitigate or recover from the impacts of negative events using predetermined responses to preserve and restore essential basic structures and functions.'

Adaptation/Adaptive capacity:

'The ability of a system to adjust, modify or change its characteristics and actions to better respond to existing and anticipated future climatic shocks and stressors and to take advantage of opportunities.'

Transformation/Transformative capacity:

'The ability of a system to fundamentally change its characteristics and actions when the existing conditions become untenable in the face of climatic shocks and stressors.'

These three definitions relating to capacity broadly cover and join concepts on the ability of a system to prepare for, respond to, and recover from climatic shocks and stressors. These three factors, individually or together, are important aspects when attempting to quantify and understand the resilience or vulnerability of a system.

4.2 Resilience and the social

Extensive research suggests that resilience can be understood as a social phenomenon. This means that resilience can be theorised and measured as a collective quality (rather than a personal attribute of an individual).

Some commentators have focused on community as:

- context (local environments providing a set of risk and protective factors that have an influence on the wellbeing of community members)
- collective actors who can exhibit resilience by organising and acting in response to adversity.

Terms such as solidarity, co-operation, the collective, group membership, identity, and reciprocity, recur in research that examines resilience as a social phenomenon.

4.3 Resilience and assessment frameworks

Figure 1 shows the relationship between resilience and our environment, expressed in terms of SES (Welle, 2014). This figure also identifies the characteristics of a resilient system or community.

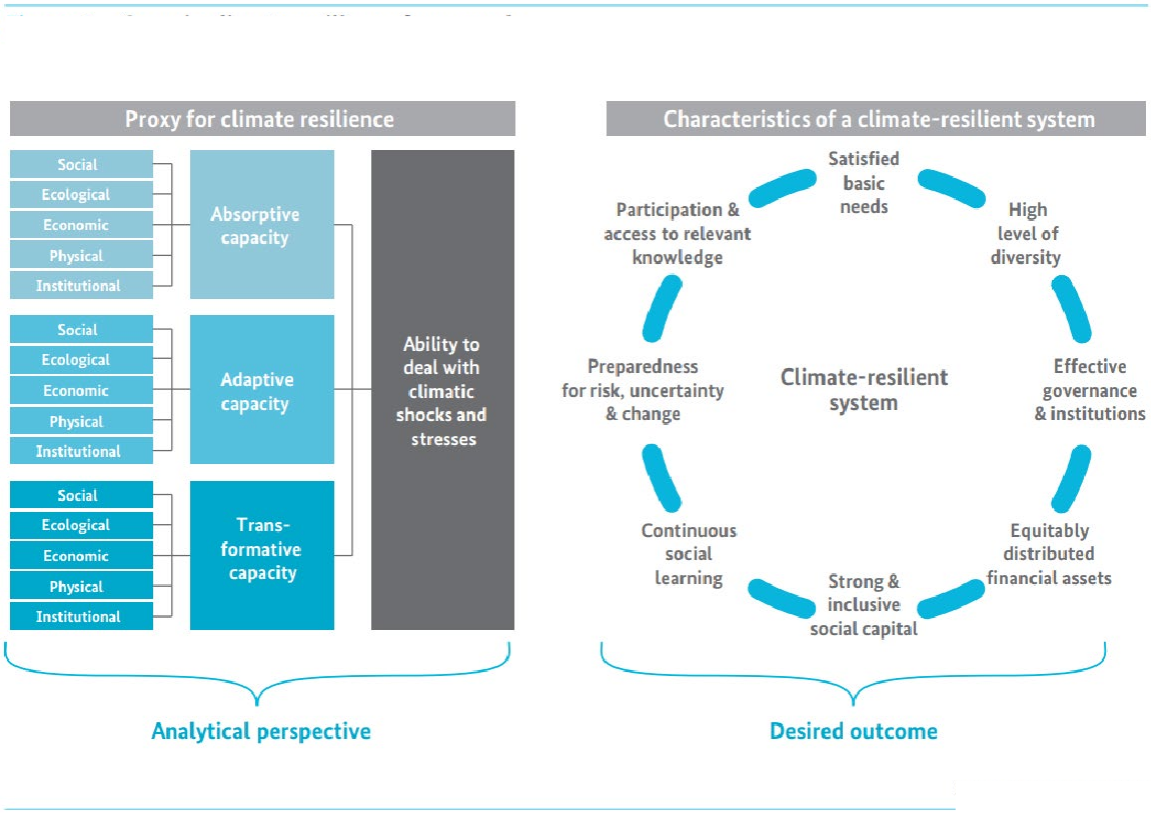

Figure 1. High-level generic climate resilience framework (Source: Welle, 2014).

Figure 1 identifies five social-ecological system components that are defined by Welle (2014):

- social: primarily refers to characteristics such as health, education and food security
- ecological: particularly addresses the diversity and state of the natural environment
- economic: comprises the economic activities within a system as well as the availability and distribution of financial assets and other endowments, which may fulfil a variety of purposes
- physical: mainly focuses on physical infrastructure such as housing, transport infrastructure, communication networks or health facilities
- institutional: focuses on effective governance and institutions as well as participation on various levels.

The relationship between the intensity of extreme weather events and severity of climate change impacts and aspects of resilience is presented in Figure 2. This figure, sourced from Cornelius et al. (2018), identifies the relationship between the absorptive coping, adaptive and transformative capacities to deal with event severity types and change.

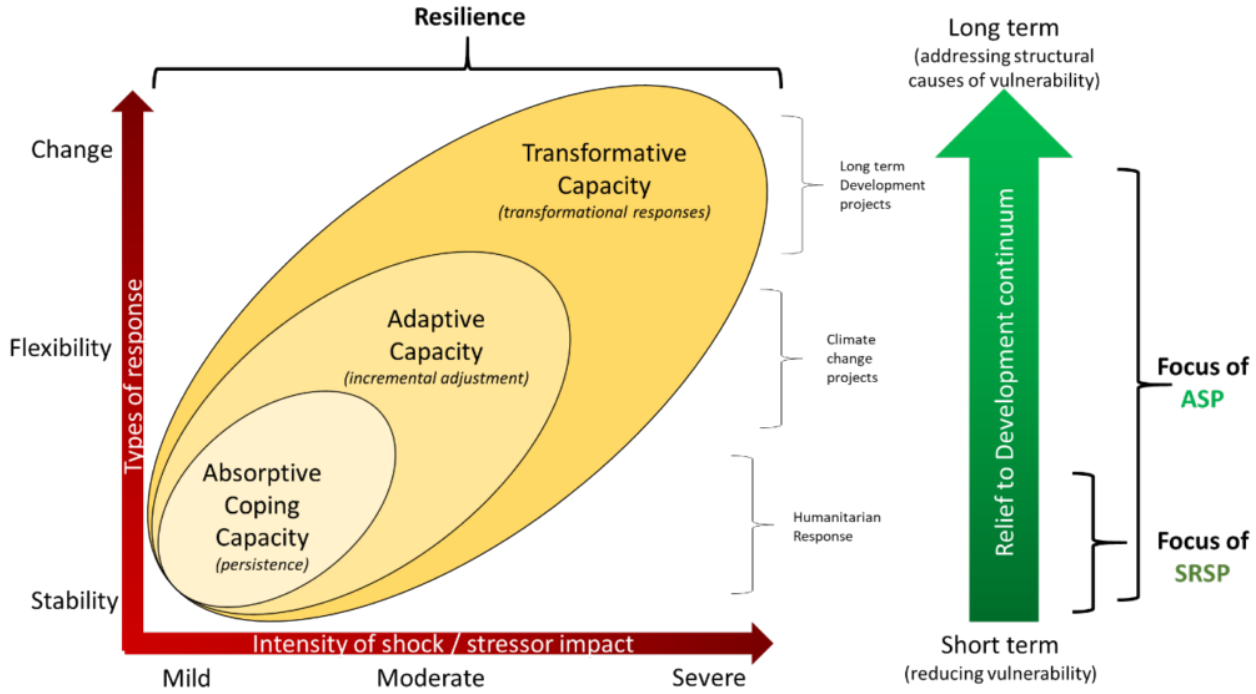

Figure 2. High-level relationship between the intensity of extreme weather events, change impacts and aspects of resilience (Source: Cornelius et al. (2018)).

5 Vulnerability assessment frameworks

5.1 Background

Underpinning the broader concepts around an overall vulnerability assessment method are the approaches developed by the Intergovernmental Panel on Climate Change (Qin, 2007). These methods describe how likely exposure to climate change, and sensitivity and adaptive capacity of assets and systems to these climate scenarios, are used to assess the likely impacts and vulnerability of assets and systems.

The broader conceptual framework on which these vulnerability assessment approaches are based is presented in Figure 3.

Solid lines indicate direct affective relationships between biophysical components (such as the impact of climate change on direct climate variables, or of non-climate variables on exposure to climatic variables). Dashed lines indicate the effects of human activity, including the impacts of climate change, and adaptation and mitigation activities (adapted from Capon et al. 2013, and developed by Brunckhorst, 2011).

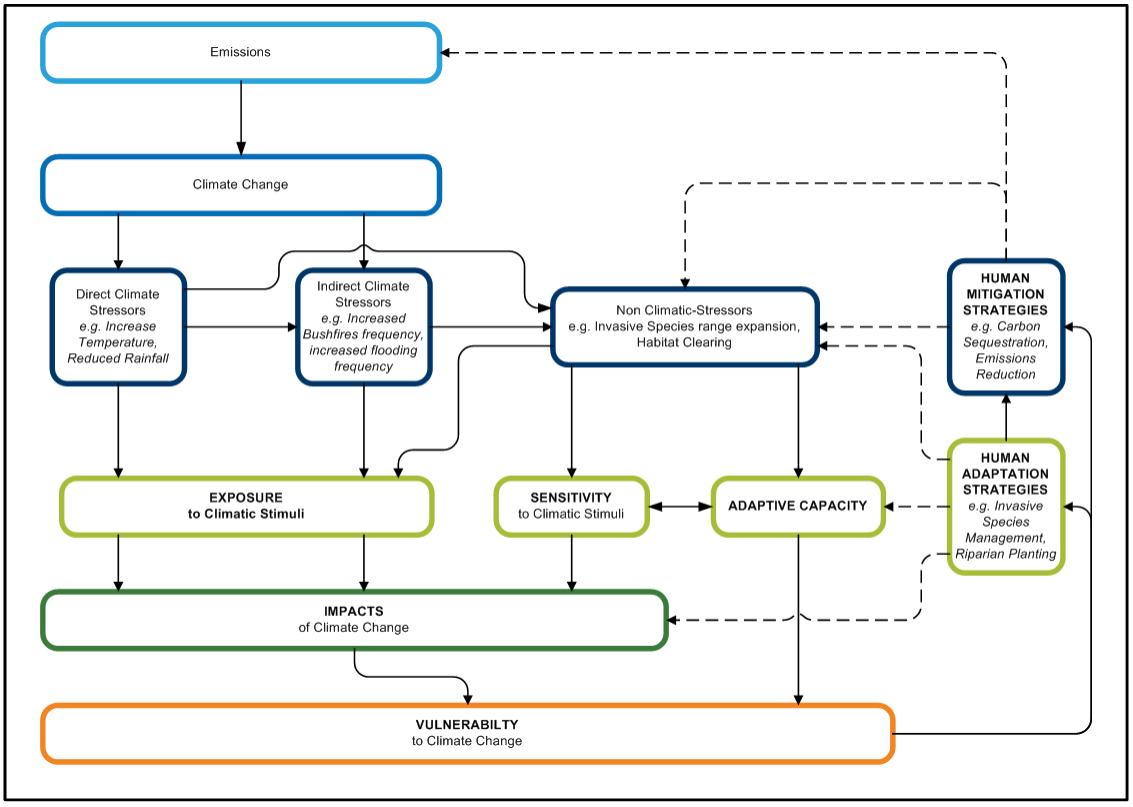

Figure 3. High-level conceptual framework for assessing vulnerability to climate change, showing relationships between exposure, sensitivity, impacts, adaptive capacity and vulnerability (Source: Capon et al. 2014).

This approach generates an impact rating based on assessed asset sensitivity to different climate change exposure scenarios. The adaptive capacity of assets in relation to impacts is also assessed and used to assign asset vulnerability, where adaptive capacity relates to asset condition and context.

The first-pass asset vulnerability assessment approach previously applied to SECCCA-built assets involved using individual asset characteristics to assign a likely estimate of an asset's sensitivity to particular climate change variables, and features of the asset impacting its adaptive capacity to such change. Suitable asset attribute information was required to support this assessment.

A review of how individual asset attributes were used to support this assessment was undertaken and agreed on with council staff.

5.2 Vulnerability assessment framework applied in SECCCA AVA

Figure 4 presents how this vulnerability assessment framework was applied in the SECCCA Asset Vulnerability Assessment (AVA) project. It is suggested to refer to this project documentation (Spatial Vision, 2021) as it will give greater context and depth to the following section. As indicated, this framework was developed by the International Panel on Climate Change (Qin, 2007) and previously applied in multiple climate change vulnerability assessments (Spatial Vision, 2020; 2021).

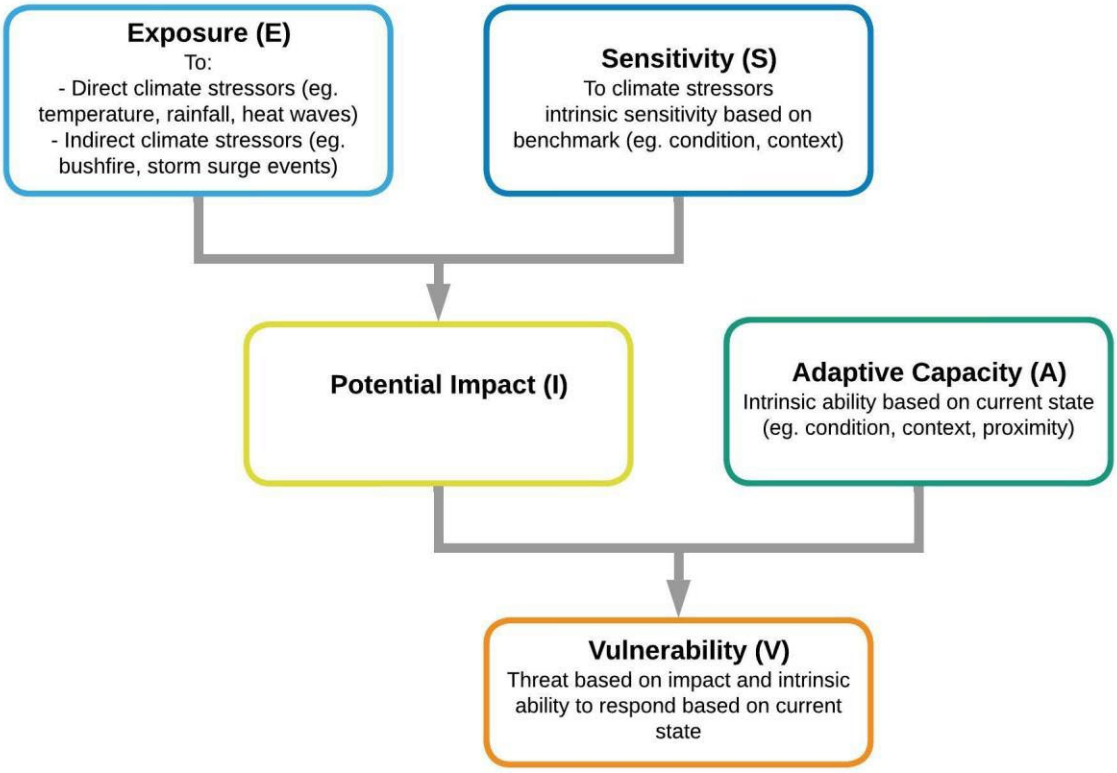

Figure 4. High-level conceptual framework applied in the SECCCA AVA project to assess vulnerability to climate change.

Key definitions

Key definitions relating to this framework, building on the vulnerability definition introduced above, are:

Exposure: relates to the influences or stimuli that impact a system. Exposure is a measure of the predicted changes in the climate for the future scenario assessed. It includes direct variables (such as increased temperature) and indirect variables or related events.

Hazard: refers to a process, natural or otherwise, that has the potential to impact a given area to a degree that assets associated with that location may be at risk. In the context of 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 are indirectly increasing the impact of the hazards.

Impact: refers to the effect on the natural or built environment by 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.

Sensitivity: reflects the responsiveness of a system to climatic variables, and the degree to which changes in climate might affect that system in its current form. Sensitive systems are highly responsive to climate and can be significantly affected by small climate changes. This term is often used interchangeably with the term 'susceptibility'.

Adaptive capacity: aligns with the previously introduced definition of adaptive capacity. Within this framework, it broadly relates to intrinsic or inherent factors 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.

Consequence: considered in the emergency-management context to be the change in circumstances, planned or otherwise, experienced by a community or its members as a result of an event and its subsequent management. A consequence approach moves the focus from a specific hazard, such as fire or flood, to broader consequences that may affect a community regardless of hazard source. Despite how resilient a community is to shocks and stresses or how well prepared it is for emergencies, events will occur that exceed a community's levels of resilience and preparedness.

5.3 Building on the AVA framework

The AVA framework has been used in many applications, and it can be adapted to new understandings within applied climate studies. A key variation on the AVA approach centres on 'risk' as a central concept and splits hazard and exposure to focus on the nature and location of the hazard (shock) and the severity of the exposure (stressor).

An assessment of risk in relation to climate change should not only concentrate on factors that relate directly to climate change, as has been the approach with the AVA framework, but it should also incorporate other pathways and options that a system may take. According to the IPCC, not only does the severity of a disaster depend on climate events, but also on exposure and vulnerability, which arise from non-climatic factors.

Key definitions

Risk: can be defined as the potential to lose or gain something of value based on particular actions or inactions. A risk assessment, or analysis, is the process by which these potential risks are evaluated, and the projected consequences are defined based on this action or inaction.

Figure 5 presents how the vulnerability framework approach applied in this and earlier SECCCA projects can be varied to incorporate risk, or potential impact, as the key output. Here, the hazard or event type shapes the sensitivity and capacity factors used to inform a vulnerability rating. This then can be further influenced by the exposure of the climate event, and factors such as severity and duration.

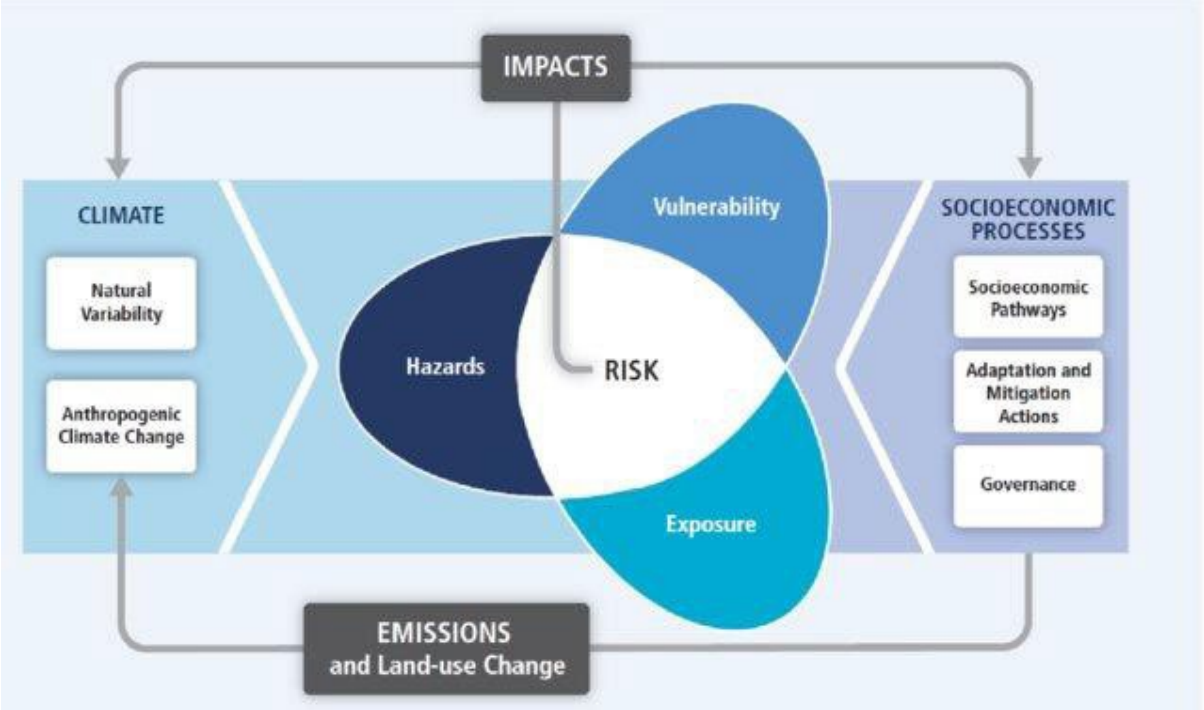

Figure 5. High-level framework that incorporates risk, or potential impact, as the key output and separates hazard from exposure (Source: Miola et al. 2015).

Figure 6 summarises how the AVA framework may be transformed by separating the hazard (threat) from the exposure (event), and having the threat inform the likely vulnerability based on sensitivity and capacity of an asset or system to respond in relation to the hazard. The potential impact or risk therefore results from the combination of the vulnerability of an asset or system and the actual exposure (event) it experiences in terms of its severity, duration, and spatial extent. This model was adopted for this project, with further details presented later in this document (see Section 11: Proposed approach to assess community vulnerability).

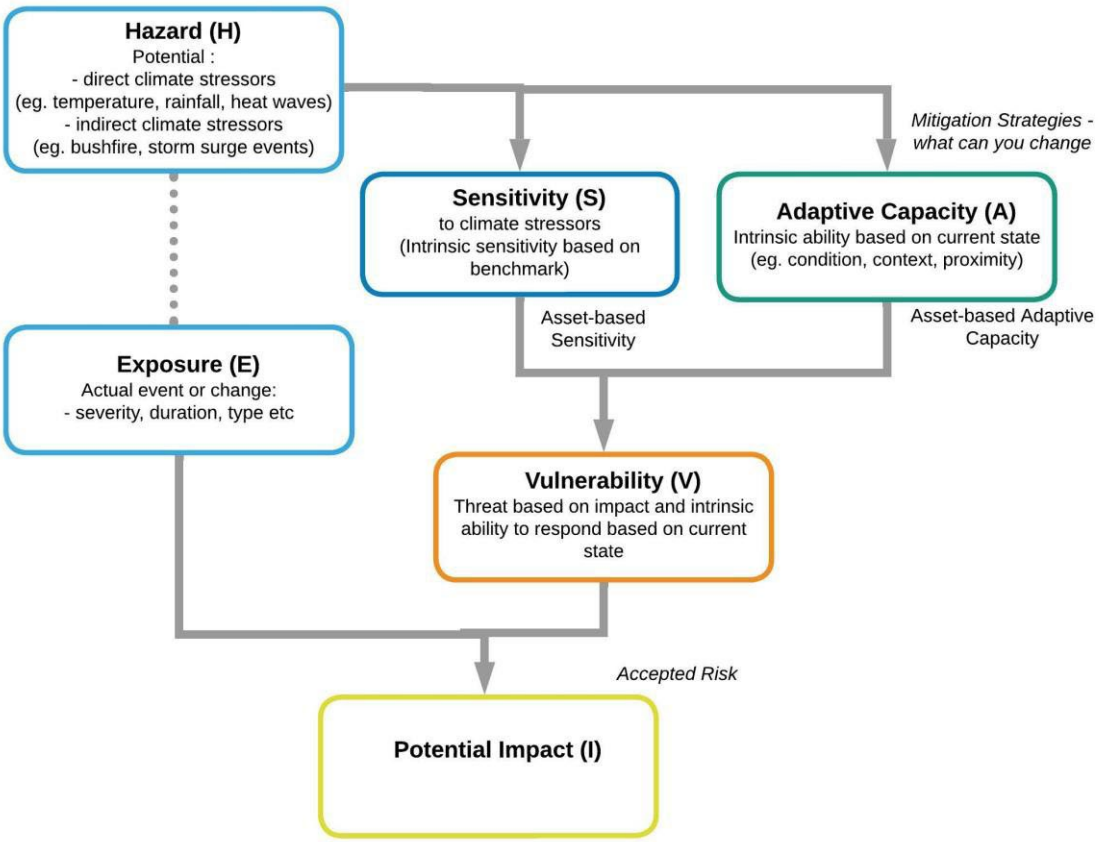

Figure 6. High-level conceptual framework adopted in this study building on the earlier AVA work.

6 Relationship between resilience and vulnerability

As introduced above, various definitions can relate to vulnerability and resilience as they relate to climatic shocks and changes.

From a practical application purpose, these definitions and frameworks on climate resilience have many competing, and often conflicting, terms of use. Welle (2014) provides guidance on this issue: 'Due to the multitude of definitions of both resilience and vulnerability, their mutual relationship is highly debated. A practical approach is to understand resilience and vulnerability as two distinct but overlapping concepts with a negative correlation. This means that systems with high resilience usually exhibit low vulnerability and vice versa.'

Practically, the inverse relationship between vulnerability and resilience can be a useful concept to carry forward throughout this project. If we can measure the relative vulnerability of a system then, conversely, we can understand how resilient the system is.

Conceptually, this inverse relationship becomes a linked system where the notion of understanding the vulnerability of a system provides insights into the resilience of a system.

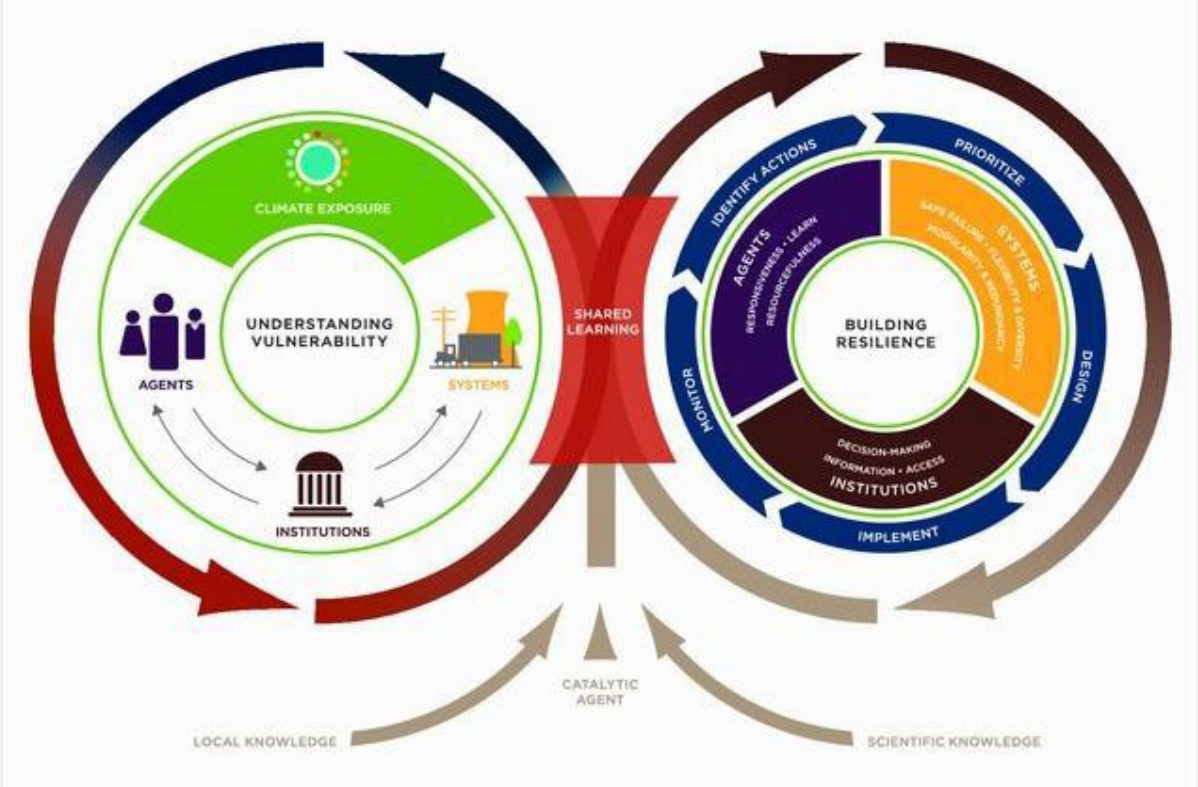

Figure 7. High-level conceptual framework linking vulnerability and resilience as an inverse relationship (Source: Moench et al. 2014).

7 Weather and climate

7.1 Weather and climate change

Key definitions

Definitions of weather and climate adopted in this project were:

> 'Weather' is day-to-day information of the changes in the atmospheric condition in any area. It refers to short-term conditions or events. However, in relation to climate change, weather is often discussed in the context of an abrupt shock or event. This is often referred to as an 'extreme weather' event.
>
> 'Climate' is statistical weather information that provides information about the average weather condition of an area over a long period. Changes in the weather condition can be observed very frequently.
>
> 'Climate change' refers to long-term changes in regional climate patterns as influenced by anthropogenic impacts such as increased fossil fuel usage and input of greenhouse gases that alter atmospheric conditions.
>
> 'Climate history' builds on the insights of paleoclimatology (the reconstruction of past climates from the archives of nature) and historical climatology (the reconstruction of past climates and weather from the archives of societies), as well as the methods of conventional history.
>
> 'Extreme weather' refers to weather phenomena that are at the extremes of the historical distribution and are rare for a particular place and/or time, especially severe or unseasonal weather. An extreme weather event is significantly different from the average or usual weather pattern. This may take place over one day or a longer period of time. Flash floods, storms, and heatwaves are examples of extreme weather events.

Figure 8 presents a high-level schematic view of the relationship between extreme weather events and climate change. It shows how resilience to events and changes in climate can be viewed in terms of the timeframe in which events and changes are viewed. It also notes how resilience to a weather-based event that occurs over a period of hours or days will require different aspects of resilience to those required to deal with longer-term climate change and associated impacts over months and years.

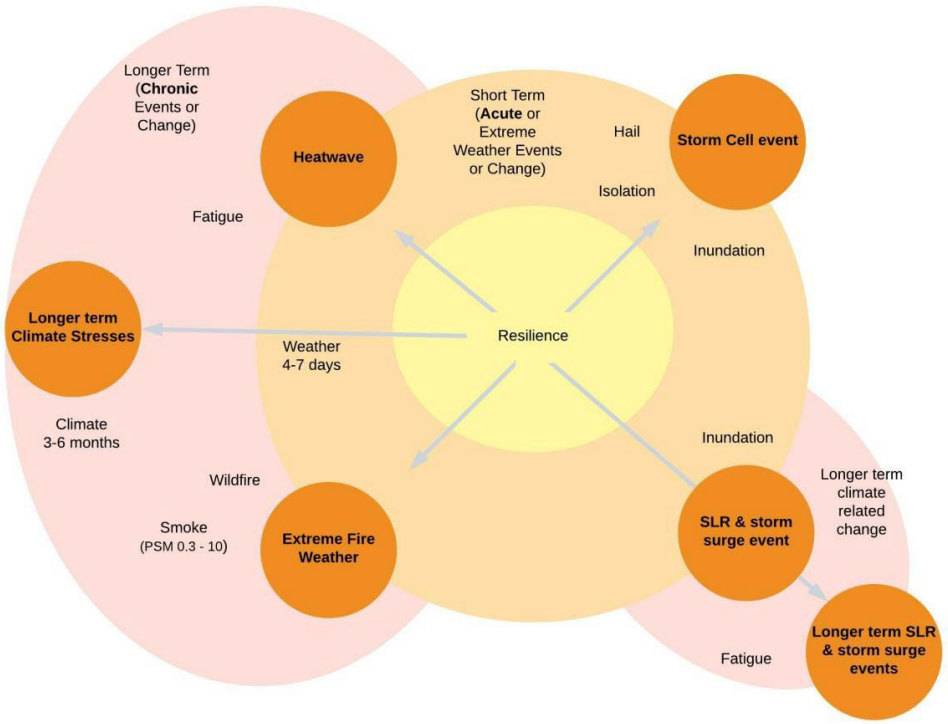

Figure 8. Compounding nature of extreme weather events and climate change impacts.

7.2 Exposure data

In assessing the likely impacts of climate change on the SECCCA region, the following areas were identified by councils to be of particular concern:

- flooding extent and depth due to severe storm cells or prolonged periods of high rainfall
- extreme heat related to summer maximum temperatures or heatwaves
- extreme fire risk related to greater frequency of dry and hot spells, in addition to greater frequency of 'fire weather'
- increased frequency and severity of coastal inundation related to sea-level rise and increased severity and frequency of coastal storm surge events.

Flooding and inundation

Flooding and inundation impacts were considered in the SECCCA AVA project but were not directly incorporated or assigned to likely climate futures. Inundation data available for use in this project includes modelled flood extent data. This information identifies the likely area flooded for selected recurrence intervals, such as a 1-in-100-year recurrence or 1 per cent Annual Exceedance Probability (AEP). Inundation data applied in this project were sourced from state government, water authorities and councils.

The data sources for this project did not provide flood depth alongside extent. The Insurance Council of Australia (ICA) National Flood Information Database (NFID), which contains flood depth information, can be used in the assessment of council-held assets for localised case study purposes.

NFID is focused on flooding that has occurred on private property and related insurance considerations.

Future climate projections of flooding extent and depth can be problematic to model. Factors such as local terrain and flow restriction points, localised landscape weak points, landslip areas prone to increased flow velocity, river flow velocities and other hydrological factors need to be accounted for when modelling future scenarios. During the SECCCA AVA project, these models were not available.

The AVA project also focused on flood recurrence intervals, which are based on likely flood frequencies such as one flood every 5 years or 100 years. It is accepted that, under likely future scenarios, flooding and inundation will become more frequent due to increased sea levels and changed climate rainfall patterns. Therefore, recurrence intervals can act as likely future scenarios, noting that the application of historical recurrence intervals in combination with future climate projections requires expert guidance. The overall assessment will include consideration of the following three inundation events:

- coastal inundation
    - sea-level rise at 20 cm, 47 cm and 82 cm
    - sea-level rise of 20 cm, 47 cm and 82 cm with 1 per cent AEP storm surge event
- overland flooding
    - 1-in-100-year flood event extent based on historical data.

Melbourne Water has begun creating a flood depth analysis using a climate forcing for their jurisdictional boundaries, but currently this is only for a limited number of creeks and basins and is only for 2100.

A basic understanding of future scenario points can be gained using current recurrence intervals and AEP levels. It is accepted that, under likely future scenarios, flooding and inundation will become more frequent due to increased sea levels and changed climate rainfall patterns.

However, the application of historical recurrence intervals in combination with future climate projections requires expert guidance.

Bushfire

A fire risk index, as a single variable measure, was not included in the vulnerability analysis.

In the initial SECCCA AVA project it was proposed that bushfire risk factors be included as a single variable in the assessment. Through subsequent discussions with the SECCCA technical reference group, in particular Ramona Dalla Pozza from the Victorian Department of Environment, Land, Water and Planning (DELWP) and Dr Roger Bodman (CSIRO), who was undertaking fire variable analysis for DELWP as part of the Victorian Climate Projections 2019 (VCP19) program, it was understood that a single index would not provide an accurate indication of fire change and risk into the future.

Therefore, a range of other key variables were adopted and assessed. These included dryness, rainfall trends and temperature increases, which when used in combination can be used to indicate areas likely to experience an increase in fire danger.

Secondary data layers, such as bushfire management overlays, and fuel load information were also considered. Tom Davies (ICA) has advised that the ICA primarily uses bushfire management overlays in their assessments.

Figure 9 presents a conceptual framework that identifies four factors that influence fire regimes or risks in a landscape. The figure indicates that, while fuel load is influenced by climate or growing conditions, climate also impacts the other elements of the framework – including fuel dryness (and hence flammability), fire weather, and likelihood of an ignition source (particularly lightning).

As indicated in Figure 9, climate variables such as seasonal rainfall distribution or deficiencies, temperature changes, dryness indexes and extreme weather days in relation to rain or temperature can be used to provide context to fuel dryness and fire weather.

This framework supports the adoption of key variables such as changes to seasonal rainfall, monthly temperatures and dryness to assess likely fire regime impacts.

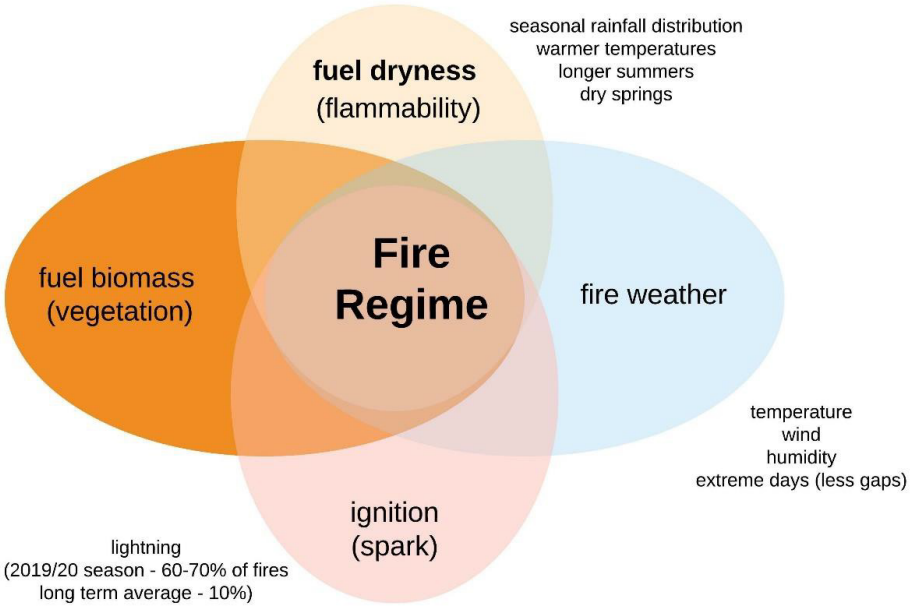

Figure 9. Relationship between climatic variables and landscape factors associated with increased fire risk.

Wind

Current observations and future climate change projections for wind factors were explored by the project team for inclusion in the project. The VCP19 database includes wind speed as part of its suite of variables. However, observations and projections are monthly and not available as daily data (as provided for other climatic variables), resulting in a comparatively coarse dataset.

Additionally, the available data only presents the average projected wind speed over a given month, and not details on wind direction or wind gust speeds. Furthermore, the available data does not show any significant variation in monthly wind speed for any of the climate scenarios.

As such, the data is more generalised than what is required for a vulnerability assessment and was not used.

Similarly, there is limited information on storm event frequency.

Heat and extreme temperatures

Exposure to heat-related events was explored using the original SECCCA climate data leveraged for the AVA. This involved using the frequency of heatwave events for the region, changes in daily maximum or minimum temperatures, or the frequency of extreme temperatures. Changes in these variables under likely future scenarios was explored relative to the current baseline climate.

Excessive periods of dryness due to low rainfall and heat were also included in the consideration of likely climate change. Changes in dryness are expressed in terms of changes in the standard precipitation index measure.

Climate change projections

To explore the likely impacts of heat-related events on vulnerable communities, this project used the most recent climate modelling prepared by CSIRO as an outcome of the IPCC 5th Assessment Report (AR5). The application-ready data was made available as part of VCP19.

The VCP19 updated modelling includes downscaled modelling to a resolution of 5 km^2 Victoria-wide, within the Coupled Model Intercomparison Project Phase 5 (CMIP5) suite of projections initially made available through CSIRO at a coarse resolution in 2015. These were updated based on new understanding and modelling techniques and are available for all of Victoria.

Up to six General Circulation Models (GCMs) for the projected years of 2030, 2050, 2070 and 2090 can be found in the VCP19 database and are available at two different Representative Concentration Pathway (RCP) emissions scenarios of 4.5 and 8.5. These six models provided a range of projected climate changes and impact assessments, ranging from a warmer and more minimal rainfall change to a hotter and drier projected future.

From these six available climate models, three were used to provide a range of potential climate futures. This includes models that present a 'hotter and drier' future for Victoria, a 'comparatively warmer and wetter' future and a 'middle ground' maximum consensus future. Respectively, these represent maximum, minimum, and median climate future projections.

Each model can be treated as an independent future scenario, with each being equally likely to transpire. Given that these are unique scenarios that depend on alternative effects of climate change, the creation of a combinatory multi-model output would not be descriptive and so is not recommended.

All future projected climate and downscaled outputs were based on a 30-year baseline period. In the VCP19 database, this baseline is derived from historical observed climate records from 1981 to 2010. Other climate databases are known to have differing baselines, but the principles of downscaling from a coarse to a higher resolution are largely similar.

Extreme weather events

While extreme weather events are not readily modelled in the latest climate science or down-scaled modelling available through the CSIRO, the latest modelling outcomes were used to help contextualise key trends in the climate data that directly influence likely extreme weather events for the region. For example, locations were identified where daily rainfall is anticipated to exceed a particular threshold at a future date under a particular scenario.

Climate change events that have a short timeframe and sharp response often relate more to extremes in climate. This includes, for example, extreme flooding and storm events such as extreme 1 per cent AEP events, or 1-in-100-year events.

7.3 Available data

Application of the latest climate change data from CSIRO involved evaluating relevant annual and monthly climate variable data for agreed carbon emissions scenarios. This information was prepared for presentation in a spatial data viewer with a supporting graph-based view of these key climate variables. Evaluation of likely change for the periods of 2030, 2050, 2070 and 2090 and historical decadal information was used to inform trends of key variables such as rainfall and daily maximum temperatures.

Views of future heatwave events for the SECCCA region are presented in Figure 10. This map view shows the significant variation in the frequency of heatwave events across the region anticipated in 2050, where red represents the higher level of heatwave frequency. The graph view shows the change from a baseline period (on the left in grey) to 2070 (on the right in green).

A view of flood-related data for the SECCCA region showing the 1-in-100 flood extent is presented in Figure 11.

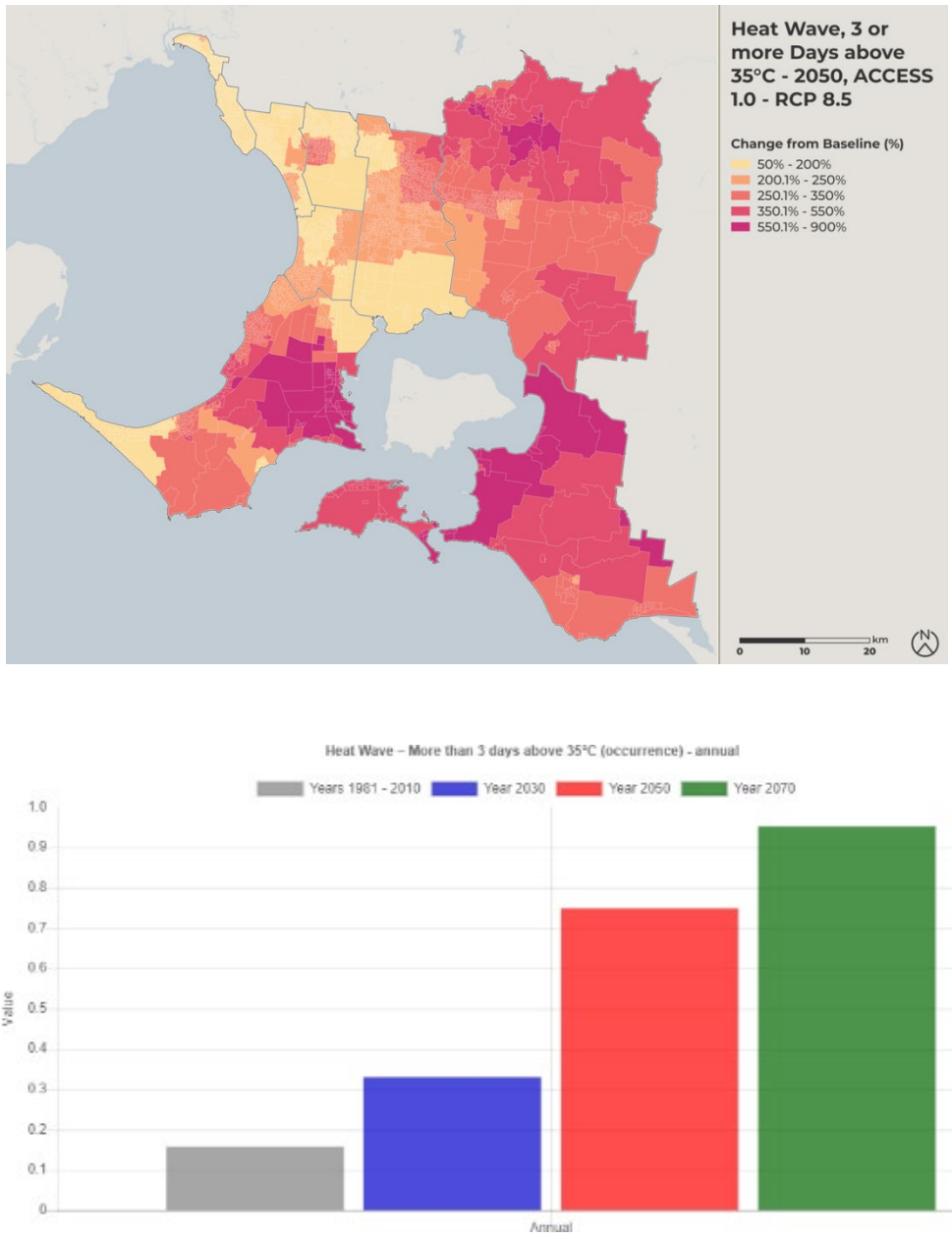

Figure 10. Views of future heatwave events (under ACCESS 1.0 GCM and RCP8.5) for the SECCCA region (map view is for 2070).

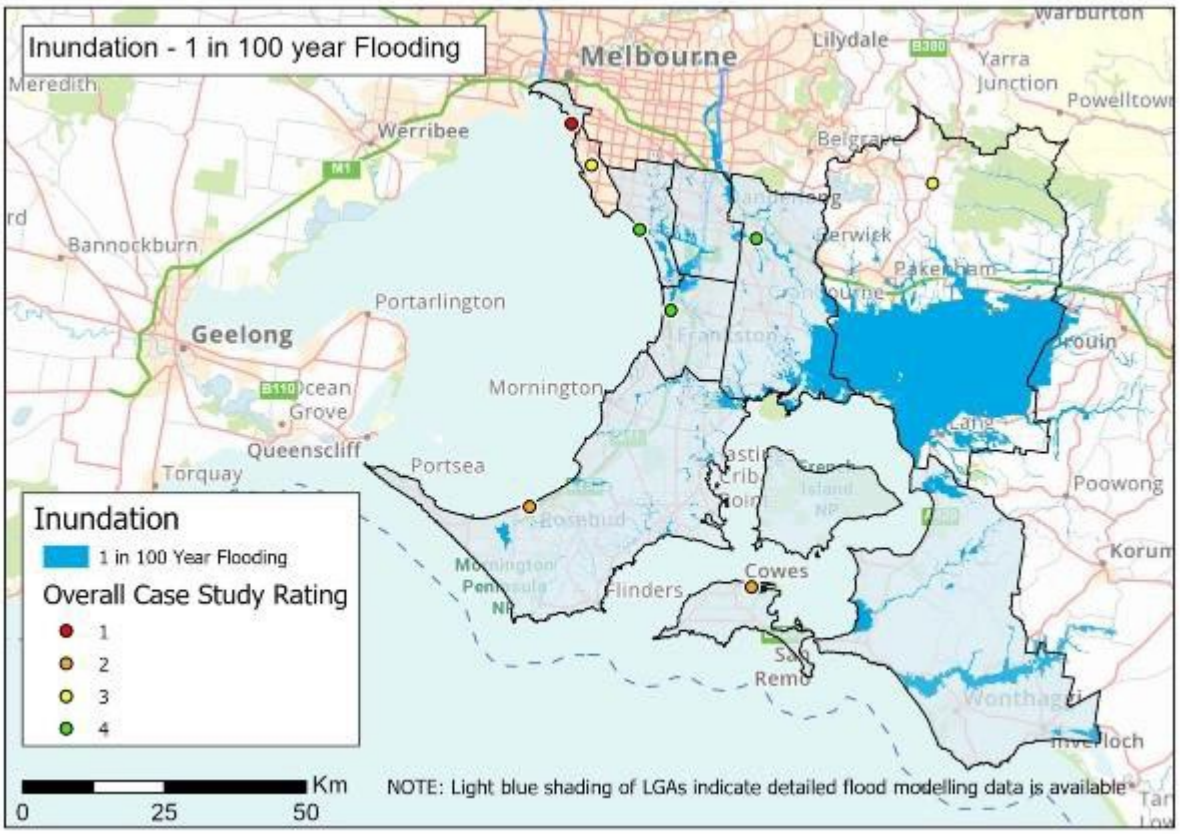

Figure 11. Views of 1-in-100-year flood event for the SECCCA region.

7.4 Alignment with other climate initiatives

The SECCCA AVA project, including the development of the second pass case studies, aimed to align with the Climate Measurement Standards Initiative's (CMSI) principles, concepts, definitions and methodologies applied.

The overarching principles of the CMSI are:

1. Use credible scientific sources, assessments and research published in peer-reviewed scientific literature or from reputable scientific authorities.
2. Use multiple lines of evidence to assess risk and, where possible, use existing assessments of multiple lines of evidence.
3. Where possible and appropriate, survey multiple model ensembles.
4. Appropriately communicate uncertainty.
5. Use model outputs appropriate for the question addressed. The principles have been further developed by the CMSI to advise:

    - supporting international standard RCPs as plausible trajectories
    - using a range of plausible regional climate change (a broad range of possibilities can be considered, including consideration of a 'best case' or 'worst case' change if that is more useful)
    - examining climate projections to ensure they are fit for purpose before using a climate projections dataset for assessing impacts, developing, where feasible, hypothetical scenarios to 'stress test' systems that invoke compound events.

A detailed explanation of these principles, concepts and definitions is provided in the CMSI (2020).

The CMSI also includes the following two types of climate change events:

Acute/abrupt event:
Climate change events that refer to climate exposures or variables that have a short timeframe and sharp response. They can relate more so to extremes in climate or flooding/storm events, the extreme 1 per cent AEP events, or 1-in-100-year events.

Chronic/incremental event:
Climate change events that refer to climate exposures or variables that have a long-term timeframe and slow response. Mainly relates to climate change over time (for example, temperature increases over time).

8 Establishing a vocabulary in relation to 'community'

8.1 Establishing a vocabulary

This project is based on the premise that positive social relationships reduce vulnerability and enhance resilience. This conviction is informed by the findings from research on the social determinants of health (Marmot and Wilkinson, 2005; Wilkinson and Pickett, 2010).

For example: '… loneliness (is) on the list of risk factors for ill-health and early death right alongside smoking, obesity and lack of exercise' (Cacioppo and Patrick, 2008: 108).

A broad-strokes understanding of the social determinants of health can be translated into outcomes that had material relevance to the work of the project:

1. Positive social connection is a key building block for wellbeing.
2. Positive social connection is a prerequisite for physical and mental health.
3. Loneliness and social exclusion are associated with poorer physical and mental health.
4. Recovery from, and resilience to, the extreme incidents and possible traumas experienced in disasters are inversely correlated to impoverished or conflictual social connection.

This project appreciated the role positive social connection can play in reducing climate-change-related vulnerability. While this project intended to develop recommendations to promote positive social connection, it was important to recognise the difficulties associated with this endeavour. Before examining the options that might enhance social connection that were considered in the later stages of the project, the following examines why it is difficult to conceptualise, and manipulate, the phenomenon that is social connection.

This first step in this examination concerns language. More specifically, it is concerned with problems of how the relevant words and terms are understood and used. This exercise is a practical step as it is impossible to understand the phenomenon in question, and to formulate practical solutions, if the conceptual vocabulary that is used precludes a clear line of sight.

8.2 The term 'community' is confusing

The ABC's national news reported that '30 communities' in and around Kalorama in the Dandenong Ranges of Victoria had been affected by a 2021 storm cell event (Channel 21; 7.00 pm; 06.06.22). Viewers probably understood this to mean 30 very small groups of houses, and their residents, plus adjacent buildings, such as shops and schools, had been impacted. In this usage, 'community' denoted something very local: a grouping that is hamlet-sized or village-like. This meaning references *geographic proximity* as the basis for affinity and group membership.

A variation to the above is where shire, regional, state or national boundaries are used to attribute group membership.

A very different meaning to the above is encountered when one hears or reads about 'the business community' or 'communities of faith'. In this usage, the meaning references commonality of interest, identity or religion as the basis of affinity rather than geography. Bundling the above, a 'human community' is a social unit (a group of living things) with commonalities such as place, norms, religion, values, customs or identity.

Logically, commonalities of interest can take many forms. These forms may, or may not, be referenced to the word 'community' (e.g. a book club is a group based on a common interest, but this assemblage is not generally understood to be a community). It might also be noted that 'interest' and 'geography' can be linked as the basis of affiliation (e.g. members of, say, the Orthodox Greek church in Oakleigh, or a neighbourhood online book club).

Proposed definition

Like 'vulnerability' and 'resilience', the term 'community' is key in the design of this project. Each of these terms can be ambiguous.

For example, 'vulnerability' can be referenced to a wide range of variables – to the risk of death, the loss of income, susceptibility to mental ill-health and more – while the term 'resilience' is especially dynamic in its usage.

'Resilience' has an unstable meaning that oscillates between its dictionary definition ('return to original shape or function') and more imprecise, even instructional, uses. Rose and Lentzos (2017) argue the term 'resilience' has become freighted with a moral dimension, in that citizens are being implicitly but powerfully summoned to remain resolute – however challenging their circumstances may be.

Concentrating on the term 'community', commentators such as Kenny and Connors (2016) argue that this term is frequently ambiguous in its usage and meaning. Given this potential to be confusing, the term 'sub-population' is generally preferred as the descriptor of choice for the different social units that are relevant to the work of this project. For example, rather than describe those who are over the age of, say, 65 as a 'community', we refer to this group as a 'sub-population'. However, a rural town, or cohesive local neighbourhood, is sensibly and reliably described using the term 'community', such as the Township of Cockatoo, which can be said to be a 'geographic community'. Similarly, 'virtual community' is so well accepted as the descriptor for groups who assemble online that this term will be used in what follows.

8.3 'Community' and 'network'

As noted above, the term 'community' can cause confusion. To minimise ambiguity, in some instances the term 'network' has advantages for the naming of certain social units. These instances may include units based on:

- faith-based affiliation
- occupation (e.g. union)
- recreational affiliation (e.g. local sporting clubs, neighbourhood book clubs)
- civic association (e.g. Masons, Rotary Club, Neighbourhood Watch)
- commercial groupings (e.g. local traders)
- ethnicity where this has a local presence but where others draw people to an extra-regional centre (e.g. Lithuanian House in North Melbourne)
- self-help/support groups (e.g. a local Alcoholics Anonymous, mothers' and new parents' groups, food co-ops)
- school-based groups
- officially facilitated groups (e.g. neighbourhood house community centres like Men's Shed)
- advocacy groups (e.g. those based on protecting heritage or parks)
- informal, local, neighbourhood-based affiliations
- online associations (e.g. Facebook groups with and without a local focus)
- support groups (e.g. online 'end-of-life' assistance networks).

Although not generally associated with the term 'community', 'kith and kin' or 'family and friend' affiliations can, and often are, denoted by the term 'network'. Extended family networks and friendship networks are two examples.

In relation to the specific interests of this project, it is important to distinguish between 'mutual aid networks' and 'asymmetric networks' where the:

- former refers to peer associations based on an expectation of reciprocity (e.g. Landcare groups)
- latter refers to circumstances where 'service' is rendered without an expectation of reciprocity (e.g. where a stranger rescues someone they do not know; where an 'end-of-life' support group is designed for a single person).

In this project, groups with similar interests are more difficult to identify than those with similar socio-economic characteristics, health status or status based on geography. The latter two approaches to identifying and assessing vulnerable communities have been the focus of this component of the Enhancing Community Resilience project.

Key definitions

Key definitions adopted for use in this project relating to community are as follows:

'Sub-populations in the community': defined by common socio-economic demographic parameters (e.g. over the age of 65 and living alone).

'Geographic community' or 'area of interest': a defined geographic – typically a rural town, location or extent (e.g. Township of Cockatoo).

'Functional community or network': defined on the basis of common interests or cultural links that have communication and institutional linkages (e.g. community of faith).

'Disperse non-functional community': a grouping of disparate individuals with no common communication and institutional linkages, e.g. homeless

'Virtual community' or 'network': groups that are active and include online communities connecting through, for example, social media forums and gaming.

9 Civil society

9.1 Introduction

Relationships may be important, but they exist between us rather than as a visible or physical presence. The nature of 'the social' realm is non-material. It follows that no single convention is licensed to itemise the elements that make up 'the social', nor is there a consensus concerning how the whole should be conceptualised.

For the current project, the term 'civil society' has been chosen to refer to the aspect of 'the social' that is of key concern: the 'third sector' of society. This is the sphere that includes family and friends and is distinct from government and business. This term is deliberately inclusive and also takes in 'the aggregate of non-governmental organisations and institutions that advance the interests and will of citizens' (https://en.wikipedia.org/wiki/Civil_society).

Within this rubric, the following categories of attention have been chosen as having a particular priority in the work of this project:

- Social cohesion: To what degree is there a sense of acceptance, group identity and camaraderie within a given group? This refers to the measure of communality in, for example, a neighbourhood, ABS mesh-block, or other group.
- Social exclusion: Can particular sectarian/class/faith inter-group tensions be identified? Such issues concern marginal or stigmatised groups who are more or less excluded because of issues related to location, transport, language and cultural disposition to equitable access to policing, schooling and health care. Such exclusion may, or may not, be institutional or structural.
- Social connection: With respect to smaller, more interpersonal relations, how strong is the quality of the intimate social network? This relates to family/extended family, friendships, informal civic associations (e.g. club memberships and voluntary affiliations such as churches) and the like. This realm can involve affectional linkages and bonding capital, as examples, and can be accessed via sociograms, network analysis and locally undertaken qualitative interviews. Social connection is related to, but not reducible to, access to information and communications technology (ICT).

In relation to the above, it should be noted that:

- the locally social tends to be the inter-personal
- social connection is a multi-dimensional construct.

Regarding language use, the following ensures that the terms 'capital', 'asset' and 'resources' are not carelessly paired with the term 'community'. That is, when the term 'community assets' is used it tends to merge the physical with the civil. In this project, the terms 'community assets', 'community capital' and 'community resources' will be used only with respect to physical items unless the opposite is stated.

9.2 Social connection

'Social connection' takes many different forms and is highly changeable. Quantitatively, it is possible to associate it with markers, such as frequency of contact or physical proximity in a residence, but the quality of connection is not determined by these factors. That is, people can be as connected or more connected to someone 10,000 km away as they are to someone they live with. Connection is defined subjectively, not geographically. More is not necessarily better: one reliable friendship can be decisive to health and wellbeing, but it might not.

Moreover, connection is invisible: unless a person is wearing a sign – think how bikies are 'badged' after initiation – it is not possible for an outsider to know about an individual's group membership. Also, membership cannot be 'accessed' as a right; no act of legislation can guarantee it. Nor can it be delivered as a product. No form of service delivery can provide social support or social inclusion.

The between-us has no voice or weight and cannot be seen, let alone commodified. This is one reason why it is easy to espouse the importance of social connection but more challenging to advance its presence. Simply put, you can't get to grips with social connection because it is used in various immaterial, nonlinear and mysterious ways.

In summary:

1. Positive social connection is a prerequisite for physical and mental health.
2. Those who are lonely or are caught up in conflictual relationships do poorly in terms of their physical and mental health.
3. The physical and mental health of those who are stigmatised/socially excluded (such as rough sleepers) are highly compromised.
4. Recovery (e.g. from trauma, physical illness or a mental health condition) is directly correlated with the quality of a person's social connections.
5. More is not necessarily better; one reliable friendship can be decisive.

9.3 Distinguishing the network from the Node

Civil society is organic, therefore it is indivisible. Given this nature, academic efforts to compartmentalise – to order into a coherent schema – what is dynamic and immaterial are, at best, of limited value. Four interdependent theory traditions are cited for their value in illuminating aspects of social life in the work of the current project.

1. Intimate relationships: couples, families, extended families and friendships

At the most basic level, 'the family' is often seen as the fundamental social unit (noting that definitions of this unit are operationally, conceptually and culturally contested). Recognising that families can be abusive and exploitative, the family is an arena for self-evaluation, a marker of identity, a welfare co-op, and more. 'Extended family' is where anthropology and sociology, social psychology and community development blur. Simply put, the sociality of extended families is both powerful and highly changeable: see, for example, Waldinger and Schulz (2023).

The same argument can be made with respect to friendship. For example, according to Lieberman (2021), 'the emergence of this crucial kind of relationship relied on the ability to recognise the unique benefits others have to offer.' Another study (Grenville-Cleave et al. 2021) reported that 'numerous scientific studies and reviews have shown us what, exactly, friends are for: they slash our risk of

mortality in half, double our chances of recovering from depression, [and] make us 4.2 times less likely to succumb to the common cold.'

2. Social capital

Two decades ago, Putnam (2000) introduced the idea of 'social capital' and the sub-divisions of 'bridging' and 'bonding' capital. An important sub-theme in the social capital literature concerns 'the strength of weak bonds'. One example is the aggregate effect of the multiple encounters a person has (or used to have) with, shopkeepers – those with whom one is familiar, but to whom one has no strong, legal, contractual or particularly intimate link. The argument is that such connection plays an important role in conditioning/regulating mood and wellbeing.

The work on 'weak bonds' built on Putnam's initial PhD. In this work he studied how (in his view) the tradition in Italy's south to be suspicious of strangers was an impediment to economic development compared with the most welcoming stance of those from the north. Being 'open for business' was a pre-condition for modernisation and financial progress.

3. Networks

A developing line of research has recently appeared with the title 'network science'. This research centres on ideas about mood and feeling. For example, 'Individuals are affected by how others around them are feeling. Mood is contagious, and though both positive and negative moods are 'caught', bad moods are more potent' (Dr Per Block, Oxford's Leverhulme Centre for Demographic Science). This line of thinking is used to examine everything from obesity to depression, from addiction to happiness. Christakis's (2020) research on the effects of COVID-19 on 'social practices', particularly the move to online connection, is a good example of how network science can be useful.

4. The implications on resilience

Whether referenced to 'network science', 'social connection' or another tradition, it is now well established that positive social support is correlated with positively managing in, and recovering from, adverse climatic events. Conversely, those who are lonely or caught up in conflictual relationships do poorly in terms of their physical and mental health. This relates to resilience.

A great deal of research focuses on resilience being a social phenomenon. That is, resilience can be theorised and measured as a collective quality (rather than a personal attribute of an individual). Some commentators have focused on community as:

- context (local environments providing a set of risk and protective factors that have an influence on the wellbeing of community members)
- collective actors that can exhibit resilience in themselves by organising and acting in response to adversity.

Terms such as solidarity, co-operation, 'the collective', group membership/identity and reciprocity recur in the scholarship that examines resilience as a social phenomenon. A critique of resilience is also present within the governmentality tradition (e.g. Huizenga et al. 2023.

9.4 Vulnerable groups and sub-populations

Like friendship, social connection cannot be 'accessed' as an entitlement or a good. Vulnerable people/sub-groups are likely to be drawn from the following candidate categories:

1. Isolation: this can be linked to physical location, non-access to ICT, physical infirmity, or age, as examples. It is worth noting that indicatively isolated people/sub-groups generally incite and often welcome attention.
2. Social identity: one or more markers associated with marginalisation and social exclusion (say, homelessness, mental illness, or substance abuse).
3. Normative/non-normative life events: aged people, physical illness or disability, and complex medical conditions.
4. Housing status: 'single person sole occupancy', most obviously, but also proxies like boarding house, supported ('special') accommodation location, insecure, unsafe, over-crowded or rough sleeping.
5. ICT status: those with little or no internet access.
6. Recently arrived in the area or Australia, especially refugees/asylum seekers.
7. SES markers: includes those with health care concessions, those on income support and those who are in the lowest, say, 20 per cent of income earning.
8. Demographics: NESB status.

More or less, it can be anticipated that the above have a lesser adaptive capacity. Most likely, the goal with the above people/groups would be to, for example, stimulate 'social practices that contribute to cooler, more liveable futures' (Healy and Mellick-Lopes, 2022). Included in this bracket are possibilities to vary practices relating to the loci of:

- work
- residence
- sociality (places of recreation).

9.5 Our approach to vulnerable groups and sub-populations

This project aied to identify those in the community most vulnerable to climate change and, in the follow-up subsequent stages of the project, to work with these vulnerable groups to build resilience to this change and associated impacts.

In the current stage, the proposed approach:

- identified the sub-populations in the community that are of greatest concern, and those within this group that are likely to be most vulnerable based on inherent sensitivity factors and capacity considerations, such as local government area (LGA) and non-government organisation services
- considered areas of interest, or geographic areas of concern, in relation to climate change impacts, identify the vulnerable groups within these areas, and consider broader ecological, physical and institutional factors (such as existing plans) that impact on vulnerability.

In the context of this project and in consideration of those assessed to be the most vulnerable to climate change, the sensitivity of any sub-population of concern was identified, and the services on offer to that group and other capacity considerations that may mitigate the vulnerability of that group were then considered.

This process drew on aspects of the asset-based community development (ABCD) approach in assessing the value of capacity considerations that may mitigate the vulnerability to climate change (see Section 10.1).

9.6 The known unknowns

When stranded on the roof of a house a person may, or may not, be rescued during a flood by a passer-by. Acts of kindness can be unpredictable. Also, bonds can be created in a moment, or strengthened by a joint experience of ordeal. Conversely, being left by a passer-by can deepen a prejudice or imprint an antagonism. It is not possible to *a priori* gauge the nature or strength of a civil relationship.

Local contingencies are very likely to be more relevant than broad generalisations in such situations. This uncertainty is directly present with respect to measures of social cohesion and inclusion/exclusion that, with few exceptions, tend to be stated at the national level.

Such high-level statistics of their nature can be problematic or even misleading. For example, Australians who are said to trust, or not trust, their local police service does not say that a member of a particular geographic or faith-based sub-population holds this view. Local, qualitative research is needed if a quality such as trust, social connection or social cohesion is to be meaningfully examined.

Problems with highly abstract measures acknowledged that certain trend lines and general conditions tend to have a particular, even pervasive, relevance to the operations of civil society. Two related phenomena are likely to be of increasing prominence to the field the current project is designed to consider: 'social atomisation' (Bauman, 2013) and 'increasing social inequality' (Wilkinson and Picket, 2010). The 'known unknowns' that will cycle through the life of the project are how these categories apply, do not apply, or apply only in part to a given sub-population or certain person.

10 Community assets

10.1 Asset Based Community Development

This project considered, and applied where practical, the concepts encapsulated in the Asset Based Community Development (ABCD) approach to sustainable community-driven development (Nurture Development, 2018).

Beyond the mobilisation of a particular community, the ABCD approach is concerned with how to link micro-assets to the macro-environment. The ABCD's premise is that communities can drive the development process themselves by identifying and mobilising existing, but often unrecognised, assets. Consequently, they can respond to challenges and create local social improvement and economic development.

The ABCD approach builds on the assets that are found in the community. It mobilises individuals, associations, and institutions to come together to realise and develop their strengths. This makes it different to a deficit-based approach, which focuses on identifying and servicing needs. From the start, an asset-based approach identifies the assets of individuals, associations and institutions that form the community. The identified assets from an individual are matched with people or groups who have an interest in, or need for, those strengths. The key is to use what is already in the community and then work together to build on the identified assets of all involved.

The first key method of the ABCD approach is to begin with the recognition of asset categories that can be uncovered in any community and place. When applying ABCD principles, communities are not thought of as complex masses of needs and problems, but as diverse and capable webs of gifts and assets. Each community has a unique set of skills and capacities it can channel for community development.

ABCD categorises asset inventories into five groups:

- individuals
- associations
- institutions
- place-based
- connections.

10.2 Role of community assets in assessing vulnerability

For the purposes of this project, community assets were identified in relation to their role in:

- providing sub-population services to mitigate the vulnerability of the community (or sub-populations within the community) to the impacts of climate change
- providing broad support to the general community as an indicator of broader community resilience or vulnerability across a larger geographic area.

Providing sub-population services

In many instances, these services and related assets will provide support services and functions that assist with a broad range of social, environmental and economic stressors and shocks. Examples include the role that schools, childcare, non-government community service centres, or places of worship play in supporting or offering a service to the community. In this regard, community assets are considered in relation to capacity factors and are used in combination with sensitivity factors to assess those of most concern within any vulnerable sub-population.

Providing broad support to the general community

Examples of community assets in this category include proximity to public transport, local shops, hospitals, and open space, as well as the number of certain assets within a given distance.

The manner in which these aspects of community assets are to be applied in the assessment of vulnerability is summarised in Figure 13.

For the purposes of this project, community assets are physical entities and do not include aspects of individuals or communities such as leadership.

A list of the community assets in this category used in the assessment of community vulnerability is listed below:

- aged care facilities
- ambulance stations
- banks
- child care centres
- community centres
- doctors
- fire stations
- fuel stations
- hospitals
- libraries
- surf lifesaving clubs
- neighbourhood safe places
- pharmacies
- places of worship
- public transport stops (bus, tram, train)
- schools and universities
- SES units
- sporting facilities
- supermarkets.

10.3 Structures, services and networks: distinguishing three classes of community asset with respect to resilience

Physical structures

The most common use of the term 'community asset' concerns objects (e.g. fire stations, roads, bridges, dams, sewerage systems). Each item in this class can be individually identified, quantified and spatially represented. Also, against specified criteria – such as measures of sea-level rise and load tolerances – estimations can be made of the degree to which such objects are resilient to the effect of, say, fire or flood.

In this situation, the term 'resilient' is ambiguous. It is inclusive of two distinct meanings:

- being able to 'hold against': to withstand, survive intact, resist destruction and suffer only a superficial loss of function
- having the ability to recover or 'bounce back'; this second usage is consistent with the dictionary meaning of resilience.

In relation to physical objects, this ambiguity can be said to be no more than an academic matter.

Practical issues, such as calculating indicators of resilience for, say, a building, can be estimated with respect to the impact of acute and enduring environmental assaults, such as fire and flood, without worrying whether this calculation concerns defying, or bouncing back, from an assault.

Different understandings of the term become a real-world problem when the idea of 'community asset' concerns 'building resilience' and references a formal community service, such as a health care program, or informal interpersonal networks, such as supportive neighbourhood groupings. Each will be discussed below.

Services

Services such as district nursing and Meals on Wheels can be understood as 'assets'. Such classes of asset are not reducible to the physical buildings within which a program is administered or its staff are located. For example, the physical base for a district nursing service might be damaged or destroyed without the service being disabled; primary carers, and the administration of this service, in addition to the necessary hardware (cars, the stock of medications, dressings) can be relocated to, and operate from, an adjacent location.

Therefore, 'building resilience' in this context includes the possibility of preparing buildings for, say, prolonged periods of extreme temperature, as it also concerns:

- preparing to physically relocate people, administration and stocks in the event of disaster
- workforce orientation to and ongoing staff training for such contingencies.

Local councils do not have responsibility for the majority of services that operate within their boundaries. Therefore, it is desirable that each council maintains a comprehensive audit of the services that operate within their boundaries, as well as of the specific services that will be required in the event of environmental assault. This audit should include, but is not restricted to:

- state-based emergency services
- utilities (such as water, power, and roads)
- health services with a local, regional, state-wide, or national organisation
- social services, social security, disability, and aged care services
- local NGOs with a specific or generic focus (e.g. neighbourhood houses)
- NGOs with a state-wide ambit (e.g. Jesuit social services)
- service associations (e.g. Rotary Club)
- faith associations.

Local council authorities do not have responsibility for, say, fire services. Nor do they have carriage of the task of allocating roles or coordinating actions prior to, or in the event of, a disaster. A council can be proactive in stimulating the systemic preparedness of each and all relevant services.

Services like physical assets can be mapped and, to an extent, quantified. That is, services are a known phenomenon.

Informal networks

Vignette one: Locals defy police

A resident in a Ministry of Housing medium-density unit in South Melbourne noticed what they thought was a gas leak and notified 000. Following a timely response, the relevant emergency service team arrived and identified that a high-pressure gas pipe had ruptured. This team concluded there was an immediate risk of explosion. Following their protocol, this unit contacted the local police with the view that police alert all residents in the vicinity to immediately evacuate their homes.

A stalemate ensued as residents defied the police order to leave their units.

It became clear that, as a group, the residents believed the local police could not be trusted: 'It is a trick. They want to get us out so they can get in. They (the police) have long had it in for us. This is a conspiracy … they want to harass us again … plant gear (substances) … to search without warrants, to make it hard for us, maybe get some arrests. You can't trust them. End of story. We are staying put.'

Despite the risk, the senior member of the on-the-ground emergency team directly negotiated with those in the immediately implicated household so that his (small) team would be allowed to attend to the leak. This task completed, there was a return to the status quo: the residual antipathy that existed between police and the residents.

The vignette speaks to the impact of the embedded antipathies that can exist between 'officials' and 'locals'. Similar dynamics can be in play between different local groups (e.g. the antagonisms that can exist between ethnicities, faiths, geographically demarcated gangs, and others). That is, it cannot be assumed that 'we are in it together'. It cannot even be assumed that if one does not help, that one will be a neutral influence.

Unlike community assets that involve services or knowable structures, informal networks and local antipathies concern civil society. As such, these networks and antipathies cannot be identified from afar, mapped at a distance, or have their influence understood and quantified without close contact.

Sometimes enduringly persistent, sometimes open-ended and subject to change, connections and exclusions can only be identified and assessed by way of fine-grained, even granulated forms of enquiry. Often, a degree of trust is a pre-condition for participants to identify the details of their significant-other relations. Nodes can be visible, but networks and antipathies are elusive. They are not necessarily forged in, nor exercised within, what is common in terms of expectations of geography, faith, gender, ethnicity, generation, and so on.

Aggregation of those bonded by friendship, neighbourhood, extended family, ethnic identity, common interest, faith or altruism cannot be externally mapped. These opaque and elusive connections are fundamental to the benefits that occasions of social inclusion provide – and the injuries that social exclusion inflicts.

This latter point is concerned with the inner workings of civil society and is worth developing. Similar to positive social networks, the dynamics of exclusion and disaffection of inter-group rivalries and feuds do not generally make themselves known to 'outsiders'. Although generally unobtrusive, in certain situations these dynamics are of first-order significance to the concerns this project examines.

Key definitions

Key definitions adopted for use in this project relating to community assets are as follows:

'Community assets' are identified as physical assets that:

- provide services to selected sub-populations to mitigate the vulnerability of the community (or sub-populations within the community) to the impacts of climate change
- provide broad support to the general community as an indicator of broader community resilience or vulnerability across a larger geographic area.

Summary

Local social networks – civil society more generally – can help to both defy and aid recovery from environmental assault. They also can assist with an in-between function – to offer support and maintenance. Not always based on mutual aid, on a symmetry of contributions from the players, networks often do a service without an expectation of a return.

Civil society cannot be mapped from a distance. It follows that locally generated data is required if the social conditions relevant to 'enhancing community resilience' to the effects of climate change are to be assessed, understood, and influenced.

11 Approach adopted to assess community vulnerability

The approach adopted to assess the vulnerability of a particular sub-population in the community is summarised in Figure 12.

This figure incorporates aspects of the models presented previously in this document. It is based on the earlier AVA approach to apply hazard and exposure separately to a community's sensitivity and capacity in relation to climate stressors. These aspects of a community sub-population are viewed in the context of absorptive, adaptive, and transformative factors of a group involving social, ecological, economic, physical and institutional aspects.

This initial model, which was applied to an individual sub-population, is further developed in the next section. This further development involves expanding the sub-population assessment to multiple sub-populations, and then considering these sub-populations in the context of a geographic area or area of interest. Refer to Appendix B for more details.

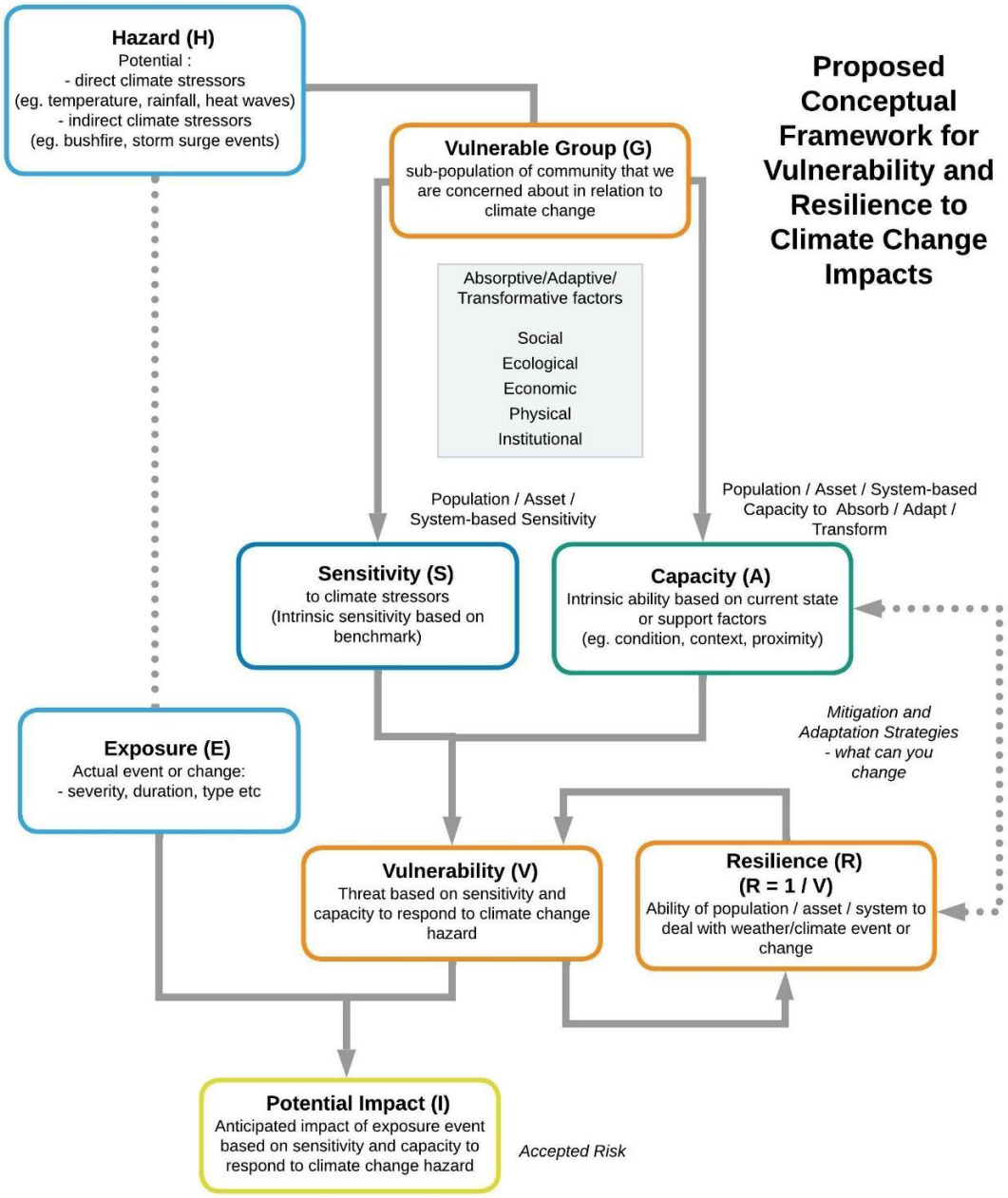

Figure 12. High-level framework to assess vulnerability and resilience of a community.

The approach used a range of variables or indicators to assign a sensitivity and capacity rating to sections of a defined community for a particular climate hazard, based on social, ecological, economic, physical, and institutional measures.

An example of these measures for a sub-population in the community (older people, defined as those aged 65 years and over) in relation to a severe storm-cell flooding event is provided below:

Table 1. Key community-based variables developed to assess sensitivity and capacity to a climate change scenario.

Sensitivity variables (defined as those characteristics inherent with the individual or community) Sensitivity increases with:	Capacity variables (defined as those characteristics that can have a mitigating impact on the vulnerability of an individual or sub-population) Capacity increases with:
• higher need for assistance	• cohabitation with others (not living alone)
• higher level of chronic health conditions	• greater financial resources
	• better connections with local community
	• proximity to public service node
	• area covered by a flood response plan
	• greater level of integrated water infrastructure (IWI) investment
	• level of service by Council or other services

Application of framework to an area of interest

For the vulnerability assessment approach to be scalable and nationally applicable, it needs to introduce a geographic area (or area of interest) component and allow the vulnerable groups within that area to be assessed in relation to different climate events or changes of concern. In this project, four geographic case studies (or climate change event-based scenarios) were developed. Each of these geographic case studies focused on a different climate event of concern. For example, the area south of Mordialloc Creek (as suggested by Kingston Council) considered flooding from a storm cell event. For new estates, (as suggested by Cardinia Council), the case study considered a heatwave event.

Introducing this concept of an area of interest supports a more nuanced approach to the treatment of capacity factors in the proposed vulnerability assessment, especially in relation to the treatment of institutional, ecological, and physical assets.

This approach also provided additional value for the building-of-resilience phase.

The approach by which an area of interest or geographic area, such as a township, can be assessed in terms of vulnerability to climate change is summarised in Figure 13.

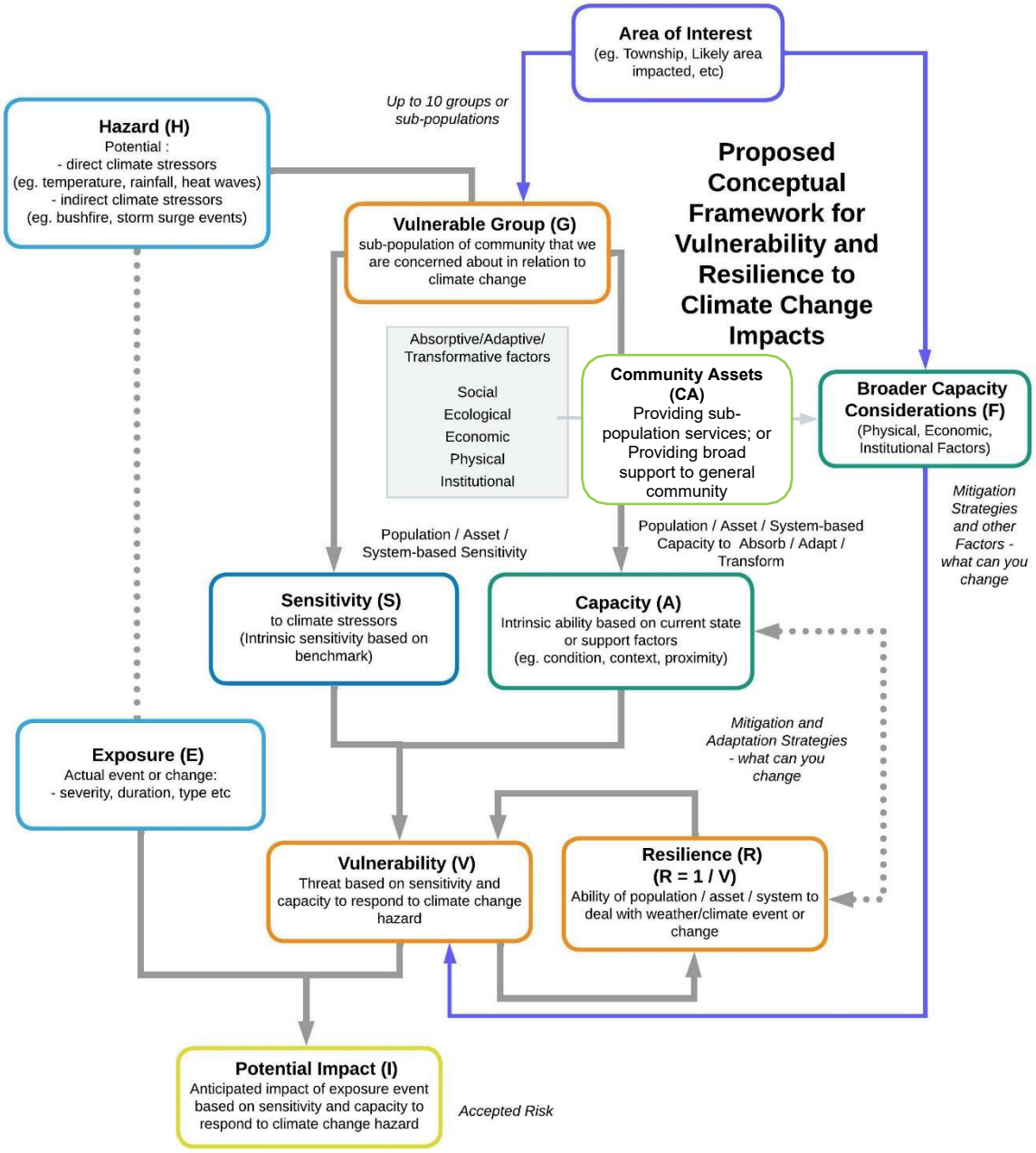

Figure 13. Inclusion of broader capacity considerations and community assets as part of the high-level framework.

Consequence

The objective of consequence management is to minimise the adverse consequences to the community (the users of services and infrastructure) caused by a major emergency. This extends to the connection to community, community wellbeing, the lifelines (services and infrastructure) of a community, and the micro- and macro-economic factors leading to sustainable and viable communities. While these concepts are perhaps better known in emergency management, they are just as relevant in business and community management of events that escalate from incident, emergency, disaster and crisis.

Figure 14 builds on the earlier framework and incorporates aspects of consequence, and consequence of loss, of extreme weather events or climate change. These include death, damage, disruption, and dispersal, which are defined as:

- death – loss of human life
- damage – asset or system replacement value
- disruption – disruption to asset or system service (economic, social, environmental)
- dispersal – dispersal in the short or long term to point community structure and capacity changes.

Key elements of the community vulnerability assessment process

Finally, the key elements of the community vulnerability assessment process described in the previous sections and adopted in this stage of the Enhancing Community Resilience project can be brought together in the framework presented in Appendix A.

This appendix presents how, for an initial SECCCA-wide vulnerability assessment, the elements of vulnerable sub-populations, climate change events, and key community assets are brought together to assign an initial assessment of vulnerability. The findings and guidance relating to the outputs of this process for this stage of the project are provided in Paper 4. The framework also shows how the outputs of this process can be combined with broader community factors and broader capacity considerations to prepare a community vulnerability profile for a geographic community (or area of interest). The outputs of this process are provided in Paper 5.

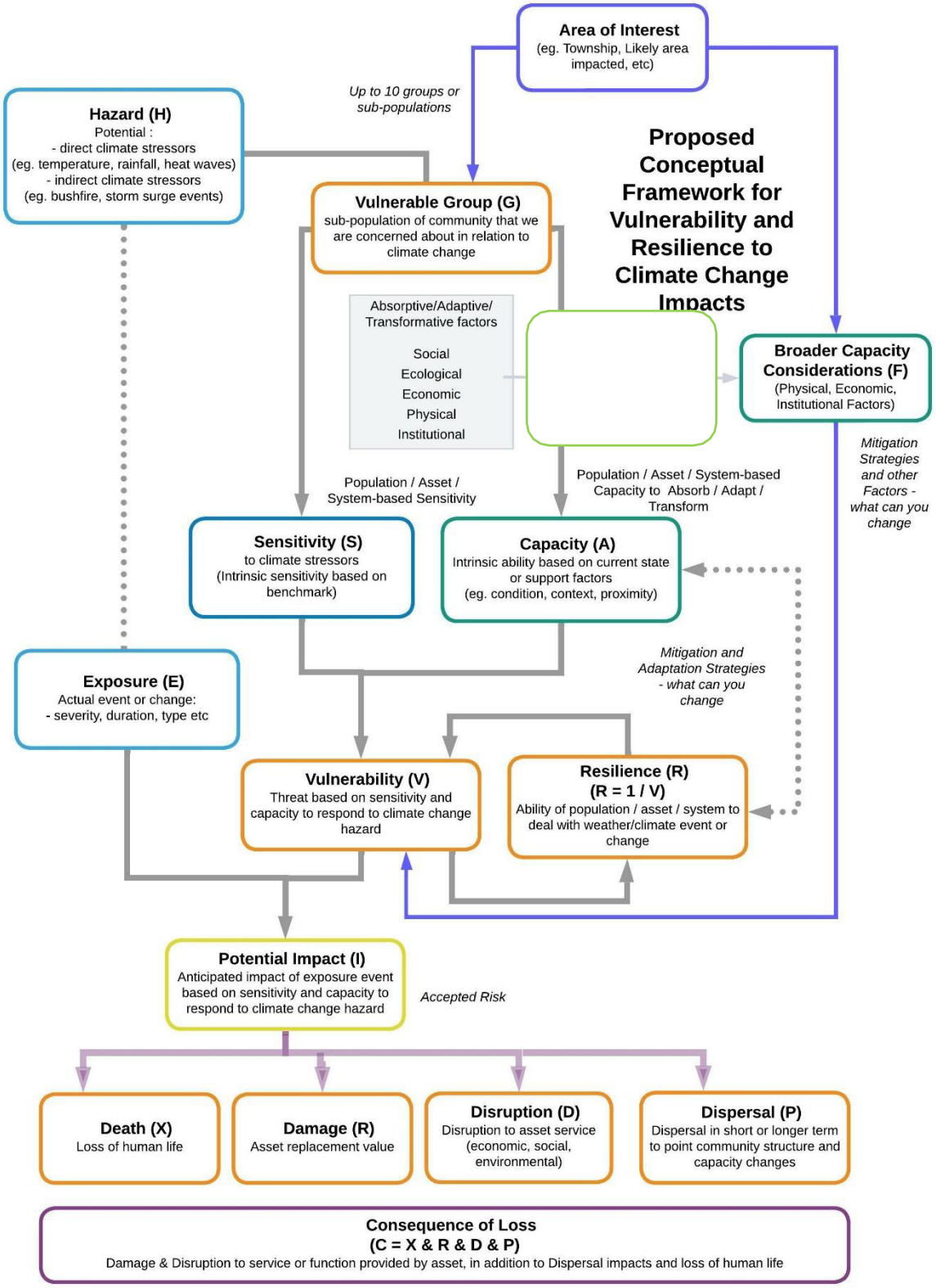

Figure 14. High-level framework to assess vulnerability of a community and consequence of loss dimension.

Community Assets

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Appendix A – Broader project context

Project background

Climate change is significantly increasing risks such as fires, floods, coastal erosion and heatwaves to local communities throughout Australia. Preparing communities for current and future changes to the climate is a critical task and requires protection of life, property and wellbeing. Proactively preparing communities to act prior to, during and after disasters builds community resilience to future impacts and minimises risks and their consequences.

The Enhancing Community Resilience project will help prepare communities in the SECCCA region for current and future changes to the climate. Leveraging the outputs of the SECCCA AVA project, it will also assess the vulnerability of the SECCCA region's community to climate change.

Working with SECCCA council members and climate science experts, the project identified and visualised the community services, demographics, locations and communities that are exposed to the impacts of climate change. Councils' community planners were integral in understanding vulnerability across communities, including cohorts such as those in aged care, those with a disability, those that are culturally and linguistically diverse (CALD), and youth.

A further stage of the project will develop, deliver and evaluate interventions to build community resilience to climate risk by working with expert community development practitioners, councils, emergency services, and communities.

The project outcomes and approach will be converted into a practical toolkit for councils and communities that can be applied throughout Australia to build community resilience to climate change. The toolkit will be developed using a parallel evaluation and collation of lessons learned throughout the project.

The project will cover the different stages of climate disasters and climate events that require different types of responses from support agencies.

Prior to a climate disaster/climate event

The project developed an understanding of the critical physical community assets from which services are provided, the services themselves, and social capital operating within communities.

Furthermore, the level of risk and vulnerability to climate disasters and events, the resources and plans required to build resilience, and how this varies between different cohorts and demographics, will be explored.

The project will provide intelligence to inform the placement of community support services during climate disasters and climate events, and to consult with the community to improve preparedness. Community planners are key stakeholders in this aspect of the project.

A further consideration is council municipal public health and wellbeing plans and primary care partnerships and how these are delivered to support and provide critical services and assets (built and social) to the community.

During and after climate disasters/events

The project will develop an understanding of shared assets (physical and social) and services that may be impacted during and after times of climate disasters and climate events. Emergency services need capabilities to identify and protect assets and services quickly and easily. The project will provide

situational awareness to enable effective delivery of community and emergency services in times of disaster, as well as the activation of community capital and networks. Councils' emergency managers and emergency services are key stakeholders in this aspect of the work.

After emergency events, councils and other agencies provide support such as food, clothing, shelter and mental health services to affected communities. As the frequency and intensity of events change, a reassessment of resourcing and of the preparedness of support services and systems is needed. Recent events will play an important part in informing this evaluation.

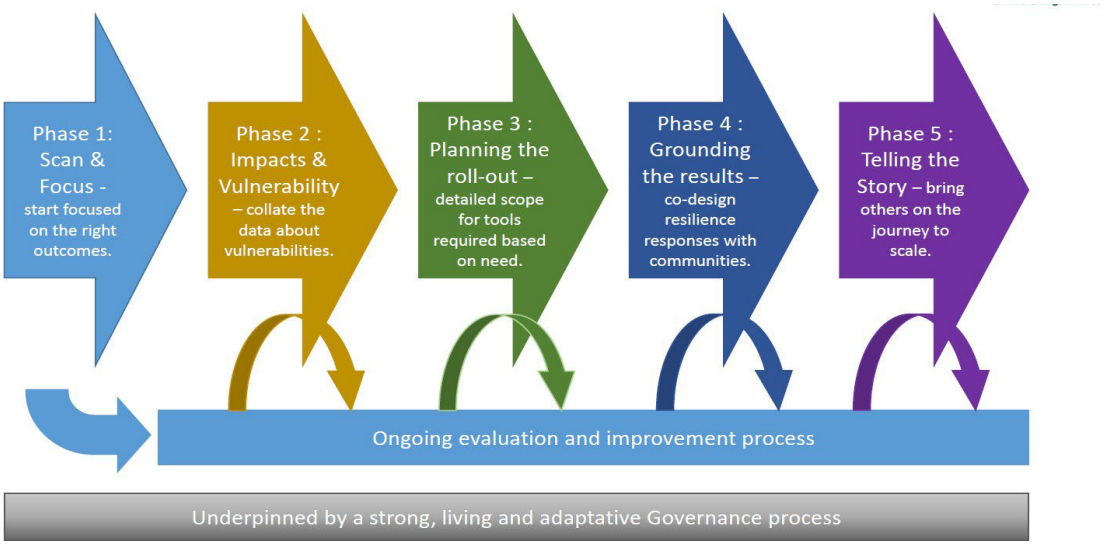
The scope of the project is to be refined through the co-design phases of the project with the relevant authorities and stakeholders. Gaps and elements that are out of scope will be captured and detailed for future consideration.

This project will draw on other recent climate change asset vulnerability studies undertaken by Spatial Vision – particularly the SECCCA AVA project, which was aimed at assisting SECCCA member councils to better understand how their buildings, roads, and drainage will be impacted by climate change and associated extreme weather events.

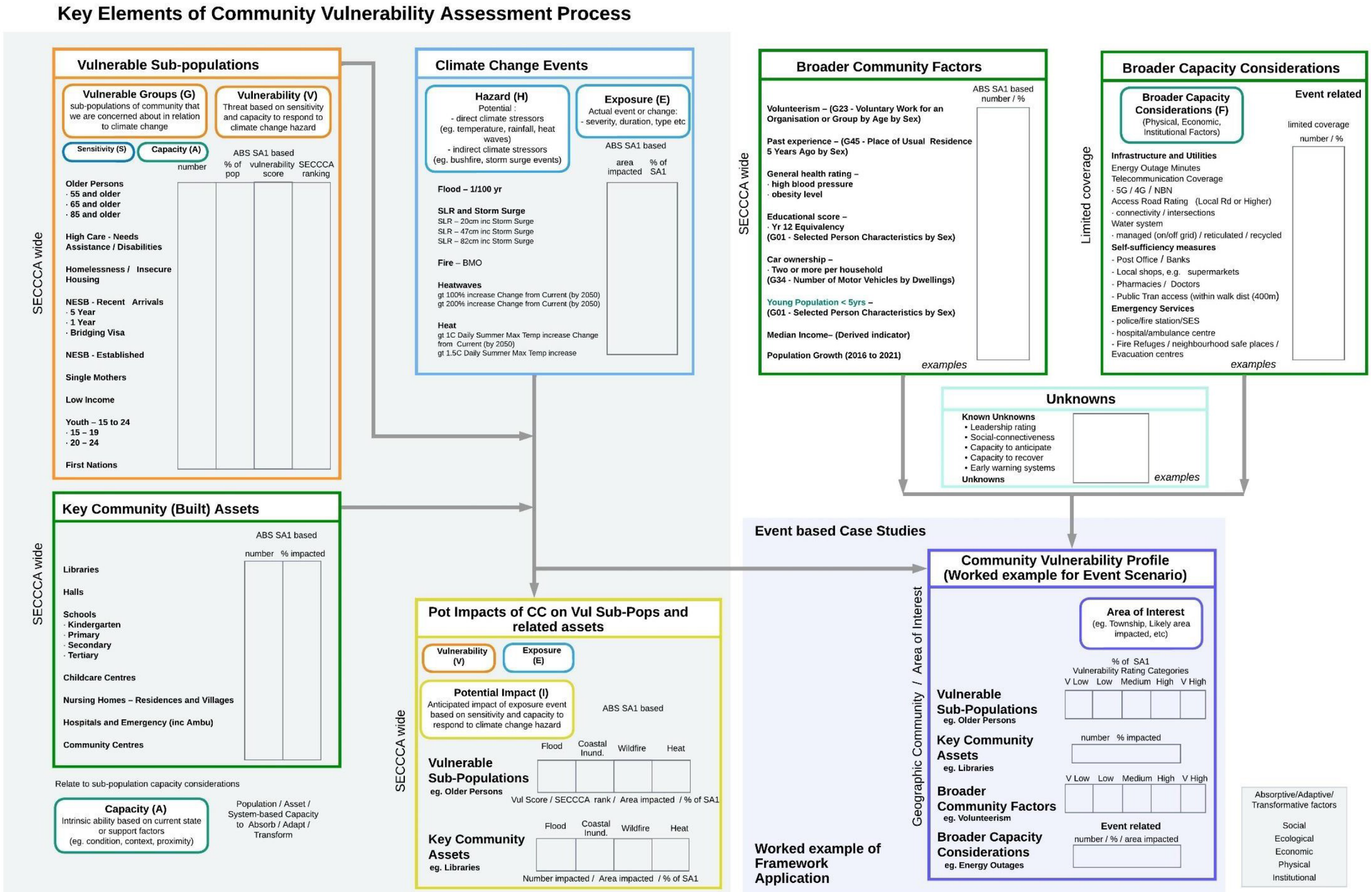
Key tasks and stages for the overall project

Key tasks identified to deliver the Enhancing Community Resilience project were:

1. Undertake research to identify the community groups within the SECCCA region that are vulnerable to climate change, and the assets and services that support them.
2. Undertake research nationally and globally to identify best practice projects and programs that have enhanced community resilience to climate change.
3. Develop and adopt a methodology that enables councils to assess the community impacts of climate change and develop appropriate responses.
4. Create a platform (using Climate Viewer and QGIS software) to enable up-to-date climate modelling to be applied across the SECCCA region and ongoing assessment of climate impacts on community assets and services.
5. Establish a spatial representation of how climate change will impact communities and council assets and services that provide services to the community.
6. Demonstrate how community resilience to climate change can be strengthened.
7. Develop and implement a community engagement strategy that informs and enables the community to understand, plan and act to build resilience to climate change.
8. Undertake research and develop recommendations for possible visualisation tools that can be used in scenario and response planning and adaptation option analysis.
9. Co-design and undertake workshops and other activities with the community to trial and deliver place-based priority case studies to improve community resilience.



Appendix B – Key Elements of the Community Vulnerability Assessment Process



Appendix C – Acronyms

ABCD	Asset Based Community Development
AEP	Annual Exceedance Probability
AR5	5th Assessment Report
AVA	Asset Vulnerability Assessment
CALD	Culturally and Linguistical Diverse
CMIP5	Coupled Model Inter-comparison Project Phase 5
CMSI	Climate Measurement Standards Initiative's
DELWP	Department of Environment, Land, Water and Planning
GCM	General Circulation Models
ICA	Insurance Council of Australia
ICT	information and communications technology
IPCC	Intergovernmental Panel on Climate Change
IWI	integrated water infrastructure
LGA	local government area
MS	Microsoft
NESB	non-English speaking background
NFID	National Flood Information Database
RCP	Representative Concentration Pathway
SA1	Australian Bureau of Statistics Statistical Area Level 1
SECCCA	South East Councils Climate Change Alliance
SES	social-ecological systems
VCP19	Victorian Climate Projections 2019

Spatial Vision