FINAL PROJECT REPORT
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THE AUSTRALIAN NATURAL DISASTER RESILIENCE INDEX

A system for assessing the resilience of Australian communities to natural hazards

Final project report

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While the authors acknowledge the guidance, input and assistance received from others during the project, responsibility for the index data, interpretations and reporting sits with the authors.

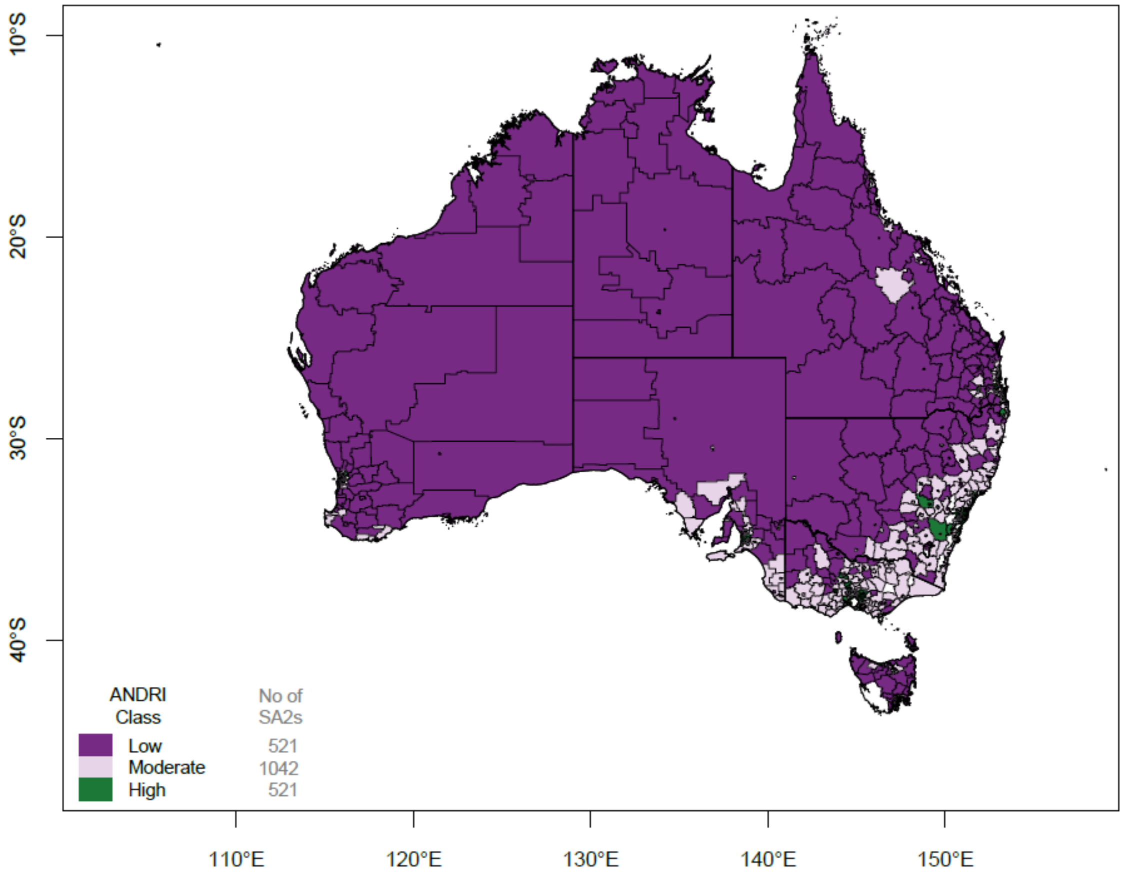
EXECUTIVE SUMMARY

Disaster resilience is a protective characteristic that acts to reduce the effects of, and losses from, natural hazard events. Disaster resilience arises from the capacities of social, economic and government systems to prepare for, respond to and recover from a natural hazard event, and to learn, adapt and transform in anticipation of future natural hazard events. This project developed the Australian Disaster Resilience Index to assess, for the first time, the capacity for disaster resilience in communities across Australia.

DISASTER RESILIENCE IN AUSTRALIA

The assessment of disaster resilience using the Australian Disaster Resilience Index shows that communities in Australia do not all have the same capacity for disaster resilience. About 52% of the population live in areas with moderate capacity for disaster resilience, about 32% in areas with high capacity for disaster resilience and about 16% in areas with low capacity for disaster resilience. Analysis of the distribution of disaster resilience in Australia revealed:

- Most of the population of Australia live in areas assessed as having moderate capacity for disaster resilience.
- There is a distinct association between capacity for disaster resilience and remoteness (see figure below).
- Most areas of higher capacity for disaster resilience are located in metropolitan and inner regional Australia. Areas of higher capacity for disaster resilience comprise only 0.5% of land surface area.
- Most areas of lower capacity for disaster resilience are located in outer regional, remote and very remote Australia. Areas of lower capacity for disaster resilience comprise over 93% of land surface area.
- There are areas of lower capacity for disaster resilience in metropolitan Australia.
- Inner regional areas have greater capacity for disaster resilience than outer regional areas.
- Patterns of capacity for disaster resilience at the national level are generally, but not always, upheld in each state or territory.



Areas of low, moderate and high capacity for disaster resilience in Australia.

Australian communities are also affected by various factors which enhance or constrain their capacity for disaster resilience. The particular combination of factors that influence capacity for disaster resilience differs from place to place. This generates a heterogeneous and complex picture of the factors associated with disaster resilience in Australia. Analysis of the distribution of the eight theme sub-indexes revealed:

- Social character often constrains the capacity for disaster resilience in Australia. Geographic distribution of the social character sub-index is mixed; however, lower values of the social character sub-index are concentrated in metropolitan and very remote areas.
- Australia has a mix of areas with higher and lower economic capital. All areas can experience constraints on disaster resilience associated with low economic capital. However, lower economic capital is most pronounced in remote and very remote areas, while higher economic capital is most pronounced in metropolitan and inner regional areas.
- Emergency services generally enable the capacity for disaster resilience in Australia. The emergency services sub-index is usually moderate to high, although considerable variation can still be evident within and between regional and metropolitan areas.

- Planning and the built environment is not a significant barrier to the capacity for disaster resilience in Australia. The planning and the built environment sub-index is moderate to high in most areas of Australia, with the exception of some remote and very remote areas.
- Australia has a mix of areas with higher and lower community capital. Higher community capital occurs in regional areas. In cities, areas of higher and lower community capital are often clustered.
- Information access is a significant barrier to the capacity for disaster resilience in Australia, particularly in regional and remote areas.
- Many areas of Australia are associated with moderate social and community engagement. High social and community engagement is concentrated in metropolitan and inner regional areas and low social and community engagement is concentrated in remote and very remote areas.
- Moderate to high governance and leadership is concentrated in metropolitan and inner regional areas. Increasing remoteness decreases governance and leadership capacities.

END-USER PROJECT IMPACT STATEMENT

Dr Holly Foster, *Research Coordination and Innovation, Emergency Management Victoria*

The work of the emergency management sector fundamentally contributes to fostering and supporting resilient communities. How emergency management organisations understand and respond to the plethora of variables influencing resilience across the broader, macro environment is complex and can be overwhelming. The Australian Disaster Resilience Index (ADRI) is a tool that assists to identify and understand the multifaceted dynamics at play across the broader social system. Moreover, it offers a way of scaling this nuanced data across States, regions and townships. The ADRI tools offer a leading-edge approach to to plan and resource activities that further enhance resilience, across planning, response and recovery activities. Moreover, we are already starting to see the critical and timely influence of this research with many organisations embedding the key principles and frameworks of the ADRI into their doctrine and planning processes.

The ADRI is a must-read for any organisation working toward resilience outcomes.

(2019)

John Schauble, *Emergency Management Victoria, Victoria*

What makes a community resilient to natural disasters is in large measure the same as makes it resilient to other shocks and stressors. Put simply, strong and connected communities are inherently resilient. The task for emergency managers is to ensure that whatever they do builds upon this rather than builds dependency. The Australian Disaster Resilience Index has significant potential to assist in this process of identifying the resilience of communities to natural hazards at scale. This will assist government and agencies to plan and resource activities that further enhance resilience, in terms of planning, response and recovery. Living in a hazard rich environment does not mean developing learned helplessness, particularly in urban environments. Understanding communities and their relationship to the environment and the natural hazards local to them will help in addressing resilience shortfalls and building the strengths to overcome them. The out workings of this project have the potential to deeply influence that dialogue and its outcomes.

(2018)

Suellen Flint, *Department of Fire and Emergency Services, Western Australia*

At their best, resilient communities are prepared, are able to adapt to changing situations, are connected to each other and are self-reliant.

Recent reports into disasters has identified that government has a responsibility to prepare for emergencies, however these reports also identified the notion of shared responsibility. It is clear that government bears a responsibility to support the community to build the knowledge, skills and importantly protective behaviours that are part and parcel of disaster resilience.

Emergency Services support communities by building these characteristics in communities. Not a simple task. It involves highly complex forms of engagement based in a raft of community development based research focused on community and individual psychology, decision making under stress, physiology, knowledge exchange and information take up by the community.

The Australian Disaster Resilience Index will be advantageous in many ways and support national, state and local governments. The ability to identify hot-spots of high or low disaster resilience in Australia, and identify areas of strength in coping and adaptive capacity will support the desired outcomes of the Australian Natural Disaster Resilience Strategy, and potentially help to embed disaster resilience not only into policy and legislation, but to lead to an increase in shared responsibility and resilience across Australia.

I commend the researchers for addressing the challenge in developing the Australian Disaster Resilience Index.

(2015)

PRODUCT USER TESTIMONIALS

Please refer to the Utilisation and Impact section for details of activities and experiments that have been undertaken throughout the project to utilize the conceptual foundations, ADRI research methods and index data, and further details of the development of the Australian Disaster Resilience Index dashboard.

INTRODUCTION

Natural hazards, such as bushfires, cyclones, floods, storms, heatwaves, earthquakes and tsunamis have always occurred and will continue to occur in Australia. While natural hazards are naturally occurring they frequently intersect with human systems to create natural disasters. Australian communities face increasing losses and disruption from natural disasters. The total economic cost of natural disasters in Australia has averaged $18.2 billion per year between 2006 and 2016 (Deloitte Access Economics 2017). This is expected to almost double by 2030 and to average $33 billion per year by 2050 (Deloitte Access Economics 2016). The social impacts of disasters are also substantial. Costs associated with social impacts may persist over a person's lifetime, and can often be greater than the costs of tangible damages (Deloitte Access Economics 2016). Climate change is expected to alter the frequency and magnitude of some natural hazard types in Australia (BOM & CSIRO 2018). An increasing population, demographic change, widening socio-economic disparity, expensive infrastructure and the location of communities in areas of high natural hazard risk also contributes to the potential for increasing losses from natural hazards.

The effects of natural hazards in Australian communities are influenced by a combination of social, economic, natural environment, built environment, governance and geographical factors. The effects of natural disasters may also be influenced by prevention, preparation, response and recovery activities. Disaster resilience is a protective characteristic that acts to reduce the effects of, and losses from, natural hazard events. Disaster resilience arises from the capacities of social, economic and government systems to prepare for, respond to and recover from a natural hazard event, and to learn, adapt and transform in anticipation of future natural hazard events. Assessing disaster resilience estimates the status of these capacities and shows how they are distributed across Australia.

The Australian Disaster Resilience Index is a nationally standardised estimate of disaster resilience based on coping and adaptive capacities (Parsons et al. 2016). Here, the index is used to undertake the first nationally standardised assessment of the state of disaster resilience in Australia. The results of the assessment can be used to aid macro-level policy, strategic planning, community planning and community engagement activities at national, state/territory and local government levels. The assessment also provides a benchmark against which to assess future change in disaster resilience. Understanding the distribution of disaster resilience in Australia will assist communities, governments, organisations and businesses to build the capacities needed for living with and adapting to natural hazards.

BACKGROUND

DISASTER RESILIENCE

There are two prominent schools of thought about the influence of natural hazards in human societies. The first school of thought derives from a vulnerability perspective where distributional inequalities in physical, social, economic and environmental factors influence the susceptibility of people to harm and the ability of people to respond to hazards (Cutter et al. 2003; Birkmann 2006; Bankoff 2019). The second school of thought derives from a resilience perspective where people are learning to live with a changing, unpredictable and uncertain environment (Folke et al. 2002; Bankoff 2019), of which natural hazards are a part. Although the definition and application of disaster resilience is keenly contested in the academic literature (Klein et al. 2003; Wisner et al. 2004; Boin et al. 2010; Tierney 2014), resilience generally refers to the capacity to cope with and absorb disturbances or changes and to maintain adaptive behaviours (Maguire and Cartwright 2008). Important in this view of resilience is the notion of adaptation, where adaptation and transformation can be proactive for future events, or reactive in response to an event that has already occurred (Handmer and Dovers 1996; Engle 2011). Learning from experience and a focus on review and adjustment helps to build resilience to future events.

The resilience school of thought has been adopted in the Australian Disaster Resilience Index, although the way that distributional inequalities influence the capacities for disaster resilience are considered in the index. Resilience is a process linking a set of capacities to a positive trajectory of functioning and adaptation after a disturbance (sensu Norris et al. 2008). The definition of natural hazard resilience adopted for the Australian Disaster Resilience Index is:

> *Resilience is the capacity of communities to prepare for, absorb and recover from natural hazard events and to learn, adapt and transform in ways that enhance these capacities in the face of future events.*

The Australian Disaster Resilience Index will assess resilience based on two sets of capacities – coping capacity and adaptive capacity:

- Coping capacity is the means by which people or organisations can use available resources and abilities to face adverse consequences that could lead to a disaster (sensu UNISDR 2009). In a practical sense, coping capacity relates to the factors influencing the ability of a community to prepare for, absorb and recover from a natural hazard event.
- Adaptive capacity is the arrangements and processes that enable adjustment through learning, adaptation and transformation. Adaptation is the ability of a system to modify or change its characteristics or behaviour to cope with actual or anticipated stresses (Folke et al. 2002). Adaptive capacity entails the existence of institutions and networks that learn and store knowledge and experience, create

flexibility in problem solving and balance power among interest groups (Folke et al. 2002).

ASSESSING DISASTER RESILIENCE USING A COMPOSITE INDEX

The Australian Disaster Resilience Index is a composite index designed for the assessment of disaster resilience. Composite indices are frequently used as an assessment tool to summarise and report complex relational measurements about a particular issue (OECD 2008). An index should capture change and respond directionally according to the behaviour of the system (Burton 2015), so that the index can be arrayed along a continuum of condition. Indices are calculated from a series of measurements, generally termed indicators. For example, a Consumer Price Index, a tool to assess cost pressures on households, is calculated from the prices of a number of consumer items.

There are three main characteristics that define the nature of a composite index: measurement models, data sources and aggregation. The first relates to the application of formative or reflective measurement models. A formative model is one where the indicators are considered to be the cause of the latent construct (disaster resilience). A reflective model is the reverse, where the latent construct (disaster resilience) causes the indicators. A formative model was used in most analyses because the capacity for disaster resilience is assessable by reference to the values of a chosen set of factors.

The second characteristic that defines the nature of composite indices relates to the sources of the data upon which the index is based. These have implications for how the index is constructed and used. Top-down data are collected from secondary sources such as the census, economic data and modelled surfaces. Bottom-up data are collected using participatory methods that engage communities to self-report through interviews, scorecards or panels. Top-down data tend to be used at large spatial scales and bottom-up data used to understand single communities or neighbourhoods. The national scale of the assessment warranted a top-down approach to data collection.

The third characteristic that defines the nature of composite indices is the strategy that is used to aggregate, or combine, indicators to produce an index. Aggregation is the strategy used to combine the indicators to produce an index. It is far more than simply adding the indicators together. The aggregation strategy accounts for rescaling and normalising data distributions, compensability of indicators (how values of different indicators may cancel each other out) and the assumption of a formative or reflective measurement model. The Index used the latest published statistical methods for aggregation of indicators in a composite index. Many of these methods were drawn from outside the field of hazard vulnerability or resilience assessment, such as from economics, psychology and information science.

In summary, the Australian Disaster Resilience Index is a national scale composite index that uses a formative measurement model with a top down approach to data acquisition and a multi-level or hierarchical aggregation strategy.

RESEARCH APPROACH

STRUCTURE OF THE AUSTRALIAN DISASTER RESILIENCE INDEX

The structure of the Australian Disaster Resilience Index is shown in Figure 1. The top level is the overall assessment of disaster resilience. The second level is made up of coping capacity and adaptive capacity. The third level is made up of themes that reflect the dimensions of disaster resilience within coping capacity and adaptive capacity. The fourth level is comprised of indicator sets that measure the status of a theme. An index is computed for the first, second and third levels, using the indicators collected at the fourth level.

Themes are community characteristics that contribute to the resilience to natural hazards, via coping and adaptive capacity (Table 1). Consistent with a formative measurement model, themes have been chosen for their basis in the literature: some with empirical evidence of the relationship between the theme and resilience, and others that conceptualize this relationship but with developing evidence.

Coping capacity is comprised of six themes that encapsulate the factors influencing the resources and abilities that communities have to prepare for, absorb and recover from natural hazard events (Table 1). Adaptive capacity is comprised of two themes that encapsulate the factors that enable institutional and social learning, flexibility and problem solving (Table 1). Indicators provide the data for a theme –the indicators are analysed together to measure the status of the theme.

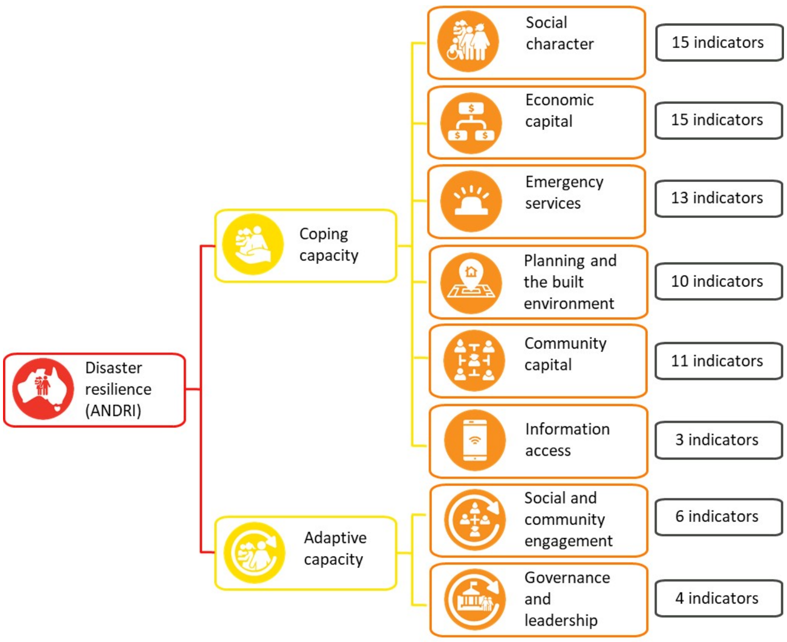


Figure 1: The Australian Disaster Resilience Index structure. The assessment is structured hierarchically across three levels: overall disaster resilience index; coping and adaptive capacity sub-indices; and, theme sub-indexes. Indicators are not a level of measurement but are used to compute each theme sub-index.

Table 1: Explanation of coping and adaptive capacity themes within the Australian Disaster Resilience Index.

Theme	Description	Relationship to disaster resilience
	Coping capacity	
Social character	The social characteristics of the community. Represents the social and demographic factors that influence the ability to prepare for and recover from a natural hazard event.	Social and demographic factors have well known influences on capacity to prepare for, respond to and recover from a natural hazard events. These include household and family composition, age, sex, education, employment, disability, language, and length of residence.
Economic capital	The economic characteristics of the community. Represents the economic factors that influence the ability to prepare for and recover from a natural hazard event.	Economic capital can facilitate disaster resilience by reducing the losses from natural hazard events. Economic resilience can contribute to the reduction of losses from natural hazard events through improved mitigation and risk management, individual flexibility and adaptation, enhanced recovery, market continuity and business continuity. Losses from natural hazards may increase with greater wealth, but increased potential for loss can also be a motivation for mitigation. High level of economic capital often goes hand in hand with high levels of social capital.
Emergency services	The presence, capability and resourcing of emergency services. Represents the potential to respond to a natural hazard event.	Emergency management and healthcare provision is a core function of government. The capacity for emergency response is integral to community disaster resilience. Emergency management is also a key inclusion in policy guiding disaster resilience and disaster risk reduction. Increasing remoteness implies barriers to the provision of, and access to, these services.
Planning and the built environment	The presence of legislation, plans, structures or codes to protect communities and their built environment. Represents preparation for natural hazard events using strategies of mitigation, planning or risk management.	Considered land use planning is a core hazard mitigation strategy in built environments. Good planning policy is essential to reduce risk and enhance resilience. Good planning policy can also reduce future risk. Building codes set construction standards to reduce damage from natural hazards.
Community capital	The cohesion and connectedness of the community. Represents the features of a community that facilitate coordination and cooperation for mutual benefit.	Participation in social networks can enhance solutions to collective action problems. Disaster resilience is enhanced by the ways the sense of community fosters participation, community competency, pro-social behaviour and preparedness through working with others to solve shared local problems. Social capital facilitates disaster resilience before, during and after disasters. Social capital is often highlighted in times of disaster because it is a resource that facilitates collective action for mutual benefit.

Table 1 (cont.)

Theme	Description	Relationship to disaster resilience
Coping capacity		
Information access	The potential for communities to engage with natural hazard information. Represents the relationship between communities and natural hazard information and the uptake of knowledge required for preparation and self-reliance.	Telecommunication and internet access is vital to information sharing through all phases of a disaster. As digital communication has become the default medium for everyday exchanges, information sharing, and access to essential services, the disadvantages of being offline increase. Community engagement activities enable disaster resilience through public participation in decision making about natural hazards. Community engagement has been shown to have direct benefit for community resilience through capacity building, social connectedness and empowerment, self-reliance, education and training, awareness of risk and psycho-social preparation.
Adaptive capacity		
Social and community engagement	The capacity within communities to adaptively learn and transform in the face of complex change. Represents the resources and support available within communities for engagement and renewal for mutual benefit.	Adaptive communities are able to manage complex change. Characteristics of adaptive communities include social engagement, trust, cooperation, learning and well-being.
Governance and leadership	The capacity within organisations to adaptively learn, review and adjust policies and procedures, or to transform organisational practices. Represents the flexibility within organisations to learn from experience and adjust accordingly.	Adaptive institutions have conditions suited to the development of the skills, knowledge and culture for managing complex change. Enabling conditions include social learning, research, innovation, collaboration and leadership. Effective response to natural hazard events can be facilitated by long term design efforts in public leadership.

Spatial resolution of the Australian Disaster Resilience Index

The grain of the Australian Disaster Resilience Index is Statistical Area Level 2 (SA2), defined in the 2011 Australian Statistical Geography Standard (ABS 2011). SA2s are delineated by the Australian Bureau of Statistics using criteria of population, functional areas, growth, gazetted suburbs or localities, local government area boundaries and rural or city locations (ABS 2011). SA2s generally have a population range of 3,000 to 25,000 persons, with an average population of about 10,000 persons (ABS 2011).

Overall, there are 2,214 SA2s across Australia. The Australian Disaster Resilience Index was computed for 2084 of these SA2s: 130 SA2s (6%) were excluded because they were areas of no or low population (e.g. national parks, ports, airports, industrial estates). Jervis Bay, Christmas Island, the Cocos-Keeling Islands, Lord Howe Island and French Island were also excluded from the index because the availability of indicator data for these areas was inconsistent.

INDICATORS

Indicators are the variables used to determine the status of a theme: the raw data used to compute the index. An indicator is a quantitative measure 'intended to represent a characteristic of a system of interest' (Tate 2012). Selecting indicators is both an art and a science. An indicator always implies that a relationship exists between the indicator and a latent construct representing some aspect of resilience. Thus, the process of indicator selection is also coupled with the purpose, framework, design and interpretation of the index. While there will always be trade-offs between indicator specificity, data availability, cost effectiveness and sensitivity (Birkmann 2013, Winderl 2014), the selection of indicators can be guided by criteria that help to bound large sets of potential indicators (Parsons et al. 2016). The use of indicator selection criteria minimizes potential sources of uncertainty in the interpretation of disaster resilience arising from the types of indicators included in computation.

An intensive, three-step process was used to identify and select indicators for the Australian Disaster Resilience Index (see Parsons et al. 2016). The indicator identification process begins with the conceptual model for the index, which determines the focus on coping and adaptive capacity and the definition of these capacities. The conceptual model subsequently sets the second step outlining the structure and design of the index and identifying latent dimensions of disaster resilience. These latent dimensions correspond to the eight themes of the index: social character; economic capital; emergency services; planning and the built environment; community capital; information and access; social and community engagement; and, governance and leadership. Themes guide the identification and selection of indicators where the goal is to obtain indicators that quantitatively measure the status of that theme. Thus, the selection of indicators for the Australian Disaster Resilience Index was initially constrained by the requirements of the conceptual model and latent dimensions of resilience, as described in Parsons et al. (2016).

The third step in indicator selection was an iterative process of literature evaluation, data availability and filtering against generalised criteria. Scores of indicators have been used to assess disaster vulnerability or resilience in top-down assessments (see reviews by Beccari 2016 and Cutter 2016). Most of these published indicators are aligned with the coping capacity part of the Australian Disaster Resilience Index conceptual model. Indicators of adaptive capacity have been used within the climate change and adaptive governance literature (Gupta et al. 2010, Engle 2011, IPCC 2012, Engle et al. 2014). We reviewed the indicators from published indexes (e.g. Cutter et al. 2008, Cutter et al. 2010, Sherrieb et al. 2010, Pfefferbaum et al. 2013, Beccari 2016) and used them as a starting point to populate the themes. Further indicators were derived for themes through exploration of available data sets, and the literature underpinning each of the latent dimensions of resilience.

Data availability was a major consideration in the identification and selection of indicators. The index takes a top-down assessment approach that provides continuous spatial coverage of the entire country at a national level. Therefore, it was necessary to use indicators that also had spatial coverage of the entire country. A comprehensive search was undertaken for available data sets relating to the latent dimensions of disaster resilience and which were also publically accessible or available for a reasonable fee.

Overall, 77 indicators were used to compute the Australian Disaster Resilience Index, across the 8 themes (Table 2). Full details of the indicators including indicator sources, resolution, indicator computation and relationship to disaster resilience are provided in Parsons et al. 2019b.

In summary, the indicators were developed from publicly available data sources including: the Australian Bureau of Statistics, Australian Institute of Health and Welfare, Australian Urban Infrastructure Research Network, Productivity Commission, Department of Infrastructure and Regional Development, Geoscience Australia National Exposure Information System, Local Government Annual Reports, Torrens University Public Health Information Development Unit, Department of Communications and the Regional Australia Institute. Where possible, indicator data were obtained at SA2 resolution. Some indicators were collected at other resolutions, such as local government area, state/territory, police district, SA4, and region. These indicators were disaggregated to SA2 resolution.

Table 2: Indicators used to compute the Australian Disaster Resilience Index. Full details of the indicators including indicator sources, resolution, indicator computation and relationship to disaster resilience is provided in Parsons et al. (2019b).

Capacity	Theme	Indicator
Coping capacity	Social character	% population arrived in Australia 2001 onwards
		% households with all or some residents not present a year ago
		% speaks English not well or not at all
		% population with a core activity need for assistance
		% one parent families
		% households with children
		% lone person households
		% group households
		Sex ratio
		% population aged over 75
		% population aged below 15
		Ratio of certificate/postgraduate educational attainment to Year 8-12 educational attainment
		% of labour force unemployed
		% not in labour force
		% employed as managers and professionals
	Economic capital	% residents owning their home outright
		% residents owning their home with a mortgage
		% residents renting their home
		Median weekly rent ($)
		Median monthly mortgage repayment ($)
		Median weekly personal income ($)
		Median weekly family income ($)
		% families with less than $600 per week income
		% families with more than $3,000 per week income
		% employment in largest single sector
		Economic Diversity Index
		% businesses employing 20 or more people
		Retail and/or commercial establishments per 1,000 people
		% population change 2001 to 2011
		Local government grant per capita
	Emergency services	Medical practitioners per 1,000 population
		Registered nurses per 1,000 population
		Psychologists per 1,000 population
		Welfare support workers per 1,000 population
		Available hospital beds per 1,000 population
		Ambulance officers and paramedics per 1,000 population
		Fire and emergency services workers per 1,000 population
		Police per 1,000 population

Table 1.2 (cont.)

Capacity	Theme	Indicator
Coping capacity (cont.)	**Emergency services (cont.)**	Fire and emergency services and SES organisations funding per 1,000 population
		Ambulance organisations funding per 1,000 population
		Fire service volunteers per 1,000 population
		SES volunteers per 1,000 population
		Distance to medical facility (km)
	Planning and the built environment	% caravan and improvised dwellings
		% residential dwellings built post 1981
		% commercial and industrial dwellings built post 1981
		Emergency planning assessment score#
		Full-time equivalent council staff
		Council area per full-time equivalent council staff
		Number of dwellings per full-time equivalent council staff
		New dwellings (2012-2016) as a proportion of 2011 dwellings
		New dwellings per week (2015-2016)
		Planning assessment score#
	Community capital	Offences against person per 100,000 population
		Offences against property per 100,000 population
		Age standardised number of people per 100 population who feel safe walking in their neighbourhood
		Age standardised number of people per 100 population who are able to get support in times of crisis
		Age standardised number of people per 100 population whose household could raise $2,000 in a week
		Age standardised number of people per 100 population who had difficulty accessing services
		% households with no motor vehicle
		Age standardised number of people per 100 population with fair or poor self-assessed health
		% residents in same residence for greater than 5 years
		% population undertaking voluntary work
		% jobless families
	Information access	% area with excellent or good ADSL coverage
		% area with mobile phone coverage
		Community engagement score#

Table 2 (cont.)

Capacity	Theme	Indicator
Adaptive capacity	**Social and community engagement**	% population with life satisfaction scale 70 and above
		% population with high generalised trust
		Migration effectiveness 2006-2011
		% population with post school educational qualification
		% population over 15 in further education
		% participation in personal interest learning
	Governance and leadership	Presence of research organisations
		Business Dynamo Index
		Local economic development support
		Emergency services governance, policy and leadership score#

Four indicators were derived from content analysis of policy, legislation and other documents. The procedures for deriving these indicators are described in Parsons et al. (2019b).

COMPUTING THE INDEX

The computation of the Australian Disaster Resilience Index takes as its starting point the 77 indicators described in Table 2. Computation of the Australian Disaster Resilience Index is then hierarchical based on the levels shown in Figure 1. There are two stages in the computation of the index: the indicator conditioning stage and the aggregation stage. The conditioning stage adjusts the indicators so that they can be validly combined into an index. The aggregation stage is concerned with the combination of the conditioned indicators into an index.

Conditioning the indicators

In their raw form, the 77 indicators have considerable variation in the range of values they take. Many indicators are percentages of a whole and so can take values between 0 and 100. Other indicators are expressed as numbers per 1,000 population or numbers per full time equivalent local government staff. Without some form of remedial adjustment, indicators with mostly small values will be overwhelmed by indicators with mostly large values in the aggregation process used to form an index. This is contrary to the assumption behind composite indices that all indicators make, if not similar contributions to the index, then at least non-negligible contributions. All indicators were rescaled to a range of 0 to 1: a common and recommended approach to conditioning indicators prior to aggregation (OECD 2008). Full details of the rescaling procedure are provided in Parsons et al. (2019b).

Indicators can have very different distributions, even if they have the same range of values. For example, an indicator can be highly skewed with mostly low values and a few very large values. While the small differences between SA2s with low values might be significant for disaster resilience, in a composite index these differences will be overwhelmed by other less skewed indicators. For this reason it is generally recommended that skewed indicators be normalised, i.e. transformed so that their distribution resembles the bell-shaped curve of the normal distribution (OECD 2008).

Similar problems for aggregation into a composite index can occur when indicators have a strongly leptokurtic distribution, where most of the values lie in the middle of the range with relatively few in the shoulders of the distribution. A method to reduce the kurtosis of strongly leptokurtic indicators was devised as part of the normalisation procedure. Full details of the normalisation procedure are provided in Parsons et al. (2019b).

The normalised, rescaled indicators that were hypothesised to have a negative relationship with disaster resilience were subtracted from 1, so that all indicators had a positive relationship with disaster resilience. Full details of the hypothesised relationships between and indicator and disaster resilience are provided in Parsons et al. (2019b). Overall, the indicator conditioning procedures were rank-preserving. The position of each SA2 in the list of SA2s sorted by raw indicator value was exactly the same as its position in the list sorted by the conditioned indicator value.

The assignment of weights to indicators is a form of conditioning that attempts to take account of evidence or beliefs about the relative importance of indicators in their contribution to the composite index. Weights may be introduced prior to, or implicitly within, aggregation procedures and, as pointed out in OECD (2008) there remains contention around their use. Parsons et al. (2019b) reviews some of the issues. For the construction of the Australian Disaster Resilience Index, it was found that evidence in the literature that might assist in attributing relative importance to indicators was generally lacking, so explicit weights were not assigned to indicators, i.e. they were equally weighted. This approach is consistent with that taken by some 44 out of 104 disaster risk, vulnerability and resilience composite indices reviewed by Beccari (2016).

Aggregating the indicators

Aggregating a series of indicators to form a composite index is mathematically equivalent to the aggregation procedures in a wide range of fields, including psychology (construction of summative scales), multi-criteria decision analysis (scoring a series of decision options), life-cycle analysis (scoring a series of consumer products) and information science (scoring the results of a web search). While the composite indices used in much of natural hazards vulnerability index research are based on simple additive procedures, such as means, sums or weighted sums, the aggregation procedure used in the Australian Disaster Resilience Index draws on the improved aggregation techniques that have been developed in fields outside of natural hazards. The decision to use these improved techniques was a response to the growing criticism and concerns about the use of simple additive procedures. These concerns have given rise to a wide range of proposed aggregation procedures that attempt to overcome the shortcomings of additive procedures (see, for example, Bertin et al. 2018; Chakraborty and Zavadskas 2014; Cherchye et al.

2007; De Muro et al. 2011). A review of the composite index literature is provided in Parsons et al. (2019b).

Seventeen aggregation functions were evaluated for use in the Australian Disaster Resilience Index. These comprised six from the European composite index tradition (e.g. OECD 2008), two from information science (e.g. Dwork et al. 2001), seven from multi-criteria decision analysis (e.g. Figueira et al. 2005) and two from the theory of aggregation functions (e.g. Grabisch et al. 2011). The criteria upon which each aggregation function was evaluated were:

- whether it discarded any information contained in the indicators;
- whether it produced a ratio index (rather than, say, a ranking);
- whether it provided control over compensatory effects;
- whether the control over compensatory effects was adjustable; and,
- the computation time for an aggregation of 77 indicators and 2,084 SA2s.

One aggregation function was rejected because it could not be validly applied to small geographic areas such as SA2s. Three functions were rejected because of impossibly or inconveniently long computation times. Eight functions were rejected because they provided rankings or ordinal scores and not a ratio index. The linear sum or mean was rejected for the reasons given in the example above. A further aggregation function, the Maziotta-Pareto Index was rejected because, while providing control over compensatory effects, it did not allow for adjustment of the level of limitation of these effects. Of the five remaining aggregation functions, only one – the discrete Choquet Integral – allowed for complete specification of the restrictions on compensatory effects for all indicator interactions. Since the number of specifications increases rapidly with the number of indicators, the discrete Choquet Integral was selected for use where there were only two or three indicators to be aggregated and it was possible to make plausible estimates of the interactions between indicators.

Of the remaining four aggregation functions, all of which allowed for generic restriction on compensatory effects rather than complete specification, Ordered Weighted Averaging was chosen as the most suitable for use in aggregations of four or more indicators, specifying an overall level of restriction of compensatory effects, rather than a complete specification.

A full description of the evaluation of aggregation functions is provided in Parsons et al. (2019b).

Aggregation strategy

Aggregation strategy refers to the approach taken in the aggregation calculation for a composite index or sub-index, to deal with the types of issues discussed above. It is defined by:

- the type of measurement model assumed – formative or reflective;
- the number of stages or levels of aggregation; and,

- the aggregation functions used.

The main possible aggregation strategies for the Australian Disaster Resilience Index are shown schematically in Figure 2.

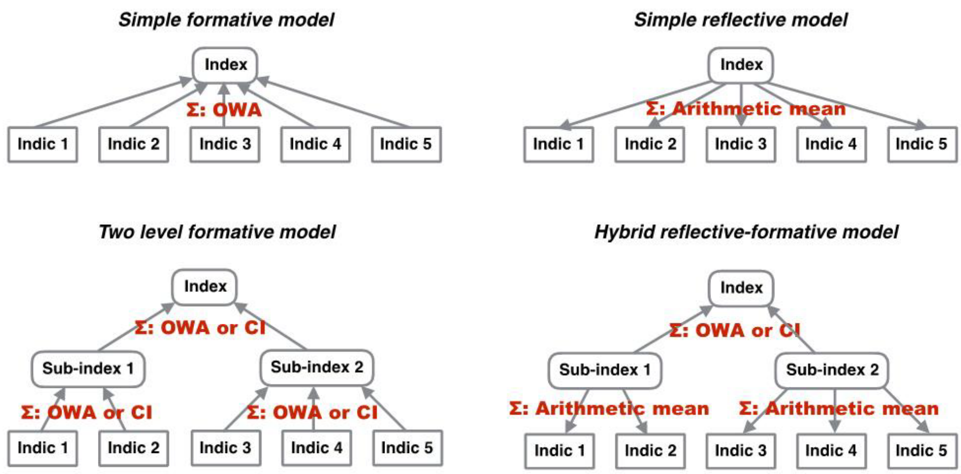


Figure 2: Aggregation strategies considered in the calculation of the Australian Disaster Resilience Index. Grey arrows show the direction of causation, red text gives the aggregation function (OWA=Ordered Weighted Average, CI=discrete Choquet integral).

The choice of aggregation strategy starts with analysis of the correlations among the set of indicators to be aggregated. The results are subsequently applied in a decision tree to select the appropriate aggregation strategy (Figure 3). Full details of the aggregation processes are provided in Parsons et al. 2019b.

Aggregation calculations

Two aggregation functions were chosen for use in the Australian Disaster Resilience Index: Ordered Weighted Averaging (OWA) and the discrete Choquet integral. The former was used where the number of indicators or sub-indices to be aggregated was four or more. In this situation, it is difficult to specify all the possible compensatory effects between pairs of indicators, so a generic constraint can be placed on compensatory effects across all indicators, using OWA. The parameter in OWA that controls the amount of constraint placed on compensatory effects between indicators is known as the orness (James 2016). For an orness of 0.5, the OWA of a set of indicators is identical to the arithmetic mean, i.e. no constraint is placed on compensatory effects between indicators. For an orness of 0.0, the OWA of a set of indicators is identical with the value of the indicator with the smallest value, i.e. no compensatory effects are allowed. Further details and examples of OWA are provided in Parsons et al. 2019b.

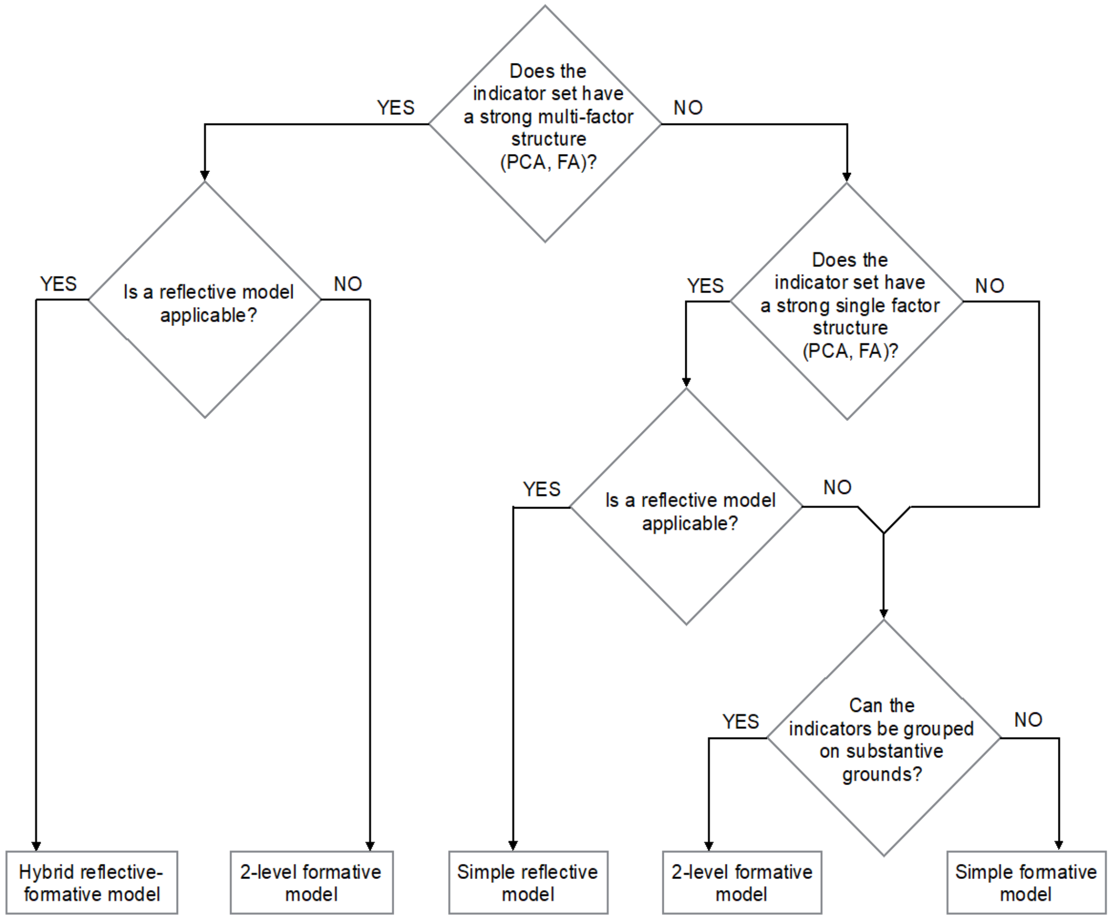


Figure 3: Decision tree for the choice of aggregation strategy.

For the Australian Disaster Resilience Index, the extent to which high values of some indicators could be allowed to compensate for low values of other indicators was known only approximately, or not at all. Consequently, just two orness values were used in aggregations using OWA: 0.125 for situations where there was some certainty that only minimal compensatory effects should be allowed, and an orness of 0.375 for situations where it was reasonable to assume that substantial amounts of compensation were permissible in aggregating indicators. As an aggregation method placing a generic constraint on compensatory effects, OWA implicitly involves equal weights on indicators.

Where two or three indicators or sub-indices in a formative model were to be aggregated, consideration was first given to using the discrete Choquet integral. This aggregation function allows for a comprehensive and nuanced specification of the degree of constraint to be placed on compensatory effects between indicators. If knowledge of the compensatory effects between, or among, these was insufficient, then OWA was used instead.

The parameter by which compensatory affects are adjusted for in aggregating with the discrete Choquet integral is called the fuzzy measure (James 2016), and is a set of weighting values. The weighting values can be adjusted to reflect the desired level of constraint on compensatory effects between each pair of indicators, as well as achieving a particular level of overall orness. To the extent that the importance of an indicator might be regarded as its capacity to compensate for low values of less important indicators, some of the weighting values in the fuzzy measure can be interpreted in the sense of importance weights. The discrete Choquet integral is used relatively infrequently in the construction of the Australian Disaster Resilience Index. It is a fairly complex calculation, and a full explanation is provided in Parsons et al. 2019b.

The theory of aggregation functions predicts that the functions used in the Australian Disaster Resilience Index, and the chosen orness values, will result in particular differences in the distribution of aggregation results, compared to what would be obtained with a simple arithmetic, mean or with other types of aggregation functions. Accordingly, for every aggregation in the Australian Disaster Resilience Index, the distribution of results for the chosen method was compared with the arithmetic mean, geometric mean and Mazziotta-Pareto Index. This provided a check that the chosen aggregation method and orness values were performing as predicted by theory. The comparisons of aggregation functions are provided in Parsons et al. 2019b.

INDEX VISUALISATION AND DISASTER RESILIENCE ASSESSMENT

The final form of the Australian Disaster Resilience Index, and component coping capacity, adaptive capacity and theme sub-indices is a value in the range of 0 to 1. Values of 0 correspond to lower disaster resilience and values of 1 correspond to higher disaster resilience. These values of the Australian Disaster Resilience Index, and component sub-indices, can be viewed spatially on maps, or analysed further to determine the spatial patterns of index values, find groups of SA2s with similar disaster resilience, or examine the relationships between index values and population characteristics.

Disaster resilience patterns

At the level of the Australian Disaster Resilience Index, the 2084 SA2s were split into three bands based on index values: high capacity for disaster resilience (>75th percentile); moderate capacity for disaster resilience (25th – 75th percentile); and, low capacity for disaster resilience (<25th percentile). Each band has an associated narrative of capacity for disaster resilience. Population, land area and remoteness characteristics of the component SA2s were tallied to estimate the proportions associated with the disaster resilience bands.

The second level of the disaster resilience assessment is made up of coping and adaptive capacity sub-indexes (Figure 1). The coping and adaptive capacity sub-indexes range from 0 to 1, with 0 being lower coping or adaptive capacity and 1 being higher coping or adaptive capacity. The 2084 SA2s were split into three band based on coping and adaptive capacity sub-index values: high coping or adaptive capacity (>75th percentile); moderate coping or adaptive capacity (25th – 75th percentile); and, low coping or adaptive capacity (<25th percentile). Each band has an associated narrative of capacity for disaster resilience. Population, land area and remoteness characteristics of the component SA2s were tallied to estimate the proportions associated with the disaster resilience bands. Remoteness characteristics were taken from the Australian Statistical Geographical Standard remoteness structure.

Disaster resilience typology

Many of the indicators used in the construction of the Australian Disaster Resilience Index have well-understood spatial relationships. This suggests that, if the eight theme sub-indices are considered, SA2s might fall into groups with similar disaster resilience profiles. Cluster analysis was used to extract groups of SA2s with unique disaster resilience profiles.

It was concluded that there is support for a three, five or nine cluster solution for the eight theme sub-indices, although the cluster structure is weak. The five cluster solution using partitioning around medoids was chosen on simple communication grounds to support further interpretive visualisation of the Australian Disaster Resilience Index using a heat-map. A nine cluster solution would overly complicate the interpretation, while a three cluster solution would be unnecessarily parsimonious. External validation of the five cluster solution using a measure of remoteness showed there were significant differences in remoteness among the five groups. This lent support for the decision to present interpretative visualisations of the Australian Disaster Resilience Index as a five-group typology. When mapped, the five groups of SA2s tended to form cohesive regions, rather than being scattered randomly, further supporting the view that, although cluster structure is weak, it is nonetheless spatially meaningful. A full description of the derivation of the typology is provided in Parsons et al. 2019b.

The disaster resilience profile associated with each of the cluster groups was determined using a three step process. First, percentiles were calculated using all 2084 SA2s within a theme to set the classes of high (>75th percentile), moderate (25th to 75th percentile) and low (<25th percentile) disaster resilience. Second, the median index values for each cluster group and theme were used to identify groups as belonging to the high, moderate or low disaster resilience band. Third, the bands were narrated using the relationships of individual indicators to the distribution of theme sub-index values. Summary statistics were also used to show the relationships between cluster groups and population, land area and remoteness, and the relationships between groups and the resilience, coping and adaptive capacity index values.

THE DESIGN OF THE INDEX BOUNDS THE INTERPRETATION OF DISASTER RESILIENCE

The design of the Australian Disaster Resilience Index bounds the interpretations that can be drawn about disaster resilience. These boundaries include:

- The index assesses the capacity for disaster resilience, not observed resilience following any one natural hazard event. This is related to the idea of antecedent and inherent conditions set out within the BRIC model (Cutter et al. 2008).

- The index considers the system of social, economic, institutional and governance factors that need to be in place for disaster resilience. It forms those into an index based on how well eight structural factors work together to support or constrain the capacities of communities to be able to cope with, absorb and adapt to natural hazards. The structural factors – or themes – were selected in relation to the available evidence about the types of social, economic and institutional factors that determine the capacity to absorb shocks and stresses or to adapt to change. Indicators of each theme were used to compute a sub-index for each theme: on their own an individual indicator expresses one sub-component of disaster resilience but combined into an index, the indicators summarise complex information about the theme.
- Second, the index is not about individuals or their behaviours. It did not ask people about their experiences with hazards or what they might do to prepare for, respond to and recover from hazard events. The index is an assessment of the structural capacities for disaster resilience that sit around communities. Even though individuals can act in many different ways, these capacities can form sometimes quite invisible supports or constraints on disaster resilience in a community. What the index does is to uncover what these supports and constraints are and where they occur around Australia. An approach that considered individual capacity for disaster resilience would use bottom-up participatory methods to form an index, and was not the intent of this project because of the national scale.
- The resolution of the index is the Statistical Area Level 2 – or SA2 division - of the Australian Bureau of Statistics. Disaster resilience was assessed in 2084 SA2s across Australia. The index is a spatial, place-based index in which a community is defined geographically by SA2. The value of the index is in comparing places and finding areas with similar strengths and similar barriers to disaster resilience around Australia. The Australian Disaster Resilience Index provides that standardised comparative function for the first time.

FINDINGS

DISASTER RESILIENCE IN AUSTRALIA

The Australian Disaster Resilience Index ranges from 0 to 1, with 0 being lower capacity for disaster resilience and 1 being higher capacity for disaster resilience. The 2084 SA2s were split into three bands based on index values: high capacity for disaster resilience (>75th percentile); moderate capacity for disaster resilience (25th – 75th percentile); and, low capacity for disaster resilience (<25th percentile). Each band has an associated narrative of capacity for disaster resilience (Table 3). Population, land area and remoteness characteristics of the component SA2s were tallied to estimate the proportions associated with the disaster resilience bands.

Table 3: Description of high, moderate and low disaster resilience bands for the Australian Disaster Resilience Index.

ADRI Class	Percentile	Description
Low	<25th percentile ADRI = 0 – 0.4461	Communities in areas of low disaster resilience may be limited in their capacity to use available resources to cope with adverse events, and are limited in their capacity to adjust to change through learning, adaptation and transformation. Limitations to disaster resilience may be contributed by entrenched social and economic disadvantage, less access to or provision of resources and services, lower community cohesion and limited opportunities for adaptive learning and problem solving.
Moderate	25 – 75th percentile ADRI = 0.4462 – 0.6598	Communities in areas of moderate disaster resilience have some capacity to use available resources to cope with adverse events, and some capacity to adjust to change through learning, adaptation and transformation. Moderate disaster resilience is generally contributed by moderate levels of coping and adaptive capacity, which in turn are associated with moderate levels of economic capital, moderate provision of an access to services, moderate community cohesion and variable encouragement for adaptive learning and problem solving.
High	>75th percentile ADRI = 0.6599 - 1	Communities in areas of high disaster resilience have enhanced capacity to use available resources to cope with adverse events, and enhanced capacity to adjust to change through learning, adaptation and transformation. Factors contributing to high disaster resilience may include employment, education, income, good access to or provision of resources and services, strong community cohesion and ample opportunities for adaptive learning and problem solving.

Most of the population of Australia live in areas assessed as having moderate capacity for disaster resilience.

Visually there is a general pattern of higher capacity for disaster resilience across the populated south east areas of Australia, and around metropolitan and major regional centres (Figure 4). Outer regional and remote areas, particularly those in northern and central Australia, have lower capacity for disaster resilience (Figure 4). Factors underlying this overall pattern are discussed in the forthcoming sections.

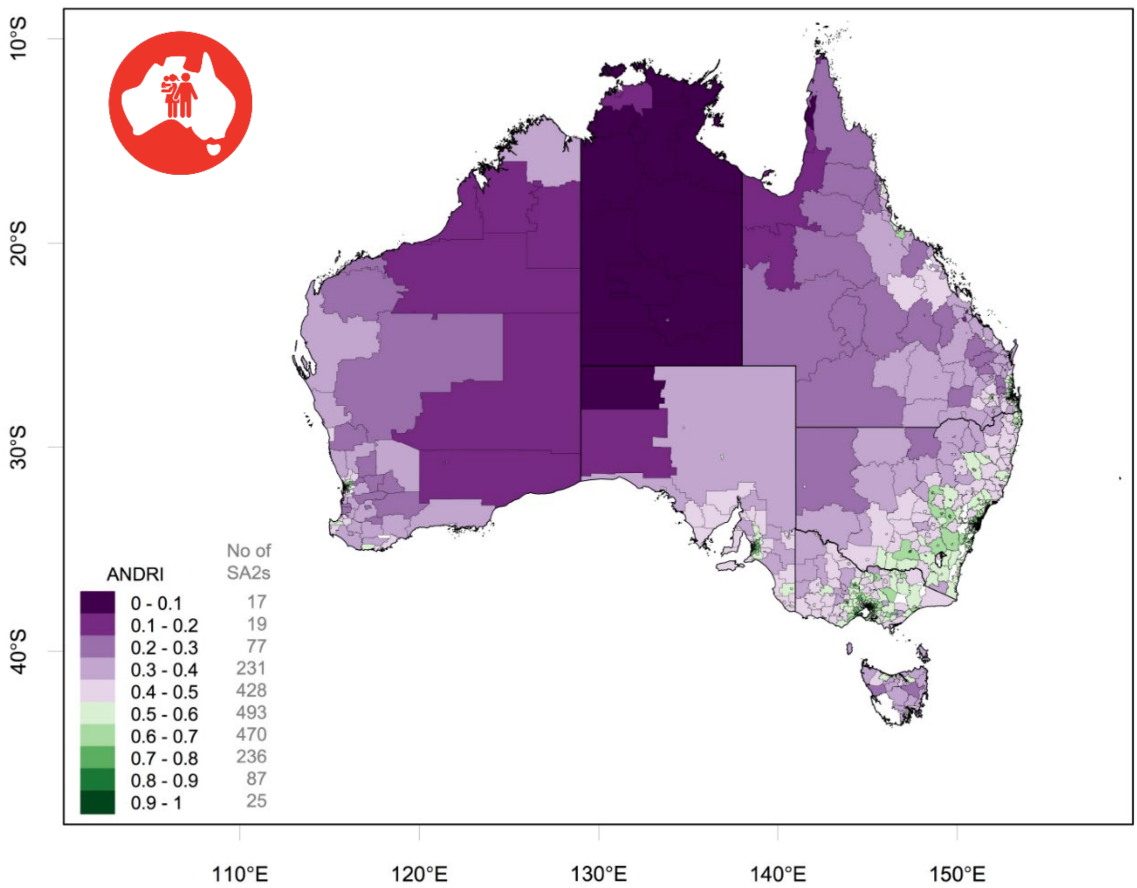


Figure 4: Capacity for disaster resilience in Australia assessed using the Australian Disaster Resilience Index. The index ranges from 0 to 1, where 0 is lower capacity for disaster resilience and 1 is higher capacity for disaster resilience. Detailed maps of the Australian Disaster Resilience Index at the resolution of state/territory and major metropolitan areas can be found in Appendix 1.

About 52% of Australia's population, or about 12.3 million people, live in an SA2 assessed as having moderate capacity for disaster resilience (Figure 5 and Table 4). Overall, areas with moderate disaster resilience comprise 6% of Australia's land area (Table 4). Most of the SA2s assessed as having moderate capacity for disaster resilience occur in metropolitan, inner regional or outer regional areas, although six remote or very remote SA2s had moderate disaster resilience (Table 4). Areas with moderate disaster resilience have some capacity to use available resources to cope with adverse events, and some capacity to adjust to change through learning, adaptation and transformation. Moderate disaster resilience is generally contributed by moderate levels of coping and adaptive capacity, which in turn are associated with moderate levels of economic capital, moderate provision of an access to services, moderate community cohesion and variable encouragement of adaptive learning and problem solving.

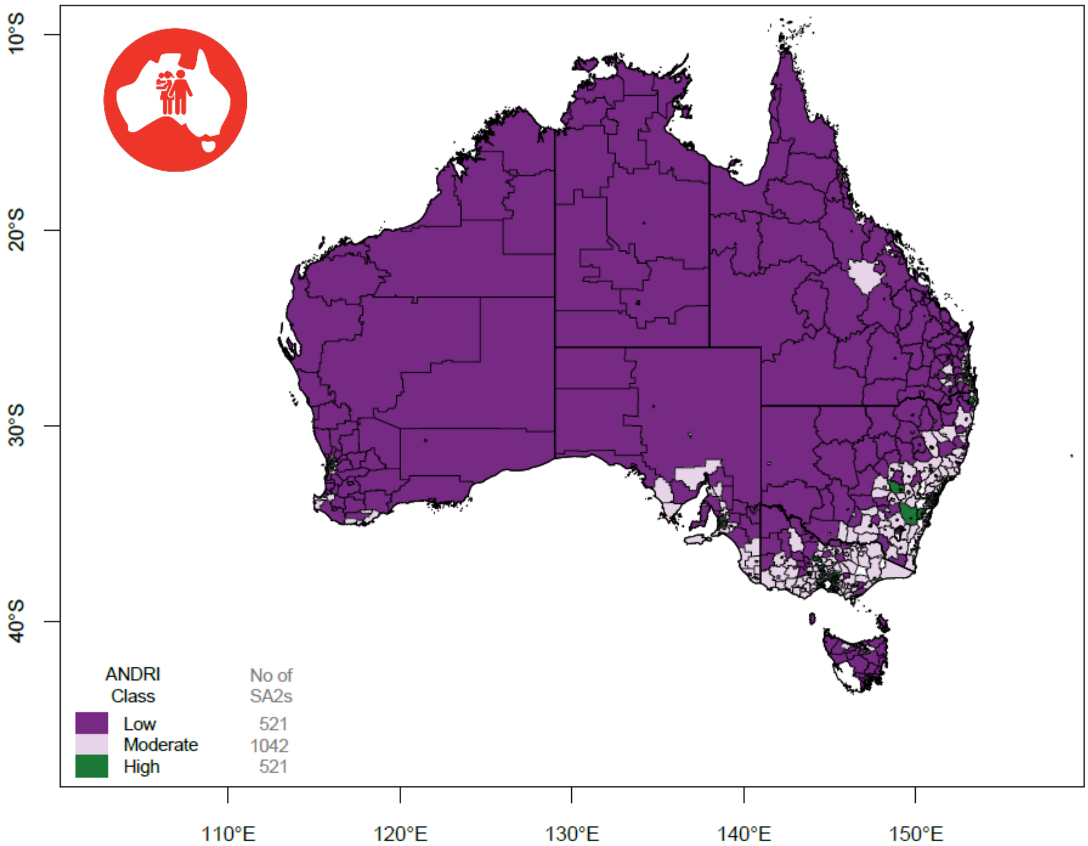


Figure 5: Distribution of low, moderate and high capacity for disaster resilience in Australia. Low, moderate and high bands are explained in Table 3.

About 32% of Australia's population, or about 7.6 million people, live in an SA2 assessed as having high capacity for disaster resilience (Figure 5 and Table 4). Areas with high disaster resilience are associated with enhanced capacity to use available resources to cope with adverse events, and enhanced capacity to adjust to change through learning, adaptation and transformation. Factors contributing to high disaster resilience may include employment, education, income, good access to or provision of resources and services, strong community cohesion and ample opportunities for adaptive learning and problem solving.

Table 4: Population, land area and remoteness associated with low, moderate and high capacity for disaster resilience.

	Capacity for disaster resilience		
	Low **<25th percentile** **0 – 0.4461**	**Moderate** **25 – 75th percentile** **0.4462 – 0.6598**	**High** **>75th percentile** **0.6599 - 1**
Population*#			
Population in component SA2s	3,842,568	12,323,025	7,638,030
Percentage population in component SA2s	16.1	51.8	32.1
Land area^			
Land area of component SA2s (km²)	7,146,933	467,381	30,448
Percentage land area in component SA2s	93.5	6.1	0.4
Remoteness$			
Metropolitan Population in component SA2s	1,266,355	8,732,737	6,960,378
Metropolitan Percentage population in component SA2s	5.3	36.7	29.2
Metropolitan Number of component SA2s	111	639	453
Inner regional Population in component SA2s	1,010,165	2,637,079	655,149
Inner regional Percentage population in component SA2s	4.2	11.1	2.8
Inner regional Number of component SA2s	131	280	65
Outer regional Population in component SA2s	1,127,561	915,174	22,503
Outer regional Percentage population in component SA2s	4.7	3.8	0.09
Outer regional Number of component SA2s	189	117	3
Remote Population in component SA2s	262,327	35,717	0
Remote Percentage population in component SA2s	1.1	0.15	0
Remote Number of component SA2s	43	5	0
Very remote Population in component SA2s	176,160	2,318	0
Very remote Percentage population in component SA2s	0.74	0.01	0
Very remote Number of component SA2s	47	1	0
SA2s+			
Number of SA2s	521	1,042	521
Percentage of SA2s	25	50	25

* Computed using ABS Estimated Resident population as of 30th June 2015.
# Excludes SA2s not used in the index. The population in SA2s used in the index is 23,803,623 people. The population in SA2s not used in the index is a further 12,372 people.
^ Excludes SA2s not used in the index. The land area of SA2s used in the index is 7,644,763km². The land area of SA2s not used in the index is a further 43,047km².
$ ABS remoteness categories, ASGS 2011.
+ Excludes SA2s not used in the index. Of the 2214 SA2s in the ASGS 2011, 2084 were used in the index and 130 excluded.

About 16% of Australia's population, or about 3.8 million people, live in an SA2 assessed as having low capacity for disaster resilience (Figure 5 and Table 4). Areas with low disaster resilience are associated with low capacity to use available resources to cope with adverse events, and are likely to be limited in their capacity to adjust to change through learning, adaptation and transformation. Limitations to disaster resilience may be contributed by entrenched social and economic disadvantage, less access to or provision of resources and services, lower community cohesion and limited opportunities for adaptive learning and problem solving.

There is a distinct association between capacity for disaster resilience and remoteness.

Each remoteness category encompasses SA2s with a range of high to low index values. However, there is a distinct relationship between remoteness and capacity for disaster resilience (Figure 6). Remote and very remote SA2s are concentrated within the lower end of index values. Outer regional, inner regional and metropolitan SA2s are progressively concentrated within the higher end of index values. Thus, metropolitan SA2s are generally associated with higher capacity for disaster resilience.

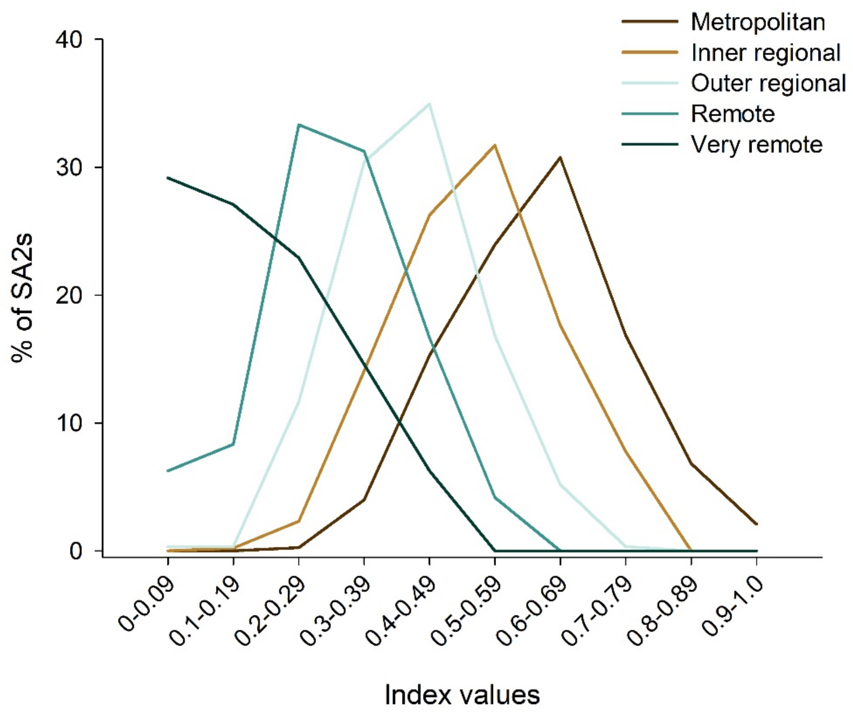


Figure 6: Distribution of Australian Disaster Resilience Index values by remoteness categories.

Most areas of higher capacity for disaster resilience are located in metropolitan and inner regional Australia. Areas of higher capacity for disaster resilience comprise only 0.5% of land surface area.

Most of the SA2s assessed as having high capacity for disaster resilience occur in metropolitan and inner regional areas of Australia, with an associated population of about 7.5 million people (Table 4). Only 3 outer regional SA2s had high capacity for disaster resilience, and no remote or very remote SA2s were assessed as having high disaster resilience (Table 4). Areas with high disaster resilience are confined to less than 0.5% of Australia's land surface area (Table 4).

In metropolitan areas, 38% of SA2s have high capacity for disaster resilience (Figure 7). This falls to only 8% outside of metropolitan areas (Figure 7). Non-metropolitan SA2s with high capacity for disaster resilience are located almost entirely within inner regional areas, generally in close proximity to metropolitan areas. Thus, proximity to metropolitan areas can be seen to enhance the potential for high capacity for disaster resilience.

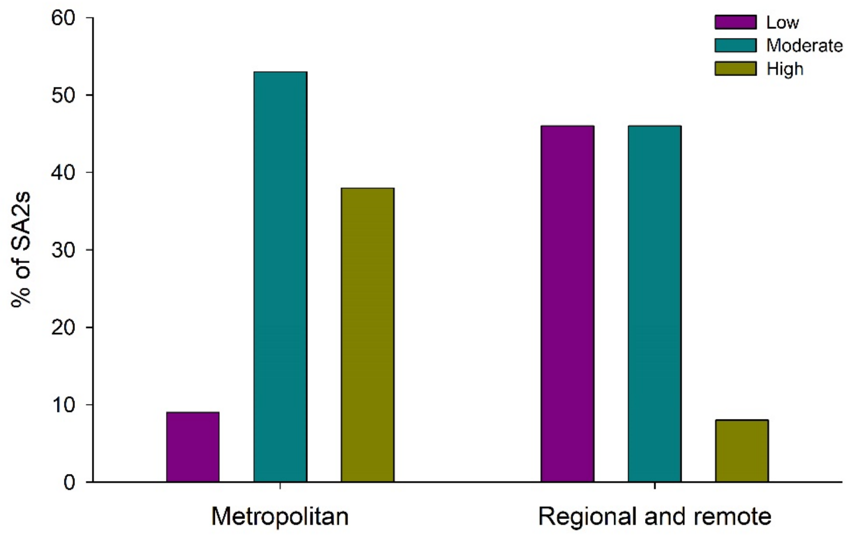


Figure 7: Proportion of SA2s with high, moderate and low capacity for disaster resilience in metropolitan and non-metropolitan (combined regional and remote) areas. Detailed maps of the Australian Disaster Resilience Index at the resolution of state/territory and major metropolitan areas can be found in Appendix 1.

The SA2s with high capacity for disaster resilience are not distributed evenly through metropolitan areas. Rather, SA2s with high capacity for disaster resilience are usually clustered together, forming multiple pockets of higher capacity within the metropolitan area (see Parsons et al. 2019a). These clusters can sometimes have substantial numbers of high capacity SA2s sharing boundaries (see Parsons et al. 2019a). These clusters often extend in one direction from the inner suburbs through to outer ring suburbs (see, for example, the Sydney, Melbourne and Adelaide maps in Parsons et al. 2019a). This indicates that specific locations within a metropolitan area can have a combination of attributes amenable to high capacity for disaster resilience.

Most areas of lower capacity for disaster resilience are located in outer regional, remote and very remote Australia. Areas of lower capacity for disaster resilience comprise over 93% of land surface area.

Low capacity for disaster resilience is associated with remote and very remote SA2s, comprising about 435,000 people (Table 4 and Figure 5). Areas with low disaster resilience comprise over 93% of Australia's land surface area (Table 4). Almost 50% of non-metro SA2s have low capacity for resilience; in metro areas it is less than 10% (Figure 5).

There are areas of lower capacity for disaster resilience in metropolitan Australia.

Despite the predominance of low capacity for disaster resilience in remote and very remote SA2s, low capacity for disaster resilience was also found in metropolitan areas. Nine percent of metropolitan SA2s, comprising about 1.3 million people, were assessed as having low capacity for disaster resilience (Table 4 and Figure 5). In most metropolitan areas, small clusters of SA2s with low capacity for disaster resilience can be observed (see maps in Parsons et al. 2019a). Those clusters are comprised of small numbers of SA2s and are found in outer, middle and inner city areas (see maps in Parsons et al. 2019a).

The "concentric zones" theory of urban sociology (Burgess 1925), which once held that the social structure of the metropolitan area could be read in terms of concentric rings progressively arranged outwards from the city centre, does not apply in the distribution of capacity for disaster resilience in the metropolitan areas. There is no clear pattern to show, for example, that SA2s on the metropolitan fringe will have lower capacity for disaster resilience than SA2s closer to the city centre. In some cities, some fringe SA2s will have low capacity for resilience, but this is not a general rule across all cities. Some inner metropolitan SA2s can also show low capacity for disaster resilience. Conversely, SA2s with high capacity for resilience can be found in inner, middle, and outer parts of metropolitan areas.

The conclusion is that while moderate disaster resilience is the dominant state across metropolitan areas, the metropolitan landscape of disaster resilience is one of localised pockets of different disaster resilience capacity. The factors used to assess disaster resilience will reflect localised differences in capacity for disaster resilience within metropolitan areas. Some metropolitan locations have a combination of factors that contribute to higher capacity for disaster resilience, while other locations have a combination of factors that contribute to lower disaster resilience.

Inner regional areas have greater capacity for disaster resilience than outer regional areas.

About 72% of inner regional SA2s were assessed as having moderate to high capacity for disaster resilience: 14% with high capacity and 58% with moderate capacity (Table 4). In contrast, only 39% of outer regional SA2s were assessed as having moderate to high capacity for disaster resilience: 1% with high capacity and 39% with moderate capacity (Table 4). However, most (72%) inner regional SA2s occur in the more populous eastern mainland states, highlighting the importance of the inner regional areas of the eastern mainland states in the geography of disaster resilience.

Patterns of capacity for disaster resilience at the national level are generally, but not always, upheld in each state or territory.

The overall patterns of population associated with areas of high, moderate and low capacity for disaster resilience are generally, but not always, displayed in each State and Territory. New South Wales and Victoria have less of their population associated with areas of low capacity for disaster resilience than at the national level (Table 5). These States also have more of their population associated with areas of high capacity for disaster resilience than at the national level (Table 5). While Queensland and Western Australia have a similar population associated with areas of moderate disaster resilience to the national level, these States have lower than national-level proportion of the population associated with areas of high disaster resilience and higher than national-level proportion of population associated with areas of low disaster resilience (Table 5). South Australia has the same population distribution across areas of low, moderate and high disaster resilience as the national level.

The Northern Territory and Australian Capital Territory patterns are different from the national-level distribution. All areas of the Northern Territory are associated with low disaster resilience (Table 5). The Australian Capital Territory follows the national level trend for population associated with areas of moderate disaster resilience (Table 5). The remainder of the Australian Capital Territory population is associated with areas of low disaster resilience and none of the population is associated with areas of high disaster resilience (Table 5).

Table 5: Population and land area associated with low, moderate and high capacity for disaster resilience for each Australian state and territory. The national-level is also shown for comparison.

	Capacity for disaster resilience		
	Low <25th percentile 0 – 0.4461	**Moderate 25 – 75th percentile 0.4462 – 0.6598**	**High >75th percentile 0.6599 - 1**
NATIONAL			
Population*#			
Population in component SA2s	3,842,568	12,323,025	7,638,030
Percentage population in component SA2s	16.1	51.8	32.1
Land area^			
Land area of component SA2s (km^2)	7,146,933	467,381	30,448
Percentage land area in component SA2s	93.5	6.1	0.4
NEW SOUTH WALES			
Population*#			
Population in component SA2s	697,199	3,733,412	3,184,250
Percentage population in component SA2s	9.2	49.0	41.8
Land area^			
Land area of component SA2s (km^2)	585,513	183,764	19,962
Percentage land area in component SA2s	74.2	23.3	2.5
VICTORIA			
Population*#			
Population in component SA2s	454,330	2,948,494	2,618,994
Percentage population in component SA2s	7.5	49.0	43.5
Land area^			
Land area of component SA2s (km^2)	81,928	132,736	6,998
Percentage land area in component SA2s	37.0	59.9	3.2
QUEENSLAND			
Population*#			
Population in component SA2s	1,173,873	2,836,002	766,851
Percentage population in component SA2s	24.6	59.4	16.1
Land area^			
Land area of component SA2s (km^2)	1,673,482	48,117	1,229
Percentage land area in component SA2s	97.1	2.8	0.1.

Table 5 (cont.)

	Capacity for disaster resilience		
	Low **<25th percentile** **0 – 0.4461**	**Moderate** **25 – 75th percentile** **0.4462 – 0.6598**	**High** **>75th percentile** **0.6599 - 1**
SOUTH AUSTRALIA			
Population*#			
Population in component SA2s	293,173	854,567	552,785
Percentage population in component SA2s	17.2	50.3	32.5
Land area^			
Land area of component SA2s (km^2)	900,171	82,502	1,347
Percentage land area in component SA2s	91.5	8.4	0.1
WESTERN AUSTRALIA			
Population*#			
Population in component SA2s	618,219	1,488,664	433,308
Percentage population in component SA2s	24.3	58.6	17.1
Land area^			
Land area of component SA2s (km^2)	2,509,286	14,509	608
Percentage land area in component SA2s	99.4	0.6	<0.1
TASMANIA			
Population*#			
Population in component SA2s	201,885	231,375	81,842
Percentage population in component SA2s	39.2	44.9	15.9
Land area^			
Land area of component SA2s (km^2)	49,034	5,587	305
Percentage land area in component SA2s	89.3	10.2	0.6
NORTHERN TERRITORY			
Population*#			
Population in component SA2s	241,997	0	0
Percentage population in component SA2s	100	0	0
Land area^			
Land area of component SA2s (km^2)	1,346,893	0	0
Percentage land area in component SA2s	100	0	0

Table 5 (cont.)

	Capacity for disaster resilience		
	Low <25th percentile 0 – 0.4461	**Moderate 25 – 75th percentile 0.4462 – 0.6598**	**High >75th percentile 0.6599 - 1**
AUSTRALIAN CAPITAL TERRITORY			
Population*#			
Population in component SA2s	161,892	230,511	0
Percentage population in component SA2s	41.3	58.7	0
Land area (km^2)^			
Land area of component SA2s	629	167	0
Percentage land area in component SA2s	79.1	20.9	0

* Computed using ABS Estimated Resident population as of 30th June 2015.
# Excludes SA2s not used in the index. The total population in SA2s used in the index is 23,803,623 people. The total population in SA2s not used in the index is a further 12,372 people.
^ Excludes SA2s not used in the index. The land area of SA2s used in the index is 7,644,763km^2. The land area of SA2s not used in the index is a further 43,047km^2.

Implications of the spatial distribution of disaster resilience in Australia

Disaster resilience is a protective characteristic that acts to reduce the effects of, and losses from, natural hazard events. Disaster resilience arises from the capacities of social, economic and government to prepare for, respond to and recover from a natural hazard event, and to learn, adapt and transform in anticipation of future natural hazard events. The state of disaster resilience in Australia is one of non-uniformly distributed disaster resilience. The assessment of disaster resilience using the Australian Disaster Resilience Index shows that communities in Australia do not all have the same capacity for disaster resilience. About 52% of the population live in areas with moderate capacity for disaster resilience, about 32% in areas with high capacity for disaster resilience and about 16% in areas with low capacity for disaster resilience.

Differences in the capacity of communities for disaster resilience might be associated with unequal impacts of, and outcomes from, a natural hazard event. Disaster resilience is a complex interplay of factors that influence coping and adaptive capacity, including social and economic characteristics, the provision of government and other services, community capital and governance regimes. In areas of high capacity for disaster resilience, the status of these factors enhances the ability of communities to use available resources to prepare for, respond to and recover from natural hazard events and to adapt and transform in the face of future events. In areas of low capacity for disaster resilience, the status of these factors constrains the ability of communities to use available resources to prepare for, respond to and recover from natural hazard events and to adapt and transform in the face of future events. In areas of moderate capacity for disaster resilience factors occur in many combinations to both constrain and support the ability of communities to use available resources to prepare for, respond to and recover from natural hazard events and to adapt and transform in the face of future events.

Findings from analyzing the distribution of the Australian Disaster Resilience Index reveal that the capacity for disaster resilience is not distributed uniformly across Australia. There is a strong geographic signal in capacity for disaster resilience. Outer regional, remote and very remote areas are generally associated with low capacity for disaster resilience, while metropolitan and inner regional areas are generally associated with high or moderate capacity for disaster resilience. This geographic pattern of disaster resilience echoes that found in social and economic assessments of education (ACARA 2016), health (NRHA 2016; AIHW 2018), planning (Horney et al. 2017), employment (Hajkowicz et al. 2016) and income (NRHA & ACOSS 2013; ACOSS & UNSW 2018), where outer regional, remote and very remote areas generally experience poorer outcomes in comparison to metropolitan areas. The outcomes of lower disaster resilience capacity may include: longer and more complex disaster recovery; increased post-disaster out-migration; disruptive regional economic change; under-resourced or distant government services to support natural hazard planning, response and mitigation functions; and, limited access to digital services and information. However, remoteness is often associated with community cohesion and capital, where community bonds may self-generate support and resources before, during and after emergencies.

The strong geographic signal in capacity for disaster resilience is also associated with vastly different land areas. Areas of low capacity for disaster resilience make up 93.5% of Australia's land area because component outer regional, remote and very remote SA2s are large in area, but have low population densities. In contrast, areas of high capacity for disaster resilience make up only 0.4% of Australia's land area because component SA2s are frequently metropolitan and have high population densities. Thus, population and land area interact to generate a non-uniform distribution of disaster resilience capacity. This has significant implications for planning for and resourcing improvements to disaster resilience capacity, because lower disaster resilience capacity, low population and large land areas generally occur together.

Despite the broadly observed associations between disaster resilience and remoteness, lower disaster resilience is not always confined to outer regional, remote and very remote areas. Approximately 9.5% of Australia's population, or about 2.3 million people, live in metropolitan and inner regional areas that have a low capacity for disaster resilience. The location of areas of low capacity for disaster resilience in metropolitan and inner regional areas signals a different set of challenges for planning for and resourcing improvements to disaster resilience capacity. For these communities, remoteness is not a barrier to disaster resilience as they are embedded within well-resourced, highly populated surrounding regions. Rather, these communities may have social characteristics that work against disaster resilience outcomes, despite their metropolitan or inner regional location. Influencing these social characteristics, such as length of residence, community cohesion and need for assistance is generally beyond the focus of any one public agency or strategy and highlights the interconnectedness among different aspects of resilience.

COPING AND ADAPTIVE CAPACITY IN AUSTRALIA

The second level of the disaster resilience assessment is made up of coping and adaptive capacity sub-indexes (Figure 1). The coping and adaptive capacity sub-indexes range from 0 to 1, with 0 being lower coping or adaptive capacity and 1 being higher coping or adaptive capacity. The 2084 SA2s were split into three band based on coping and adaptive capacity sub-index values: high coping or adaptive capacity (>75th percentile); moderate coping or adaptive capacity (25th – 75th percentile); and, low coping or adaptive capacity (<25th percentile). Each band has an associated narrative of capacity for disaster resilience (Table 6). Population, land area and remoteness characteristics of the component SA2s were tallied to estimate the proportions associated with the disaster resilience bands.

Table 6: Description of high, moderate and low coping and adaptive capacity bands.

Capacity	Class	Percentile	Description
Coping	Low	<25th percentile 0 – 0.3945	Communities in areas of low coping capacity may be constrained in their capacity to use available resources to cope with adverse events and to prepare for, absorb and recover from a natural hazard event.
	Moderate	25 – 75th percentile 0.3946 – 0.6311	Communities in areas of moderate coping capacity have some capacity to use available resources to cope with adverse events and to prepare for, absorb and recover from a natural hazard event.
	High	>75th percentile 0.6312 - 1	Communities in areas of high coping capacity have enhanced capacity to use available resources to cope with adverse events and to prepare for, absorb and recover from a natural hazard event.
Adaptive	Low	<25th percentile 0 – 0.4515	Communities in areas of low adaptive capacity may be constrained in their capacity to adjust to change through learning, adaptation and transformation.
	Moderate	25 – 75th percentile 0.4516 – 0.6656	Communities in areas of moderate adaptive capacity have some capacity to adjust to change through learning, adaptation and transformation.
	High	>75th percentile 0.6657 - 1	Communities in areas of high adaptive capacity have enhanced capacity to adjust to change through learning, adaptation and transformation.

Index results: coping and adaptive capacity

Visually there is a general pattern of higher coping capacity along the eastern state coastal fringe, and around metropolitan and major regional centres (Figure 8). Higher adaptive capacity is concentrated into south eastern Australia and in metropolitan and major regional centres (Figure 9). Regional and remote areas, particularly those in Northern Australia, have lower coping and adaptive capacity (Figure 8 and 9).

About 72% of Australia's population, or 17.2 million people, live in SA2s assessed as having a combination of moderate or high coping and adaptive capacity (Table 7). These SA2s comprise about 4.3% of Australia's land area (Table 7). About 11% of the population, or 2.6 million people, live in SA2s assessed as having low adaptive capacity but moderate or high coping capacity (Table 7). These SA2s comprise about 3.4% of Australia's land area (Table 7). Conversely, about 10% of the population, or 2.4 million people, live in SA2s assessed as having low coping capacity but moderate or high adaptive capacity (Table 7). These SA2s comprise about 6.7% of Australia's land area (Table 7). The remaining 9% of the population, or 1.6 million people, live in SA2s assessed as having low coping and adaptive capacity (Table 7). However, these SA2s comprise 85.7% of Australia's land area (Table 7).

These population and land area patterns of disaster resilience can be explained in large part by remoteness. Most of the population assessed as having high or moderate coping and adaptive capacity occurs in metropolitan (58%) or inner regional (12%) areas (Table 8). Populations located in some outer regional, remote and very remote areas have moderate or high coping capacity, but no remote or very remote areas are associated with high adaptive capacity (Table 8). All remoteness classes – metropolitan through to very remote – were associated with the combination of low coping and low adaptive capacity (Table 8).

Implications of the distribution of coping and adaptive capacity in Australia

Assessment of disaster resilience requires consideration of the capacities within a system that influence a community's ability to absorb and persist in the presence of natural hazards and which enable learning, adjustment and transformation. The Australian Disaster Resilience Index takes the view that coping and adaptation emerge from social processes that develop the capacities required to anticipate and withstand unpredictable and adverse events such as natural hazards (Parsons et al. 2016). Coping capacity captures the characteristics of a system that allow it to anticipate, act, achieve goals, and manage resources, or which are associated with absorptive capacity and mobilization when a natural hazard event occurs (Parsons et al. 2016). Adaptation is the decision-making processes and actions undertaken to adjust to current or future predicted change. The capacities which enable adaptation are related to the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups (Folke et al. 2002; Parsons et al. 2016).

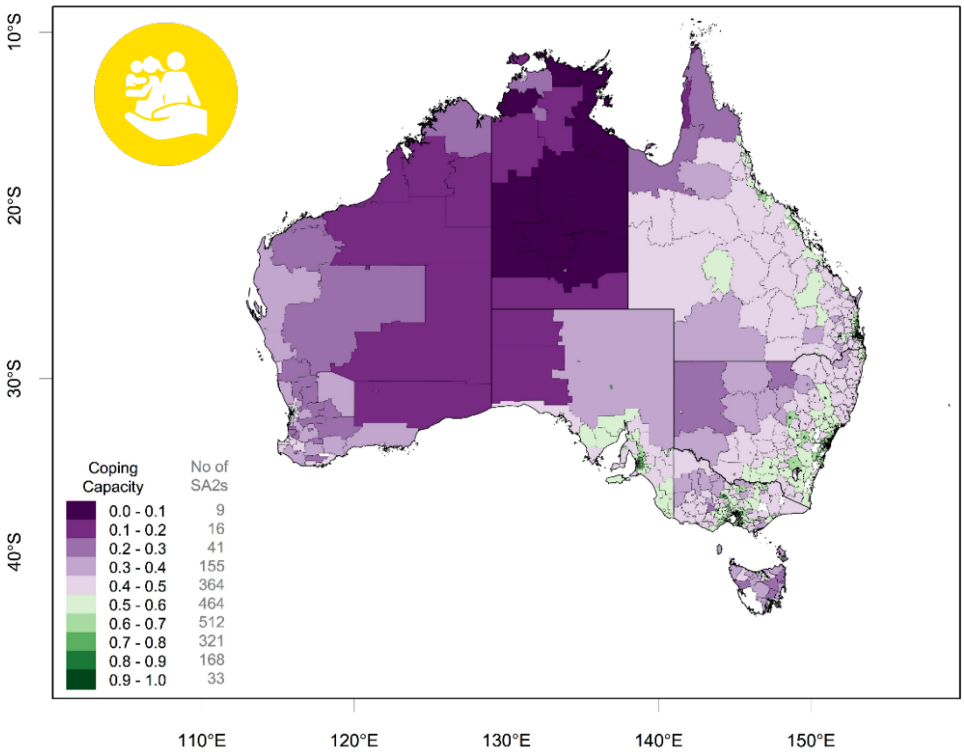


Figure 8: Coping capacity in Australia. The sub-index ranges from 0 to 1, where 0 is lower disaster resilience and 1 is higher disaster resilience. Maps of coping capacity at the resolution of state/territory and major metropolitan areas are shown in Parsons et al. 2019a.

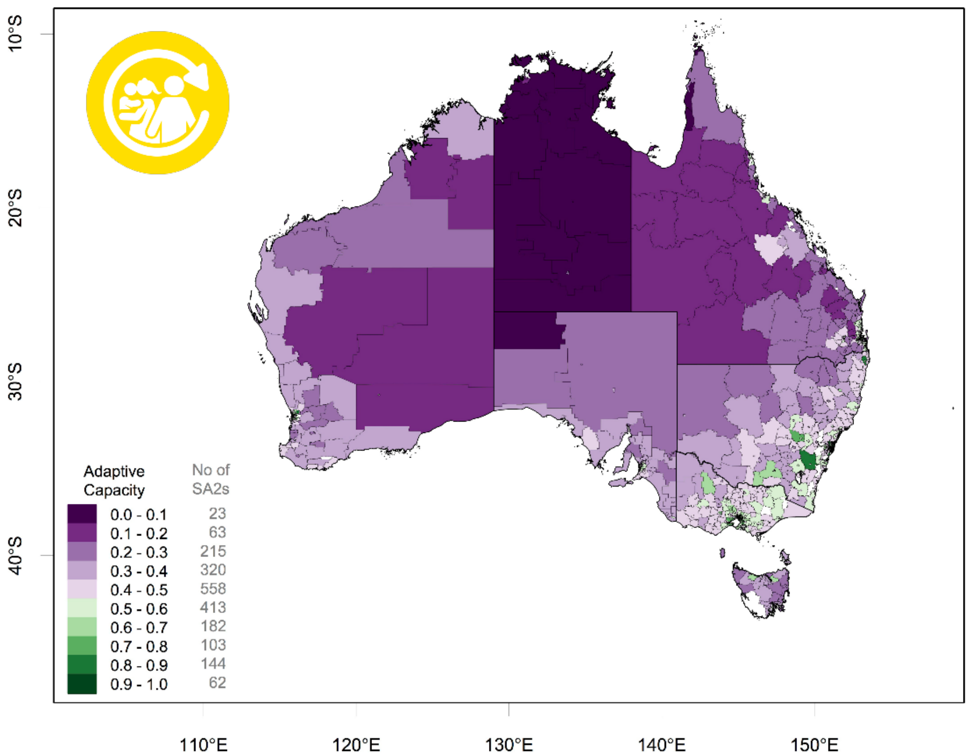


Figure 9: Adaptive capacity in Australia. The sub-index ranges from 0 to 1, where 0 is lower disaster resilience and 1 is higher disaster resilience. Maps of adaptive capacity at the resolution of state/territory and major metropolitan areas are shown in Parsons et al. 2019a.

Table 7: Population and land area associated with low, moderate and high coping and adaptive capacity.

		COPING CAPACITY		
		Low **<25th percentile** **0 – 0.3945**	**Moderate** **25 – 75th percentile** **0.3946 – 0.6311**	**High** **>75th percentile** **0.6312 - 1**
ADAPTIVE CAPACITY	**Low** **<25th percentile** **0 – 0.4515**	**Population*#** 1,653,084 (6.9%) **Area^** 6,548,084 km^2 (85.7%)	**Population** 2,184,525 (9.2%) **Area** 258,247km^2 (3.4%)	**Population** 376,507 (1.6%) **Area** 1,027 km^2 (0.01%)
	Moderate **25 – 75th percentile** **0.4516 – 0.6656**	**Population** 1,863,726 (7.8%) **Area** 501,887 km^2 (6.6%)	**Population** 6,404,662 (26.9%) **Area** 256,254 km^2 (3.4%)	**Population** 3,194,350 (13.4%) **Area** 7,943 km^2 (0.1%)
	High **>75th percentile** **0.6657 - 1**	**Population** 530,303 (2.2%) **Area** 10,958 km^2 (0.1%)	**Population** 4,482,181 (18.8%) **Area** 55,577km^2 (0.7%)	**Population** 3,114,285 (13.1%) **Area** 4,786 km^2 (0.1%)

* Populations were computed using ABS Estimated Resident population as of 30th June 2015.
# All values exclude SA2s not used in the index. The total population in SA2s used in the index is 23,803,623 people. The total population in SA2s not used in the index is a further 12,372 people.
^ All values exclude SA2s not used in the index. The land area of SA2s used in the index is 7,644,763km^2. The land area of SA2s not used in the index is a further 43,047km^2.

Table 8: Remoteness associations with low, moderate and high coping and adaptive capacity. Figures are the population and percentage of total population in each remoteness category. Remoteness codes: M = metropolitan; IR = inner regional; OR = outer regional; R = remote; VR = very remote.

		COPING CAPACITY		
		Low **<25th percentile** **0 – 0.3945**	**Moderate** **25 – 75th percentile** **0.3946 – 0.6311**	**High** **>75th percentile** **0.6312 - 1**
ADAPTIVE CAPACITY	**Low** **<25th percentile** **0 – 0.4515**	M 390,383 (1.6%)* # IR 315, 827 (1.3%) OR 563,687 (2.4%) R 221,011 (0.9%) VR 162,176 (0.7%)	M 972,559 (4.1%) IR 594,447 (2.5%) OR 571,409 (2.4%) R 36,514 (0.2%) VR 9,596 (<0.1%)	M 195,117 (0.8%) IR 111,187 (0.5%) OR 65,868 (0.3%) R 4,335 (<0.1%) VR 0 (0%)
	Moderate **25 – 75th percentile** **0.4516 – 0.6656**	M 1,051,099 (4.4%) IR 510,717 (2.1%) OR 286,077 (1.2%) R 11,445 (<0.1%) VR 4,388 (<0.1%)	M 4,371,683 (18.4%) IR 1,587,353 (6.7%) OR 418,569 (1.7%) R 24,739 (0.1%) VR 2,318 (<0.1%)	M 2,509,662 (10.5%) IR 572,686 (2.4%) OR 112,002 (0.5%) R 0 (0%) VR 0 (0%)
	High **>75th percentile** **0.6657 - 1**	M 495,329 (2.1%) IR 17,652 (0.1%) OR 0 (0%) R 0 (0%) VR 0 (0%)	M 4,088,084 (17.2%) IR 363 793 (1.5%) OR 30 304 (0.2%) R 0 (0%) VR 0 (0%)	M 2,885,554 (12.1%) IR 228 731 (1.0%) OR 17,322 (0.1%) R 0 (0%) VR 0 (0%)

* Populations were computed using ABS Estimated Resident population as of 30th June 2015.
# All values exclude SA2s not used in the index. The total population in SA2s used in the index is 23,803,623 people. The total population in SA2s not used in the index is a further 12,372 people.

About 72% of Australia's population, or 17.2 million people, live in SA2s assessed as having a combination of moderate or high coping and adaptive capacity. Communities with these combinations of coping and adaptive capacity are supported by social processes that develop the capacities to anticipate and withstand unpredictable and adverse events such as natural hazards and to adjust to current or future predicted change. As with the national scale assessment of disaster resilience, the areas of strong coping and adaptive capacity tend to occur in the most highly populated areas - metropolitan or inner regional areas. Thus, the systems generating coping and adaptive capacities are enhanced in these areas.

About 9% of the population, or 1.6 million people, live in SA2s assessed as having a combination of low coping and adaptive capacity. Areas with the combination of low coping and adaptive capacity face constraints on their ability to anticipate and withstand unpredictable and adverse events such as natural hazards and to adjust to current or future predicted change. These constraints may arise from the status of social, economic or government processes and the ways that these inhibit access to resources and opportunities or the ability for flexibility and agility.

Communities may also have a combination of strength in coping or adaptive capacity and constraint in the other. About 21% of the population, or 5 million people, live in SA2s with these combinations. The extent to which good coping capacity can compensate for inhibited adaptive capacity is not clear, because the characteristics make different contributions through the disaster management cycle. For example, adaptive capacity (at least the way we have defined it in this assessment) applies to changes and reforms that tend to be made outside crisis periods in response to an unpredictable future hazards, although they may happen in response to a particular event. Coping capacity relates to the macro-system of factors that influence the capacity to prepare for, respond to and recover from hazard events, including social character, economic capital, emergency services and planning and the built environment. Thus, a strength in either capacity is advantageous.

DISASTER RESILIENCE PROFILES IN AUSTRALIA

The themes that influence disaster resilience in different locations in Australia are summarised using a typology. A typology identifies SA2s that have similar characteristic patterns of theme sub-index values and places these SA2s together into groups. Thus, the SA2s within a group are similar to each other, but each group has a different disaster resilience profile. The profile associated with each group can then be used to understand disaster resilience in local communities and the strengths and opportunities for enhancing or improving disaster resilience.

Cluster analysis revealed five groups of SA2s, each with a different disaster resilience profile. High and low theme sub-index values were associated with each group. For example, Group 4 has high economic capital theme sub-index values while Group 3 has much lower economic capital theme sub-index values. Based on median values, each group could then be placed into a band of high, moderate or low disaster resilience. For example, Group 4 falls into the high band for economic capital while Group 3 falls into the low band. These bands have an associated narration, forming the basis for interpreting the typology.

The disaster resilience profile of each typology group is discussed in detail in the following sections. Full details of the typology groups and the SA2s belonging to each group can be found in Parsons et al. 2019a.

Typology Group 1

The disaster resilience strengths associated with communities with the Typology Group 1 disaster resilience profile are emergency services, economic capital, planning and the built environment, information access and governance and leadership (Table 9). Thus, these communities are generally well- supported by government services that enhance disaster preparation, response and recovery, identify and mitigate risk and guide organisations through complex change.

Constraints to disaster resilience arise from community capital, social and community engagement and social character (Table 9). Thus, there are opportunities for building disaster resilience in these communities through improved attention to vulnerable groups, community cohesion and enhancing community capacity to adjust to complex change.

All States and Territories have SA2s with this disaster resilience profile, with the exception of the ACT. SA2s with this disaster resilience profile are located across a mix of areas: metropolitan, inner regional, outer regional and remote.

Typology Group 1 corresponds to 0.1% of Australia's land area (Table 9). Approximately 15% of the population, or 3.6 million people, live in areas with this disaster resilience profile (Table 9). There are 308 SA2s across Australia with this disaster resilience profile (Table 9), or 15% of all 2,084 SA2s assessed.

Examples of SA2s in this typology group include:

> The Entrance, Maitland, Warilla, Junee, Rockdale-Banksia, Penrith, Brunswick, Frankston, Mildura, Cairns City, Innisfail, Gladstone, Mackay, Bundaberg, North Adelaide, Elizabeth, Parafield Gardens, Woodville-Cheltenham, Kadina, Port Lincoln, Mount Gambier, Burnie-Wivenhoe, Devenport, Darwin City, Berrimah, Nightcliff, Moulden, Larapinta, Ross.

The full list of SA2s in typology Group 1 can be found in Parsons et al. (2019a).

Table 9: Overview of the disaster resilience profile of Typology Group 1.

Typology group	Group 1
Number of SA2s	308
Mean ADRI value	0.4787
Approximate population and proportion of total	3.6 million 15%
Land area and proportion of total	10,399 km² 0.1%
Location	SA2s in Typology Group 1 are located across a mix of areas: metropolitan, inner regional, outer regional and remote. Parsons et al. (2019a) lists the SA2s within typology Group 1.
Disaster resilience strengths 	**Emergency services (High)** The presence, capability and resourcing of emergency services should enhance the capacity of these communities to respond to natural hazard events. While the combination of emergency services characteristics will vary across SA2s within the group, it is likely that most of these communities will have relatively high levels of emergency service volunteers, well-resourced ambulance services and good access to medical services.
	Economic capital (Moderate) These communities have some economic characteristics that support the capacity to prepare for, respond to and recover from natural hazard events, but may also have some economic characteristics that constrain this capacity. The combination of supporting and constraining economic characteristics will vary across SA2s within the group, but it is likely that communities will have mid-range proportions of renters and mid-range income levels. Their economies are likely to be only moderately diversified
	Planning and the built environment (Moderate) These communities have some planning system and built environment characteristics that support their capacity to prepare for, respond to and recover from natural hazard events using strategies of mitigation, planning or risk management. However, there may also be some planning system and built environment characteristics that constrain this capacity. The combination of supporting and constraining planning and the built environment characteristics will vary across SA2s in the group, but it is likely that many communities will have a significant proportion of older buildings. Others with fewer older buildings may be constrained instead by emergency and other planning systems that could be improved to a higher standard.
	Information access (Moderate) These communities have some capacity to engage with natural hazard information and to access knowledge associated with natural hazard preparation, self-reliance and response. There may be some constraints on capacity arising from less than universal telecommunications access
	Governance and leadership (Moderate) These communities are associated with a governance environment that supports the capacity of organisations to adaptively learn, transform and adjust to complex change, including that related to natural hazards. However, the governance environment may also face some constraints on this capacity, associated with the need for improvement in research presence, innovation or agency agility, flexibility and adaptation.

Table 9 (cont.)

Barriers to disaster resilience	**Community capital (Low)** The cohesion and connectedness of these communities may constrain the capacity to coordinate and cooperate for mutual benefit, including preparing for, responding to and recovering from natural hazard events. The circumstances constraining this capacity will vary across SA2s in the group but are likely to arise from a high incidence of crime, low community safety and other factors that limit social support and community participation. The level of volunteering activity is also likely to be low.
	Social and community engagement (Low) These communities have constrained capacity to adaptively learn and transform in response to complex change, including that associated with natural hazards. The characteristics constraining capacity will vary across SA2s in the group but are most likely to arise from low levels of past and present participation in education. Some communities may also be constrained by high levels of population turnover.
	Social character (Low) These communities have social and demographic characteristics that may constrain their capacity to prepare for, respond to and recover from natural hazard events. The circumstances limiting this capacity will vary, but it is likely that many of these communities will have lower levels of education, employment and English language proficiency. Further constraints on capacity may come from a higher need for assistance and a relatively higher proportion of the working population in occupations other than management and professional occupations.

Typology Group 2

The disaster resilience strengths associated with communities with the Typology Group 2 disaster resilience profile are social character, community capital, social and community engagement, economic capital, planning and the built environment, emergency services and governance and leadership (Table 10). Thus, the disaster resilience of these communities is contributed by social cohesion, economic resources, well-resourced government services that enhance disaster preparation, response and recovery, identify and mitigate risk and guide organisations through complex change.

Constraints to disaster resilience arise from information access (Table 10). Thus there are opportunities for building resilience through improving access to telecommunications and increasing the engagement of communities with natural hazard information before, during and after natural hazard events.

All States and Territories have SA2s with this disaster resilience profile, with the exception of the NT. SA2s with this disaster resilience profile are predominantly inner regional, but also contain a moderate proportion of outer regional and metropolitan SA2s.

Typology Group 2 corresponds to 5.3% of Australia's land area (Table 10). Approximately 14% of the population, or 3.3 million people, live in areas with this disaster resilience profile (Table 10). There are 389 SA2s across Australia with this disaster resilience profile (Table 10), or 19% of all 2,084 SA2s assessed.

Examples of SA2s in this typology group include:

> Braidwood, Moruya-Tuross Head, Jilliby-Yarramalong, Dungog, Scone, Armidale, Lennox Head-Skennars Head, Bowral, Mosman, Wentworth Falls, Heathcote-Waterfall, Daylesford, Woodend, Benalla, Beechworth, Wodonga, Bairnsdale, Traralgon, Macedon, Horsham, Clermont, Lockyer Valley-West, Adelaide Hills, McLaren Vale, Jamestown, Kangaroo Island, Augusta, Busselton, Margaret River, Cottesloe, Esperance, South Arm, West Hobart, Grindelwald-Lanena, Westbury, Port Sorell, Aranda, Evatt, Deakin, Yarralumla, Kambah, Curtin, Torrens.

The full list of SA2s in typology Group 2 can be found in Parsons et al. (2019a).

Table 10: Overview of the disaster resilience profile of Typology Group 2.

Typology group	Group 2
Number of SA2s	389
Mean ADRI value	0.5731
Approximate population and proportion of total	3.3 million 14%
Land area and proportion of total	405,546 km^2 5.3%
Location	SA2s in Typology Group 2 are predominantly inner regional, but also contain a moderate proportion of outer regional and metropolitan SA2s. Parsons et al. (2019a) lists the SA2s within Typology Group 2.
Disaster resilience strengths 	**Social character (High)** These communities have social and demographic characteristics that should enhance the capacity to prepare for, respond to and recover from natural hazard events. In general, enhanced capacity comes from higher levels of education, employment and English language proficiency and a somewhat lower need for assistance.
	Community capital (High) The cohesion and connectedness of these communities should enhance the capacity to coordinate and cooperate for mutual benefit, including preparing for, responding to and recovering from natural hazard events. These communities are likely to have low crime rates, and be safe, supportive and relatively well-off neighbourhoods with significant levels of community participation activity such as volunteering.
	Social and community engagement (High) These communities have enhanced capacity to adaptively learn and transform in response to complex change, including that associated with natural hazards. The enhanced capacity of these communities for learning and transformation may arise through high levels of past participation in education, high life satisfaction and a stable population.
	Economic capital (Moderate) These communities have some economic characteristics that support the capacity to prepare for, respond to and recover from natural hazard events, but may also have some economic characteristics that constrain this capacity. The combination of supporting and constraining economic characteristics will vary across SA2s within the group, but it is likely that communities will have mid-range proportions of renters and mid-range income levels. Their economies are likely to be only moderately diversified.
	Planning and the built environment (Moderate) These communities have some planning system and built environment characteristics that support their capacity to prepare for, respond to and recover from natural hazard events using strategies of mitigation, planning or risk management. However, there may also be some planning system and built environment characteristics that constrain this capacity. The combination of supporting and constraining planning and the built environment characteristics will vary across SA2s in the group, but it is likely that many communities will have a significant proportion of older buildings. Others with fewer older buildings may be constrained instead by emergency and other planning systems that could be improved to a higher standard.

Table 10 (cont.)

Disaster resilience strengths (cont.)	**Emergency services (Moderate)** Some characteristics of emergency services supports the capacity of these communities to respond to natural hazard events, while other emergency services characteristics may constrain this capacity. The combination of supporting and constraining emergency services characteristics will vary across SA2s within this group, but most communities are likely have high levels of emergency services volunteers and well-resourced ambulance organisations. Capacity to respond to natural hazard events may be constrained by poorer access to medical services.
	Governance and leadership (Moderate) These communities are associated with a governance environment that supports the capacity of organisations to adaptively learn, transform and adjust to complex change, including that related to natural hazards. However, the governance environment may also face some constraints on this capacity, associated with the need for improvement in research presence, innovation or agency agility, flexibility and adaptation.
Barriers to disaster resilience 	**Information access (Low)** These communities have constrained capacity to engage with natural hazard information and to access knowledge associated with natural hazard preparation, self-reliance and response. The main characteristic contributing to reduced capacity is limited telecommunications access.

Typology Group 3

The disaster resilience strengths associated with communities with the typology Group 3 disaster resilience profile are social character, community capital and social and community engagement (Table 11). Thus, the disaster resilience of these communities is contributed by a strong pro-social setting characterised by community coherence, community capital and capacity for communities to adapt to complex change. Although these factors were classed as moderate (Table 11) they suggest the potential for community as a resource and asset to prepare for, respond to and recover from disasters, and to adapt to complex change.

Communities with the group 3 disaster resilience profile face the greatest structural constraints to disaster resilience, in comparison to the other profiles. Constraints to disaster resilience arise from economic capital, planning and the built environment, emergency services, information access and governance and leadership (Table 11). Thus there are many factors that could be addressed to improve disaster resilience in these communities, usually sitting outside community control. These include improving economic prosperity, systems of planning for hazards, access to telecommunications and access to and provisioning of emergency services.

All States and Territories have SA2s with this disaster resilience profile. The majority of remote and very remote SA2s have this disaster resilience profile, but there are also many outer regional and inner regional SA2s with this disaster resilience profile, and a few metropolitan SA2s.

Typology Group 3 corresponds to 94.3% of Australia's land area (Table 11). Approximately 13% of the population, or 3.2 million people, live in areas with this disaster resilience profile (Table 11). There are 447 SA2s across Australia with this disaster resilience profile (Table 11), or 21% of all 2,084 SA2s assessed.

Examples of SA2s in this typology group include:

> Batemans Bay, Lithgow, Bellingen, Bourke-Brewarrina, Gloucester, Hay, Griffith, Ulladulla, Loddon, Seymour, Red Cliffs, Kerang, Cobram, Yarrawonga, Port Douglas, Chinchilla, Goondiwindi, Millmerran, Stanthorpe, Emerald, Emu Park, Mount Morgan, Yeppoon, Bowen, Proserpine, Weipa, Carpentaria, Longreach, Kingaroy, Palm Island, Ceduna, Flinders Ranges, Wattle Range, Barmera, Loxton, Waroona, Pemberton, Mandurah, Wembley-West Leederville, Gosnells, Fremantle, Canarvon, Exmouth, Kalgoorlie, Geraldton, Meekatharra, Karratha, Albany, Cunderdin, Merredin, York-Beverley, New Norfolk, Longford, Derwent Valley, Humpty Doo, Tanami, Barkly, Tennant Creek, West Arnhem, Elsey, Holt, Scullin, Ngunnawal, Palmerston, Gilmore, Mawson.

The full list of SA2s in typology Group 3 can be found in Parsons et al. (2019a).

Table 11: Overview of the disaster resilience profile of Typology Group 3.

Typology group	Group 3
Number of SA2s	447
Mean ADRI value	0.3717
Approximate population and proportion of total	3.2 million 13%
Land area and proportion of total	7,211,800 km^2 94.3%
Location	Most of the SA2s in Typology Group 3 are inner regional and outer regional. Typology Group 3 also contains the majority (96%) of remote and very remote SA2s. Parsons et al. (2019a) lists the SA2s within Typology Group 3.
Disaster resilience strengths 	**Social character (Moderate)** These communities have some social and demographic characteristics that support the capacity to prepare for, respond to and recover from natural hazard events, but may also have some social and demographic characteristics that constrain this capacity. The combination of supporting and constraining social and demographic characteristics will vary across SA2s within the group, but it is likely that communities will have mid-range levels of education, employment and English language proficiency.
	Community capital (Moderate) The cohesion and connectedness of these communities supports the capacity to coordinate and cooperate for mutual benefit, including preparing for, responding to and recovering from natural hazard events. However, there may be some community capital characteristics that constrain this capacity. The combination of supporting and constraining circumstances will vary across SA2s in the group, but capacity may be constrained by mid-range crime rates, slightly less supportive and well-off neighbourhoods and lower levels of volunteering.
	Social and community engagement (Moderate) These communities have some capacity to adaptively learn and transform in response to complex change, including that associated with natural hazards, but may also face some constraints on this capacity. While the characteristics supporting and constraining capacity will vary across SA2s in the group, but these communities can be expected to have mid-range levels of in and out migration, suggesting a slightly less stable population.
Barriers to disaster resilience 	**Economic capital (Low)** These communities have economic characteristics that may constrain their capacity to prepare for, respond to and recover from natural hazard events. The circumstances limiting this capacity will vary, but it is likely that these communities will have relatively high proportions of rental households and low income households, resulting in a limited capacity to buffer external financial shocks. In many cases this will be exacerbated by an economy dominated by a single industry sector.
	Planning and the built environment (Low) Planning systems and the character of the built environment may constrain the capacity of these communities to prepare for natural hazard events using strategies of mitigation, planning or risk management. While the characteristics constraining this capacity will vary across SA2s in the group, most communities are likely to have a predominance of older building stock and relatively more people residing in caravans or improvised dwellings.

Table 11 (cont.)

Barriers to disaster resilience (cont.)	**Emergency services (Low)** These communities have emergency services characteristics that may constrain their capacity to respond to natural hazard events. Constraint largely arises because of remoteness, which limits the availability of emergency and other services. Due to other sources of disadvantage, these communities may have a greater presence of welfare support workers and police, but these positive aspects of response capacity are offset by their very limited access to medical services.
	Information access (Low) These communities have constrained capacity to engage with natural hazard information and to access knowledge associated with natural hazard preparation, self-reliance and response. The main characteristic contributing to reduced capacity is limited telecommunications access.
	Governance and leadership (Low) These communities are associated with a governance environment that may be limited by the capacity of organisations to adaptively learn, transform and adjust to complex change, including that related to natural hazards. The characteristics constraining capacity will vary across SA2s in the group, but it is likely that these communities do not have the benefit of research organisation presence and innovative commercial firms. Levels of local economic development support may also be limited.

Typology Group 4

SA2s with this disaster resilience profile are best placed overall to cope with and adapt to complex change associated with natural hazards. The disaster resilience strengths associated with communities with the Typology Group 4 disaster resilience profile are economic capital, information access, governance and leadership, which all correspond to high disaster resilience, and social character, planning and the built environment, emergency services, community capital and social and community engagement, which all correspond to moderate disaster resilience (Table 12). Thus, communities with this disaster resilience profile are socially cohesive, economically well-resourced, well-supported by government services and able to adapt to complex change.

This disaster resilience profile is not characterised by any apparent constraints to disaster resilience, in comparison to the other profiles. All eight themes of disaster resilience were classified as corresponding to moderate or high disaster resilience (Table 12).

All States have SA2s with this disaster resilience profile, but the ACT or the NT does not have any SA2s with this disaster resilience profile. SA2s with this disaster resilience profile are predominantly metropolitan, but also contain a small proportion of inner regional SA2s.

Typology Group 4 corresponds to 0.1% of Australia's land area (Table 12). Approximately 31% of the population, or 7.5 million people, live in areas with this disaster resilience profile (Table 12). There are 572 SA2s across Australia with this disaster resilience profile (Table 12), or 27% of all 2,084 SA2s assessed.

Examples of SA2s in this typology group include:

> Bathurst, Corowa, Swansea-Caves Beach, Wallsend-Elermore Vale, Castle Hill, Woollahra, Coogee-Clovelly, Five Dock-Abbotsford, Manly-Fairlight, Cambridge Park, Carlingford, Miranda-Yowie Bay, Ballarat, Geelong, Phillip Island, Sale, Elwood, Toorak, Templestowm Blackburn, Bentleigh East, Carnegie, Malvern-Glen Iris, Bundoora East, Elthan, Knoxfield-Scoresby, Vermont, Mulgrave, Newport, Capalaba, Ringalpa, McDowall, Camp Hill, Yeronga, Wishart, Riverhills, Chapel Hill, Hawthorne, Wilston, Redlynch, Burleigh Heads, Elanora, Hope Island, Ripley, Shailer Park, Wamuran Lawnton, Golden Beach-Pelican Waters, Coolum Beach, Nambour, Annandale, Athelstone, Prospect, Unley-Parkside, Panorama, Happy Valley, Willunga, West Lakes, Duncraig, Hillarys, Padbury, Stirling-Osborne Park, Wembley Downs-Churchlands-Woodlands, Willetton, Bull Creek, Hobart, Sandy Bay, Launceston, Ulverstone.

The full list of SA2s in typology Group 4 can be found in Parsons et al. (2019a).

Table 12: Overview of the disaster resilience profile of Typology Group 4.

Typology group	Group 4
Number of SA2s	572
Mean ADRI value	0.7020
Approximate population and proportion of total	7.5 million 31%
Land area and proportion of total	10,689 km^2 0.1%
Location	SA2s in group 4 are predominantly metropolitan, but also contain a small proportion of inner regional SA2s. Parsons et al. (2019a) lists the SA2s within Typology Group 4.
Disaster resilience strengths 	**Economic capital (High)** These communities have economic characteristics that should enhance the capacity to prepare for, respond to and recover from natural hazard events. The enhanced capacity of these communities arises through access by individuals and households to greater economic resources. This will occur where fewer households are paying rent, and income levels are higher. Enhanced capacity also derives from a diversified economy.
	Information access (High) These communities have enhanced capacity to engage with natural hazard information and to access knowledge associated with natural hazard preparation, self-reliance and response. Generally, this enhanced capacity will be associated with good telecommunications access and, to a lesser extent, engagement in hazard education.
	Governance and leadership (High) These communities are associated with a governance environment that should enhance the capacity of organisations to adaptively learn, transform and adjust to complex change, including that related to natural hazards. Enhanced capacity may be contributed by the presence of research organisations and innovative commercial firms, and an emergency services sector with a capacity for agility, flexibility and adaptation.
	Social character (Moderate) These communities have some social and demographic characteristics that support the capacity to prepare for, respond to and recover from natural hazard events, but may also have some social and demographic characteristics that constrain this capacity. The combination of supporting and constraining social and demographic characteristics will vary across SA2s within the group, but it is likely that communities will have mid-range levels of education, employment and English language proficiency.
	Planning and the built environment (Moderate) These communities have some planning system and built environment characteristics that support their capacity to prepare for, respond to and recover from natural hazard events using strategies of mitigation, planning or risk management. However, there may also be some planning system and built environment characteristics that constrain this capacity. The combination of supporting and constraining planning and the built environment characteristics will vary across SA2s in the group, but it is likely that many communities will have a significant proportion of older buildings. Others with fewer older buildings may be constrained instead by emergency and other planning systems that could be improved to a higher standard.

Table 12 (cont.)

Disaster resilience strengths (cont.)	**Emergency services (Moderate)** Some characteristics of emergency services supports the capacity of these communities to respond to natural hazard events, while other emergency services characteristics may constrain this capacity. The combination of supporting and constraining emergency services characteristics will vary across SA2s within this group, but most communities are likely to have high levels of emergency services volunteers and well-resourced ambulance organisations. Capacity to respond to natural hazard events may be constrained by poorer access to medical services.
	Community capital (Moderate) The cohesion and connectedness of these communities supports the capacity to coordinate and cooperate for mutual benefit, including preparing for, responding to and recovering from natural hazard events. However, there may be some community capital characteristics that constrain this capacity. The combination of supporting and constraining circumstances will vary across SA2s in the group, but capacity may be constrained by mid-range crime rates, slightly less supportive and well-off neighbourhoods and lower levels of volunteering.
	Social and community engagement (Moderate) These communities have some capacity to adaptively learn and transform in response to complex change, including that associated with natural hazards, but may also face some constraints on this capacity. While the characteristics supporting and constraining capacity will vary across SA2s in the group, these communities can be expected to have mid-range levels of in and out migration, suggesting a slightly less stable population.
Barriers to disaster resilience	No themes classed as low

Typology Group 5

The disaster resilience strengths associated with communities with the typology Group 5 disaster resilience profile are planning and the built environment, governance and leadership, economic capital, emergency services, information access, and social and community engagement (Table 13). Thus, these communities are economically prosperous, and are generally well-supported by government services that enhance disaster preparation, response and recovery, and identify and mitigate risk. Communities and organisations are also well-placed to adapt to complex change.

Constraints to disaster resilience arise from social character and community capital (Table 13). Thus, there are opportunities for building disaster resilience in these communities through improved attention to vulnerable groups and community cohesion.

Five of the eight States and Territories have SA2s with this disaster resilience profile, with the exception of SA, TAS and the NT. The majority of SA2s with this disaster resilience profile are located in metropolitan areas.

Typology Group 5 corresponds to 0.1% of Australia's land area (Table 13). Approximately 27% of the population, or 6.3 million people, live in areas with this disaster resilience profile (Table 13). There are 368 SA2s across Australia with this disaster resilience profile (Table 13), or 18% of all 2,084 SA2s assessed.

Examples of SA2s in this typology group include:

> Quakers Hill-Acacia Gardens, Marrickville, Potts Point-Woolloomooloo, Bondi Beach-North Bondi, Maroubra, Hurstville, Ashfield, Homebush, Crows Nest-Waverton, Ryde-Putney, Cabramatta-Lansvale, Carlton, Docklands, Box Hill, Epping, Cranbourne, Dandenong, Springvale, Sunshine, Taylors Hill, St Lucia, West End, Bentley Park, Toowong, Pacific Pines-Gaven, Southport, Surfers Paradise, Beenleigh, Loganlea, Sippy Downs, Subiaco-Shenton Park, Ellenbrook, Joondalup-Edgewater, Scarborough, Carramar, Canning Vale-West, Banjup, Wattleup, Port Kennedy, Warnbro, Belconnen.

The full list of SA2s in typology Group 5 can be found in Parsons et al. (2019a).

Table 13: Overview of the disaster resilience profile of Typology Group 5.

Typology group	Group 5
Number of SA2s	368
Mean ADRI value	0.5731
Approximate population and proportion of total	6.3 million 27%
Land area and proportion of total	6,328 km² 0.1%
Location	The majority of SA2s in Typology Group 5 are located in metropolitan areas. Parsons et al. (2019a) lists the SA2s within Typology Group 5.
Disaster resilience strengths 	**Planning and the built environment (High)** Planning systems and the character of the built environment should enhance the capacity of these communities to prepare for natural hazard events using strategies of mitigation, planning or risk management. While the combination of planning and built environment characteristics may vary across SA2s within the group, most of these communities are likely to have newer residential and commercial or industrial buildings, and high standards of emergency and other planning systems. Many of these communities will also be in well-resourced local government areas.
	Governance and leadership (High) These communities are associated with a governance environment that should enhance the capacity of organisations to adaptively learn, transform and adjust to complex change, including that related to natural hazards. Enhanced capacity may be contributed by the presence of research organisations and innovative commercial firms, and an emergency services sector with a capacity for agility, flexibility and adaptation.
	Economic capital (Moderate) These communities have some economic characteristics that support the capacity to prepare for, respond to and recover from natural hazard events, but may also have some economic characteristics that constrain this capacity. The combination of supporting and constraining economic characteristics will vary across SA2s within the group, but it is likely that communities will have mid-range proportions of renters and mid-range income levels. Their economies are likely to be only moderately diversified.
	Emergency services (Moderate) Some characteristics of emergency services supports the capacity of these communities to respond to natural hazard events, while other emergency services characteristics may constrain this capacity. The combination of supporting and constraining emergency services characteristics will vary across SA2s within this group, but most communities are likely to have high levels of emergency services volunteers and well-resourced ambulance organisations. Capacity to respond to natural hazard events may be constrained by poorer access to medical services.
	Information access (Moderate) These communities have some capacity to engage with natural hazard information and to access knowledge associated with natural hazard preparation, self-reliance and response. There may be some constraints on capacity arising from less than universal telecommunications access.

Table 13 (cont.)

Disaster resilience strengths (cont.)	**Social and community engagement (Moderate)** These communities have some capacity to adaptively learn and transform in response to complex change, including that associated with natural hazards, but may also face some constraints on this capacity. While the characteristics supporting and constraining capacity will vary across SA2s in the group, these communities can be expected to have mid-range levels of in and out migration, suggesting a slightly less stable population.
Barriers to disaster resilience	**Social character (Low)** These communities have social and demographic characteristics that may constrain their capacity to prepare for, respond to and recover from natural hazard events. The circumstances limiting this capacity will vary, but it is likely that many of these communities will have lower levels of education, employment and English language proficiency. Further, constraints on capacity may come from a higher need for assistance and a relatively higher proportion of the working population in occupations other than management and professional occupations.
	Community capital (Low) The cohesion and connectedness of these communities may constrain the capacity to coordinate and cooperate for mutual benefit, including preparing for, responding to and recovering from natural hazard events. The circumstances constraining this capacity will vary across SA2s in the group but are likely to arise from a high incidence of crime, low community safety and other factors that limit social support and community participation. The level of volunteering activity is also likely to be low.

KEY MILESTONES

The sequence of key project tasks is outlined below. Further details of end-user meetings and consultation, and utilisation activities can be found in the Utlisation and Impact section.

The project ran in three phases across multiple contracts:

- March 2014 – June 2017 – Development of the Australian Disaster Resilience Index.
- July 2017 – June 2020 – Development of the Australian Disaster Resilience Index and utilisation activities.
- May 2019 – June 2020 – Development of the Australian Disaster Resilience Index dashboard.

Milestone	Date	Note
Initial project meeting with end users	28-29 July 2014 (Armidale)	• This workshop explored the overall approach, design and expectations for the Australian Natural Disaster Resilience Index with project end users.
Development of the conceptual model for the Australian Disaster Resilience Index	March 2014 - May 2015	• Development of a conceptual framework is standard practice in assessment of disaster resilience using a composite index. • Conceptual model draft to end users for comment – October 2014 • Finalised conceptual model report submitted to BNHCRC – May 2015 • Conceptual model report released by BNHCRC – February 2016 • Conceptual model paper submitted to International Journal of Disaster Risk Reduction February 2016, published July 2016
Indicator data collection	June 2015 – June 2017	• Collection of a national dataset (at the SA2 resolution) of indicators across the eight themes set out in the conceptual model of disaster resilience. • Data collection involved steps of indicator identification, data availability, compilation of data, derivation of some indicators from GIS or content analysis, data quality control, interpolation of missing data. • List of indicators to be used in the index submitted to BNHCRC - June 2016 • List of indicators to be used in the index released by BNHCRC - December 2016
Data analysis for the Australian Disaster Resilience Index	January 2017 to June 2018	• Computation of the Australian Natural Disaster Resilience Index and associated data interpretation and visualization tasks. • This task included researching the best practice and latest composite index methods, trialling indicator conditioning and aggregation methods, coding the statistical analysis in R, revising statistical methods and trialling and developing data visualization approaches. • A draft Australian Disaster Resilience Index was presented at the BNHCRC Showcase in Wellington, NZ in May 2018.

		• Further revisions to the index were then made leading into the development of the State of Disaster Resilience report. • The results of the Australian Disaster Resilience Index delivered publicly at the Australian Disaster Resilience Conference –September 2018, Perth.
Report I State of Disaster Resilience Report	July 2018 to March 2019	• The State of Disaster Resilience Report uses the Australian Disaster Resilience Index to report on the strengths and barriers to disaster resilience across Australia. • The final formatted State of Disaster Resilience Report submitted to the BNHCRC – May 2019. • State of Disaster Resilience Report released by the BNHCRC – July 2020 (to be confirmed)
Report II Reporting of the technical details of the Australian Disaster Resilience Index	July 2018 to August 2019	• The technical volume reports in detail the methods used in the Australian Natural Disaster Resilience Index. Designed for full transparency, the technical report covers the conceptual framework, indicator justification and derivation, statistical analysis and the sensitivity and uncertainty analysis. • The final formatted Australian Natural Disaster Resilience Index technical report submitted to the BNHCRC – August 2019. • Australian Disaster Resilience Index technical report released by the BNHCRC –July 2020 (to be confirmed)
Development of the Australian Disaster Resilience Index Dashboard	May to July 2019 and March 2020 to June 2020	• The dashboard is a separate, but related, project that seeks to develop an integrative web platform for using and reporting on the results of the Australian Natural Disaster Resilience Index. • The design of the dashboard was developed in consultation with end users in July 2019. • The dashboard is being developed in conjunction with the UNE CASI group and was launched on 31 July 2020.

UTILISATION AND IMPACT

SUMMARY

Utilisation activities have evolved through the life of the ADRI project. The four utilisation activities that were planned mid-way through the project have been shelved because agency priorities changed or planned projects such as websites or indicator portals were postponed but others have taken their place (see below). It is likely that with the release of the Australian Disaster Resilience Index dashboard in July 2020, utilisation opportunities adopting both the dashboard and API products will increase.

The major enablers of utilisation of the ADRI have been: 1) strong and trusted relationships built between the project team and end users which will foster ongoing utilisation activities after the research reports and dashboard are released; 2) BNHCRC support and development of networks for utilisation opportunities; 3) the increasing prevalence and costs of natural disasters in Australia, highlighting the need for better-informed strategic planning in the area of disaster resilience.

The major barriers to utilisation of the ADRI have been: 1) the index was not ready until the end of 2018; 2) research reports and associated data were held back for a year by the BNHCRC in order to release these with the dashboard; 3) several agency projects (for example, web portals) where the ADRI data were to be inserted have been discontinued; 4) staff turnover within agencies; 5) tensions between the national scale of the index and state-agency needs for local, scorecard-type understandings of community resilience.

Throughout the development of the ADRI, interest was registered in the project from many non-end user organisations including, but not limited to Geoscience Australia, AFAC, AIDR, ANZEMCC, QRA, AGD, ACT Government, BoM, Red Cross, local governments, consulting firms, VIC IGEM, QLD Department of Communities, SAFECOM, IAG, CSIRO, Resilient Organisations NZ, Actuaries Institute of Australia, Optus.

AUSTRALIAN DISASTER RESILIENCE INDEX CONCEPTUAL MODEL AND INDICATORS

Output description

This utilisation element refers to the conceptual model, disaster resilience themes and indicators used to frame the development of the Australian Disaster Resilience Index. These concepts are detailed in the following publication:

- Parsons, M., Glavac, S., Hastings, P., Marshall, G., McGregor, J., McNeill, J., Morley, P., Reeve, I. and Stayner, R. (2016) Top-down assessment of disaster resilience: a conceptual framework using coping and adaptive capacities. *International Journal of Disaster Risk Reduction*, 19: 1-11.

Extent of use

- Themes from the Australian Disaster Resilience Index conceptual model were used in Western Australia's Department of Fire and Emergency Services Monitoring and Evaluation Framework for Community Preparedness Programs and evaluation of the Bushfire Ready program.
- Themes from the Australian Disaster Resilience Index conceptual model were used to underpin the Tactical Research Grant project 'Reimagining Program Monitoring and Evaluation for Resilience Outcomes'. These themes were: Disaster resilience is a process; Absorbing and adapting are core concepts of disaster resilience; Disaster resilience is a system; and, Disaster resilience is scaled. It also used the eight disaster resilience themes from the index to show how the resources and capacities for disaster resilience are generated through multiple factors.
- Disaster resilience concepts, themes and indicators were used in the development of the Victorian Emergency Management Community Resilience Dashboard. This is an information display of sector identified critical data relating to/about the resilience of a community to emergencies. This information aims to increase the sector's capacity to understand the resilience of Victorian communities to emergencies. The Resilience Dashboard links with the broader VPS Data Reform Strategy which aims for better decisions in the Public Service that is underpinned by data. Ensuring this data is provided in a user-friendly and interpretable interface will also help incentivise the better use of data in decision making in the Victorian emergency management sector. The Resilience Dashboard will be refined with practitioners across the sector and will continue to be expanded through ongoing testing and evaluation. It is governed by a multi-agency Project Working Group with members from EMV (Chair), DEDJTR, VICSES, DET, CFA, DHHS, and community resilience academics from both the University of New England and University of Melbourne.

- Davis and Davidson (2018) used the concepts of the Australian Disaster Resilience Index to ‘examine how the resilience construct is reflected within disaster management policy’.
- Concepts of disaster resilience as absorbing, coping and adaptive were used to underpin the definition of resilience to emergency and disaster in the AFAC Doctrine ‘Resilience through community risk reduction’.
- A collaborative workshop held in Ngukkur, NT, in 2015 with other researchers from the BNHCRC resilience cluster examined the assessment of disaster resilience in remote indigenous communities using the alternative bottom-up scorecard resilience assessment method.

Utilisation potential

- The project advanced three aspects of the thinking about disaster resilience: assessing resilience at a national scale using top-down methods; absorbing hazard impacts through coping and adaptive capacity; and, the themes needed to assess disaster resilience (rather than social vulnerability or preparedness). These new ideas are regularly being picked up in scholarly and policy publications outlined below.
- Utilisation potential of the innovative framework of disaster resilience used to underpin the Australian Disaster Resilience Index includes: government strategy and policy development; assessments of disaster resilience in other countries; adoption by business as a framework for future disaster resilience planning.

Utilisation impact

- The peer reviewed paper outlining the conceptual model for the Australian Disaster Resilience Index has been cited 47 times between 2017 and 2020. It is in the 97th percentile of all citations reported on Scopus (accessed 23 June 2020). It has a field-weighted citation factor of 5.71 (accessed 23 June 2020, Scopus), where values >1 indicate that the document is more cited than expected.
- Constructs of disaster resilience as the capacity to absorb and adapt to natural hazards were incorporated into two policy pieces: the AFAC doctrine on Resilience Through Disaster Risk Reduction and the framework for Reimagining Program Monitoring and Evaluation for Disaster Resilience Outcomes.

Utilisation and impact evidence

- Parsons, M. and Foster, H. (2020). Reimagining program monitoring and evaluation for disaster resilience outcomes. Bushfire and Natural Hazards CRC: Melbourne.
- AFAC. (2019). Resilience through community risk reduction. AFAC Doctrine Number 2049. AFAC: Melbourne.

- Armstrong, R. (2018). Program evaluation, preparedness and resilience: Western Australia examples. Australian Journal of Emergency Management, 33(4): 16-17.
- Parsons, M., Foster, H. and Redlich, S. (2018). Case study: the Victorian Emergency Management Community Resilience Index. Australian Journal of Emergency Management, 33: 21-22.
- Davis, L., and Davidson, K. (2018). Planning for natural hazard resilience: An assessment of contemporary Australian disaster management policy and strategy. Australasian Journal of Regional Studies, 24(3): 258-283.
- Parsons, M. and Morley, P. (2017). The Australian Natural Disaster Resilience Index. Australian Journal of Emergency Management, 32: 20-22.
- Bushfire and Natural Hazards CRC. (2017). Assessing Australia's resilience to natural hazards. Hazard Note Number 39, September 2017. BNHCRC: Melbourne.
- Morley, P., Russell-Smith, J., Sanga, K.K., Sutton, S. and Sithole, B. (2016). Evaluating resilience in two remote Indigenous Australian communities. Australian Journal of Emergency Management, 31(4): 44-50.
- Bushfire and Natural Hazards CRC. (2016). What is disaster resilience and how can it be measured? Hazard Note Number 17, June 2016. BNHCRC: Melbourne.

AUSTRALIAN DISASTER RESILIENCE INDEX FINDINGS

Output description

This utilisation element refers to the research components of the Australian Disaster Resilience Index, including the composite index method, the index results and maps and the typology of disaster resilience profiles.

1. A short summary of the State of Disaster Resilience Report, produced in a glossy brochure format. Available at https://www.bnhcrc.com.au/adri-summary

2. Parsons, M., Reeve, I., McGregor, J., Marshall, G., Stayner, R., McNeill, J., Hastings, P., Glavac, S. and Morley, P. (2019). The Australian Natural Disaster Resilience Index. Volume I – State of Disaster Resilience Report. Bushfire and Natural Hazards CRC, Melbourne. 243 pp.

3. Parsons, M., Reeve, I., McGregor, J., Morley, P., Marshall, G., Stayner, R., McNeill, J., Glavac, S. and Hastings, P. (2019). The Australian Natural Disaster Resilience Index. Volume II – Index Design and Computation. Bushfire and Natural Hazards CRC, Melbourne. 830 pp.

Extent of use

- These reports were only recently released by the BNHCRC (on 31 July 2020).

Utilisation potential

- International potential for using the composite index method and R code to develop a disaster resilience index in other countries.
- Using the Australian Disaster Resilience Index data to develop narratives about the strengths and barriers to disaster resilience in different places.
- Using the Australian Disaster Resilience Index typology data to identify partners and consortia for programmes, funding, lobbying and disaster risk reduction activities.
- Using the Australian Disaster Resilience Index data to support strategic planning for recovery.

Utilisation impact

- The state of disaster resilience report and ADRI technical reports have not yet been released by the BNHCRC (as of 23 June 2020).
- Some utilisation of the Australian Disaster Resilience Index data was trialed with Geoscience Australia in 2019. The ADRI data was used to form a narrative around the recovery potential of communities in relation to earthquake or cyclone impacts. Five trials were undertaken, and these were considered experimental applications of the ADRI:
    - Disaster resilience in the greater Perth area as part of the Earthquake Impact and Risk Assessment for Perth and Supporting Infrastructure (EIRAPSI).
    - Disaster resilience in the regional town of York as part of the Earthquake Impact and Risk Assessment for Perth and Supporting Infrastructure (EIRAPSI).
    - Disaster resilience in northern Western Australia as part of the Severe Wind Hazard Assessment for Western Australia (SWHA).
    - Disaster resilience in the Bundaberg region in relation to severe wind impacts and recovery.
    - Disaster resilience in the Newcastle and Lake Macquarie region in relation to earthquake impact and recovery.

Utilisation and impact evidence

Parsons, M. (2019). The Australian Natural Disaster Resilience Index: Newcastle and Lake Macquarie overview. Report to Geoscience Australia by the University of New England and BNHCRC. August 2019.

Parsons, M. (2019). The Australian Natural Disaster Resilience Index: Bundaberg region overview. Report to Geoscience Australia by the University of New England and BNHCRC. August 2019.

Parsons, M. (2019). The Australian Natural Disaster Resilience Index: Geraldton, Broome, Port Hedland, Karratha, Exmouth and Carnarvon overview. Report to Geoscience Australia by the University of New England and BNHCRC. April 2019.

Parsons, M. (2019). The Australian Natural Disaster Resilience Index: Perth region overview. Report to Geoscience Australia by the University of New England and BNHCRC. April 2019.

Parsons, M. (2019). The Australian Natural Disaster Resilience Index: York-Beverley overview. Report to Geoscience Australia by the University of New England and BNHCRC. April 2019.

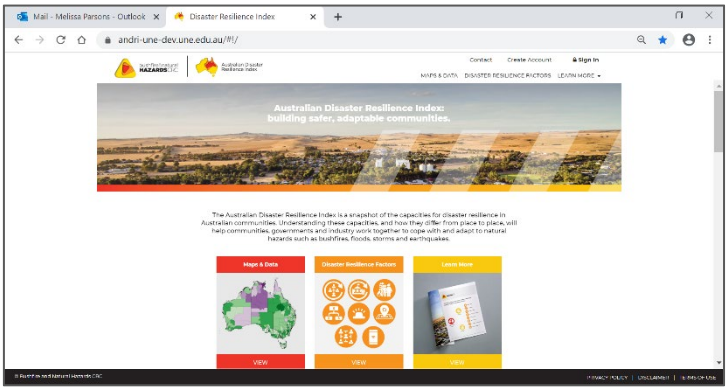
AUSTRALIAN DISASTER RESILIENCE INDEX DASHBOARD

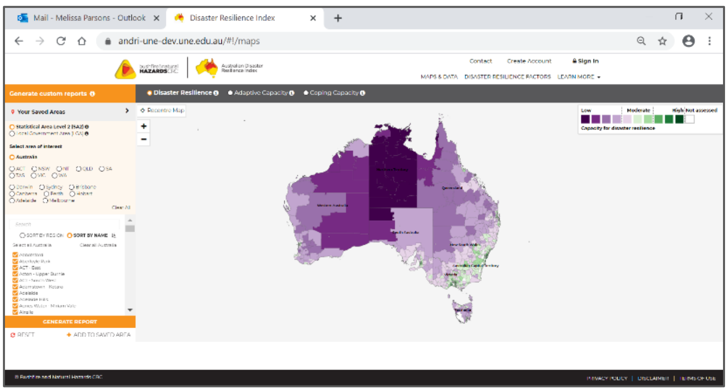
Output description

The Australian Disaster Resilience Index is a tool for assessing the disaster resilience of Australian communities. The Australian Disaster Resilience Index is a nationally standardised assessment of disaster resilience to support decision making and provide input into macro-level policy, strategic planning and community engagement. The purpose of the Australian Disaster Resilience Index dashboard is to provide a public platform for accessing and interpreting the index data.

The principles of the dashboard design are:

- Ease of use
- Data discoverability
- Functions to suit a range of use cases
- Functions to suit a range of users, from beginner to advanced
- Harmonisation with the scientific concepts and methods underpinning the index





Extent of use

- The dashboard was launched on 31 July 2020.

Utilisation potential

The Australian Disaster Resilience Index is an assessment of the capacity for disaster resilience in Australian communities, with three levels of insight:

1) An index of disaster resilience, coping capacity and adaptive capacity
2) Factors that enhance or constrain disaster resilience
3) Profiles showing which places have similar strengths and barriers to disaster resilience

Who might use the index?	**Activities**
Business and industry	Business development
Emergency service agencies	Community engagement
General public	Community planning
Local, state and federal governments	Community profiling
Not-for-profit organisations	Emergency planning
Universities and researchers	Monitoring and evaluation
	Policy development
	Recovery planning
	Regional development
	Research and modelling
	Resource planning
	Risk assessment
	Strategic planning
	Urban planning

Utilisation impact

- The dashboard was launched on 31 July 2020. There has been substantial interest in the dashboard across the sector and requests for use of the data by state agencies, federal agencies and NGOs. Opportunities to 'roadshow' the dashboard among state agencies and other parties have been discussed and scheduled for March 2021.

Utilisation and impact evidence

- Patch, B. (2020). The new Australian Disaster Resilience Index: a tool for building safer, adaptable communities. Australian Journal of Emergency Management, July 2020.

CONCLUSION

At a broad level, resilience is the capacity of Australia to manage and absorb external shocks, including those created by natural hazards such as bushfires, floods, storms and heatwaves. There are many social, economic and institutional capacities that make up resilience. These capacities work together to influence how well communities might fare – not in the act of facing a firestorm – but within the system of planning, preparation, mitigation, response and recovery associated with natural hazards in Australia.

Our research into disaster resilience is showing that communities across Australia are not equal when it comes to their capacity for disaster resilience. Communities will have social, economic or institutional strengths that influence their disaster resilience, but they'll also face challenges. The mix of these strengths and challenges differs from place to place.

The Australian Disaster Resilience Index shows that in some places the capacity for disaster resilience comes from within the community through connectedness, social capital and social engagement. But these same places can also face challenges to disaster resilience because of lack of access to government services, telecommunications or low economic capital.

In other places, the capacity for disaster resilience comes from strong service provision in the areas of emergency services, local and regional planning or telecommunications, combined with adaptive governance and leadership and economic prosperity. But these same places can also face challenges to disaster resilience because of lower community connectedness and a demographic profile dominated by groups that we know are more vulnerable to the impacts of disasters.

The geographic variation in disaster resilience across Australia means that what works to build disaster resilience in one place will not necessarily work somewhere else. It also means that building disaster resilience needs to be shared among communities, governments and industry, depending on the mix of strengths and challenges.

Our research to capture the national picture of disaster resilience will help to understand what is needed where to help communities, governments and industry to cope with and adapt to natural hazards.

The Australian Disaster Resilience Index dashboard will make the exploration of disaster resilience easy and accessible for communities, businesses and governments.

NEXT STEPS

There is great potential for utilisation activities to occur following the release of the Australian Disaster Resilience Index research and technical reports, and the launch of the Australian Disaster Resilience Index dashboard. Many of the utilisation ideas for which relationships have been built (see Utilisation and Impact and End User sections) can be furthered because the index data are available to be used and explored. Case studies of the index being used to support policy development, community engagement, strategic planning, risk assessment and resilience assessment within agencies can be developed. The innovative method used to compute the composite index can also be transferred to other countries.

The Australian Disaster Resilience Index has a currency of 7-10 years because of the national scale of the assessment. The following two research projects are proposed to keep ADRI relevant into the future and to provide decision support capability.

Recalculation of ADRI(2)

Scope: One of the design features of the Australian Disaster Resilience Index was that it could be recomputed through time to build a longitudinal picture of how disaster resilience in Australia changes through time in response to structural settings. The scale of the index suggests that recomputation every 7-10 years would capture change in the themes that drive disaster resilience at a National scale.

Recalculation of the index ADRI(2) would involve:

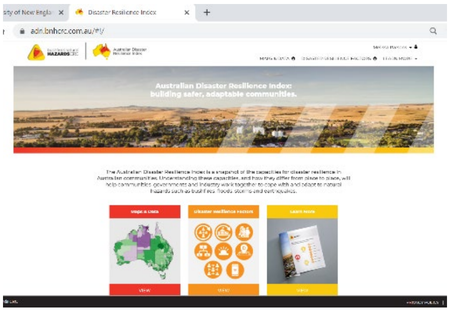
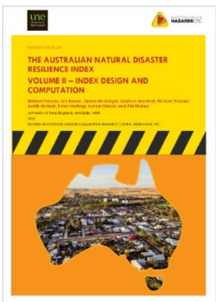
1. Updating indicators (including social and economic data from the 2016 or 2021 Census);
2. Recalculating the index using the new indicators;
3. Comparing disaster resilience between ADRI(1) and ADRI(2), providing a measure of enhanced or reduced disaster resilience at a decadal time scale in Australia; and,
4. Build ADRI(2) and a longitudinal comparison function into the ADRI Dashboard.

ADRI predictive decision support

Scope: The factors that influence disaster resilience in Australia are captured in the ADRI as a system of governance, social, economic and government capacities. The ADRI identified profiles across Australia showing that areas have different strengths and barriers to disaster resilience. Adding a predictive function to the ADRI would enable decision makers to test policy options to maximise investments in disaster resilience and disaster risk in Australia. If action A is undertaken then what effects does it have on the strengths and barriers to disaster resilience in Australia?

PUBLICATIONS LIST

SUMMARY OF AUSTRALIAN DISASTER RESILIENCE INDEX PRODUCTS

	**The Australian Disaster Resilience Index dashboard*** adri.bnhcrc.com.au The dashboard allows users to explore and report on disaster resilience around Australia using maps and charts.
	**The Australian Disaster Resilience Index summary report** https://www.bnhcrc.com.au/adri-summary This report provides a summary overview of disaster resilience in Australia, using the index.
	**State of Disaster Resilience Report** https://www.bnhcrc.com.au/publications/biblio/bnh-7099 This report assesses the state of disaster resilience in Australia, using the Australian Disaster Resilience Index.
	**Australian Natural Disaster Resilience Index technical report** https://www.bnhcrc.com.au/publications/biblio/bnh-7100 This report describes the computation of the Australian Disaster Resilience Index. It is comprised of six chapters covering the design of the index, indicators, statistical methods, statistical outputs and sensitivity and uncertainty analyses.

*Note that the name of the index changed to the Australian Disaster Resilience Index upon release of the dashboard. Some products retain the research name of the Australian Disaster Resilience Index.

PEER-REVIEWED JOURNAL ARTICLES

Submitted or in preparation

McGregor, J., Parsons, M. and Glavac, S. Local government capacity and land use planning for natural hazards: A comparative evaluation of Australian local government areas. Planning Practice and Research. Submitted June 2020.

Parsons, M., Reeve, I., McGregor, J., Marshall, G., Hastings, P., Glavac, S., McNeill, J., and Stayner, R. The state of disaster resilience in Australia: an assessment using a composite index. In preparation for International Journal of Disaster Risk Reduction. Submit September 2020.

Parsons, M. and Reeve, I. National level profiles of disaster resilience: a typological approach using a disaster resilience index. In preparation for Applied Geography.

Reeve, I. and Parsons, M. A composite index for assessing disaster resilience. In preparation for Social Indicators Research.

Published

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Parsons, M. and Thoms, M.C. (2018). From academic to applied: Operationalizing resilience in river systems. *Geomorphology,* 305: 242-251.

Parsons, M., Foster, H. and Redlich, S. (2018). Case study: the Victorian Emergency Management Community Resilience Index. Australian Journal of Emergency Management, 33: 21-22.

Parsons, M. and Morley, P. (2017). The Australian Natural Disaster Resilience Index. Australian Journal of Emergency Management, 32: 20-22.

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Conceptual framework and indicator approach. Bushfire and Natural Hazards Cooperative Research Centre, Melbourne, Australia.

CONFERENCE AND OTHER PRESENTATIONS

Several planned 2020 conference and other presentations were cancelled due to COVID-19 including the Research Advisory Forum (Darwin), the Natural Hazards Centre Workshop (Boulder Colorado) and AFAC (Adelaide).

Parsons, M. (2020). A profile of Australia's disaster resilience. River Basin Management Society, NSW Forum. Armidale, February 2020.

Parsons, M., Morley, P., Glavac, S., Hastings, P., Marshall, G., McGregor, J., McNeill, J., Reeve, I., Stayner, R. (2019). The Australian Natural Disaster Resilience Index: A profile of Australia's disaster resilience. 12th Australasian Natural Hazards Management Conference, Canberra, June 2019.

Parsons, M., McGregor, J., Morley, P., Glavac, S., Hastings, P., Marshall, G., McNeill, J., Reeve, I., Stayner, R. (2019). The Australian Natural Disaster Resilience Index: A profile of Australia's Disaster Resilience. BNHCRC Research Advisory Forum, Canberra, June 2019.

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CONFERENCE PAPERS

Parsons, M., Morley, P., Glavac, S., Marshall, G., McGregor, J., McNeill, J., Reeve, I., Stayner, R. (2017). The Australian Natural Disaster Resilience Index: Assessing the Resilience of Australian communities to natural hazards. Research Forum 2017: Proceedings from the Research Forum at the Bushfire and Natural Hazards CRC & AFAC Conference, Sydney, September 2017.

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Parsons, M., Boshoff, J. and Reeve, I. (2020). The Australian Disaster Resilience Index dashboard. AFAC Conference, Adelaide, September 2020. Cancelled because of COVID-19.

Parsons, M., Morley, P., Glavac, S., Marshall, G., McGregor, J., McNeill, J., Reeve, I., Stayner, R. (2019). A profile of Australia's disaster resilience. AFAC Conference, Melbourne, September 2019.

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Bushfire and Natural Hazards CRC. (2017). Assessing Australia's resilience to natural hazards. Hazard Note Number 39, September 2017. BNHCRC: Melbourne.

TEAM MEMBERS

RESEARCH TEAM

The core research team from the University of New England remained reasonably constant through the project. Research team members and their area of contributed specialisation are listed below.

Researcher	Specialisation
Dr Melissa Parsons (Project Leader 2014-2020, 0.7 FTE)	Disaster resilience
Dr Phil Morley (Project Leader to 2014-2017, 0.3 FTE)	Spatial analysis, telecommunications indicators
Dr Ian Reeve	Composite index calculation, statistics, R coding, data visualisation
Dr James McGregor	Urban and regional planning indicators
Dr Graham Marshall	Economics, governance indicators
Dr Richard Stayner	Economics indicators
Dr Judith McNeill	Economics, local government indicators
Dr Peter Hastings	Natural Hazards, Emergency Management indicators
Dr Sonya Glavac	Urban and regional planning indicators
Kelli Wang (casual employment)	Research assistance and data compilation
Sahar Alian (casual employment)	Research assistance and data compilation
Michael Coleman (casual employment)	Research assistance and data compilation

END-USERS

End users associated with the project throughout its lifetime are listed below. Several factors influenced the level of engagement with the project: 1) The length of the project; 2) Staff turn-over or restructuring within agencies; 3) The delivery of the useable index results at the end of the 4 year project; 4) Changing agency priorities and programmes (see the Utlisation section for further detail); 5) The national focus of the project using a top down assessment approach rather than a local score card approach.

The project team thank these end users and their organisations for their support and guidance at all stages of the ADRI project.

End-user organisation	End-user representative	Extent of engagement (Describe type of engagement)
NSW SES	Andrew Richards Emma Davis	Cluster lead end user End user
WA DFES	Suellen Flint Rachel Armstrong	Cluster lead end user End user
Emergency Management Victoria	Holly Foster	End user
VIC CFA	Gwynne Brennan Karen Enbom	End user
VIC MFB	Trent Curtin Geoff Kaandorp	End user
NSW RFS	Sunara Fernando Anthony Bradstreet	End user

	Tony Jarrett	
SA MFS	Paul Fletcher	End user
Red Cross	John Richardson	End user (non-formal)
TAS SES	Colleen Ridge	End user
Australian Emergency Management Institute, AGD	Raelene Thompson	End user
VIC DEPI/DELWP	Tamara Beckett	End user
TAS TFS	Sandra Barber	End user
AFAC Community Engagement Technical Group	Various	End user (non-formal)
Geoscience Australia	Mark Edwards	End user (non-formal)

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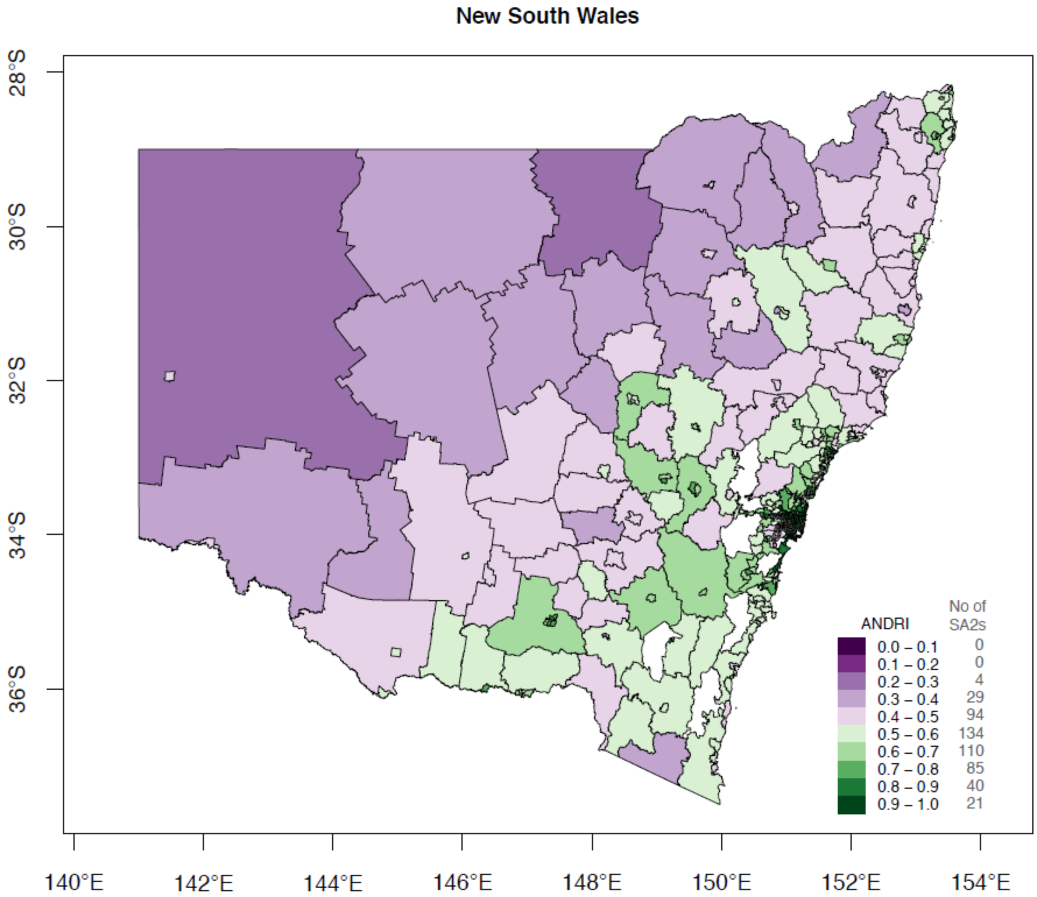
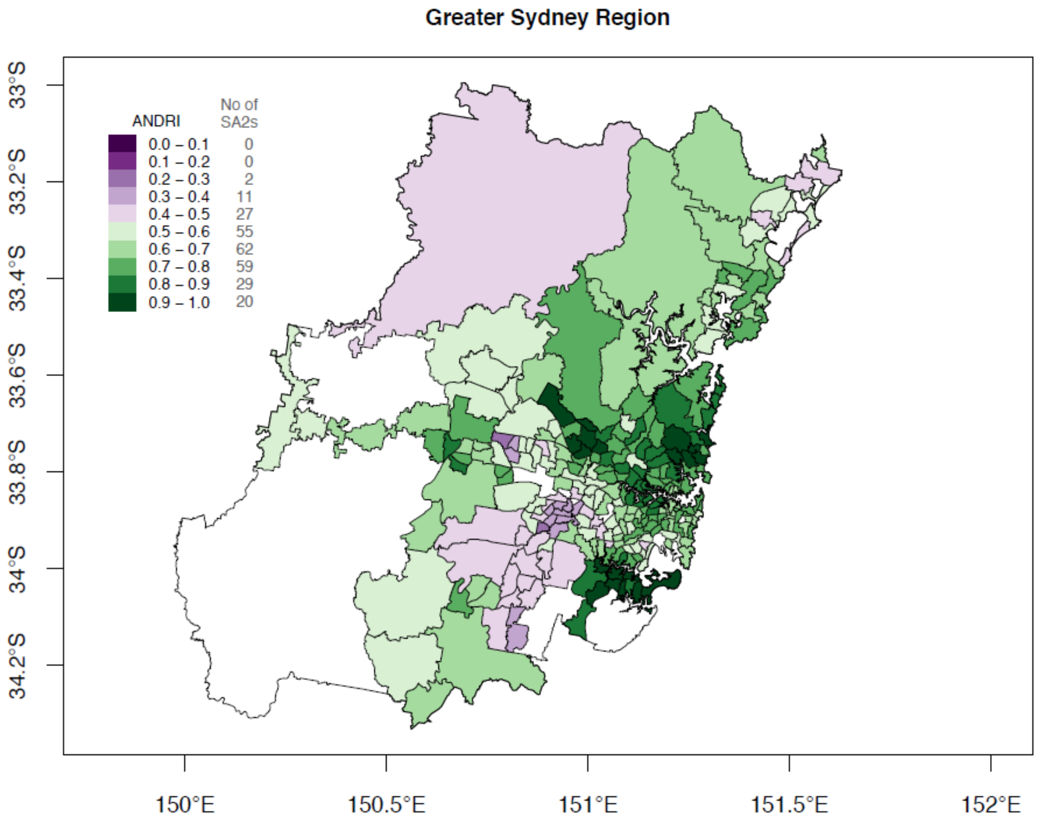
APPENDIX 1 - MAPS: DISASTER RESILIENCE IN AUSTRALIA

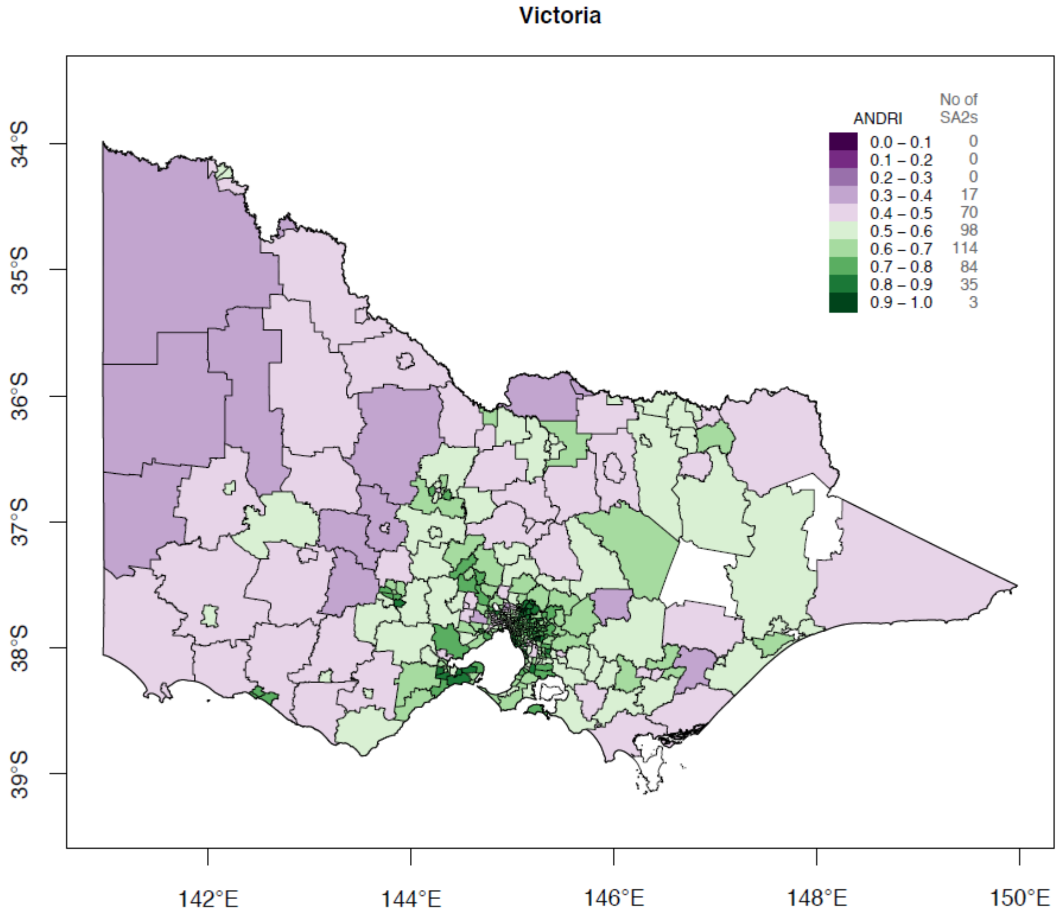
Appendix 1 maps the Australian Disaster Resilience Index at the resolution of individual States and Territories, and major metropolitan areas.

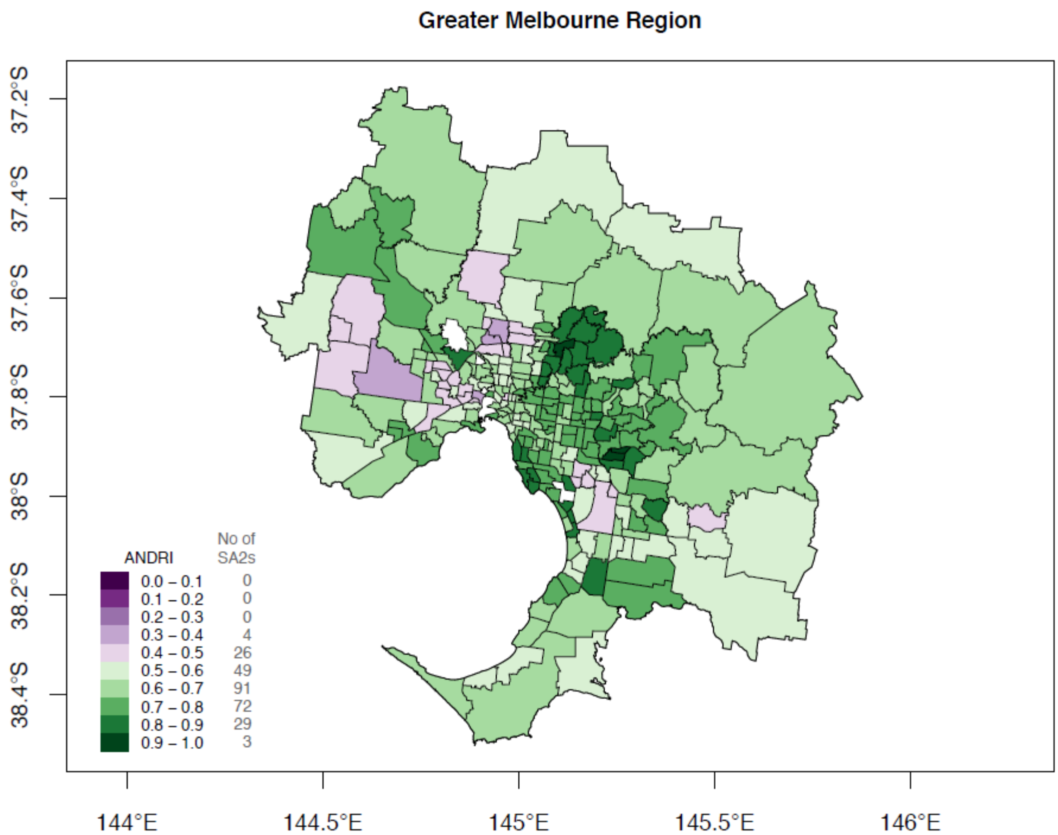
Appendix 1. Australian Disaster Resilience Index, NSW.



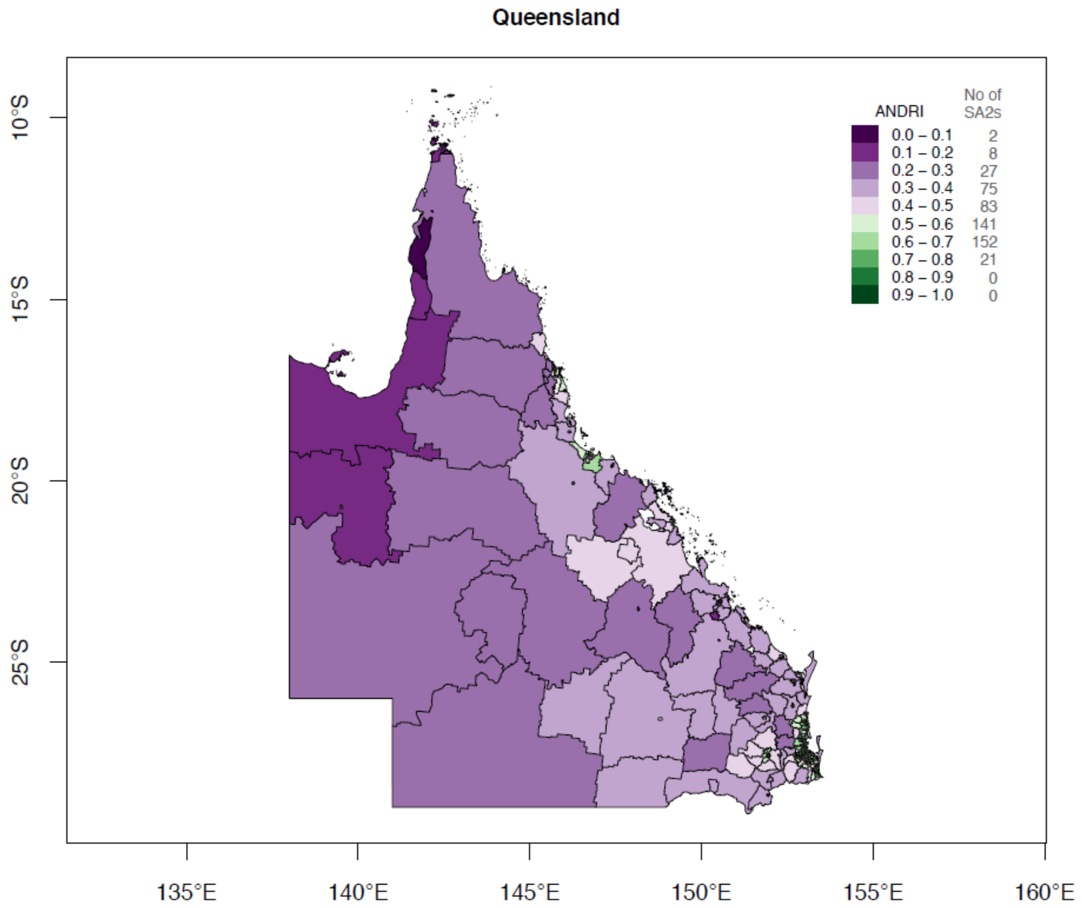


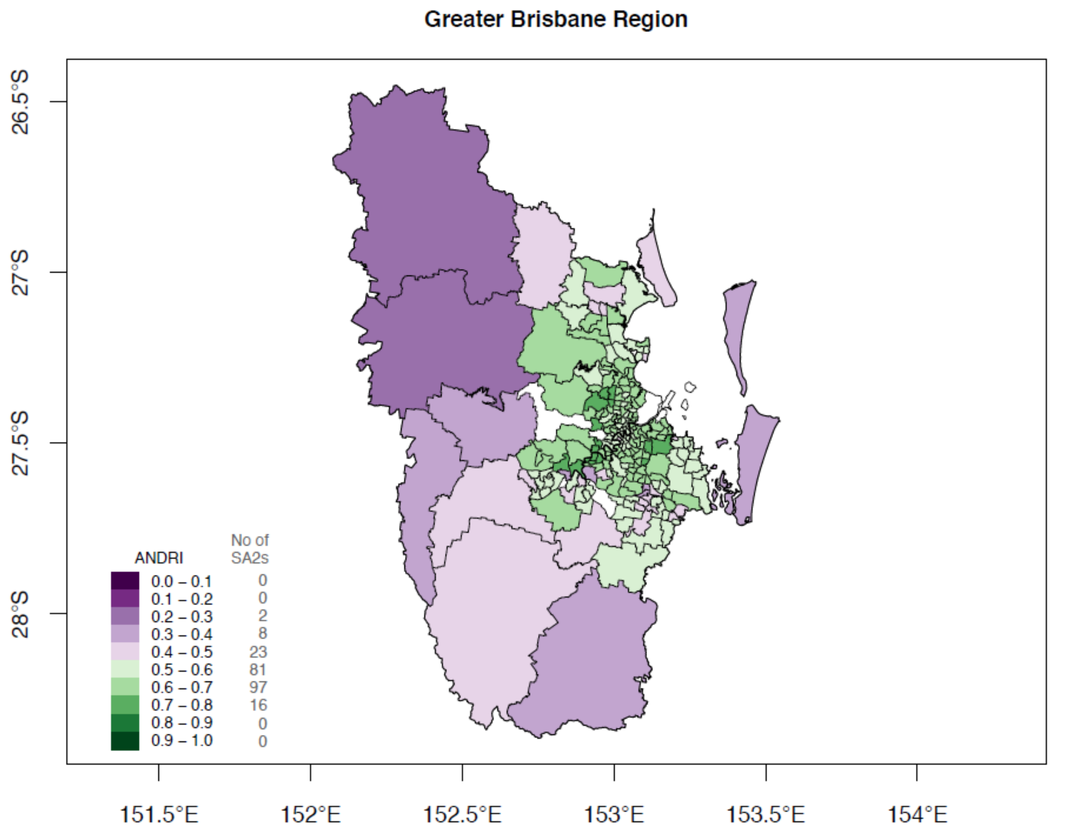
Appendix 1. Australian Disaster Resilience Index, VIC.



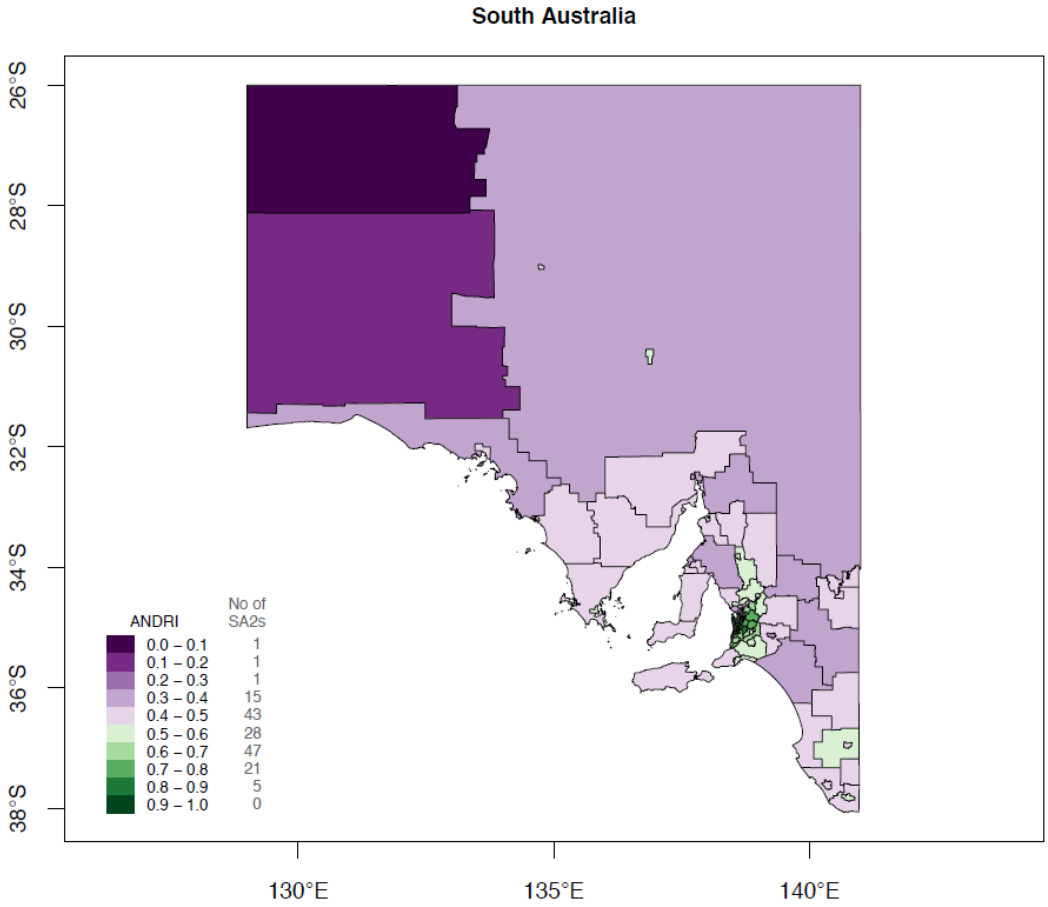


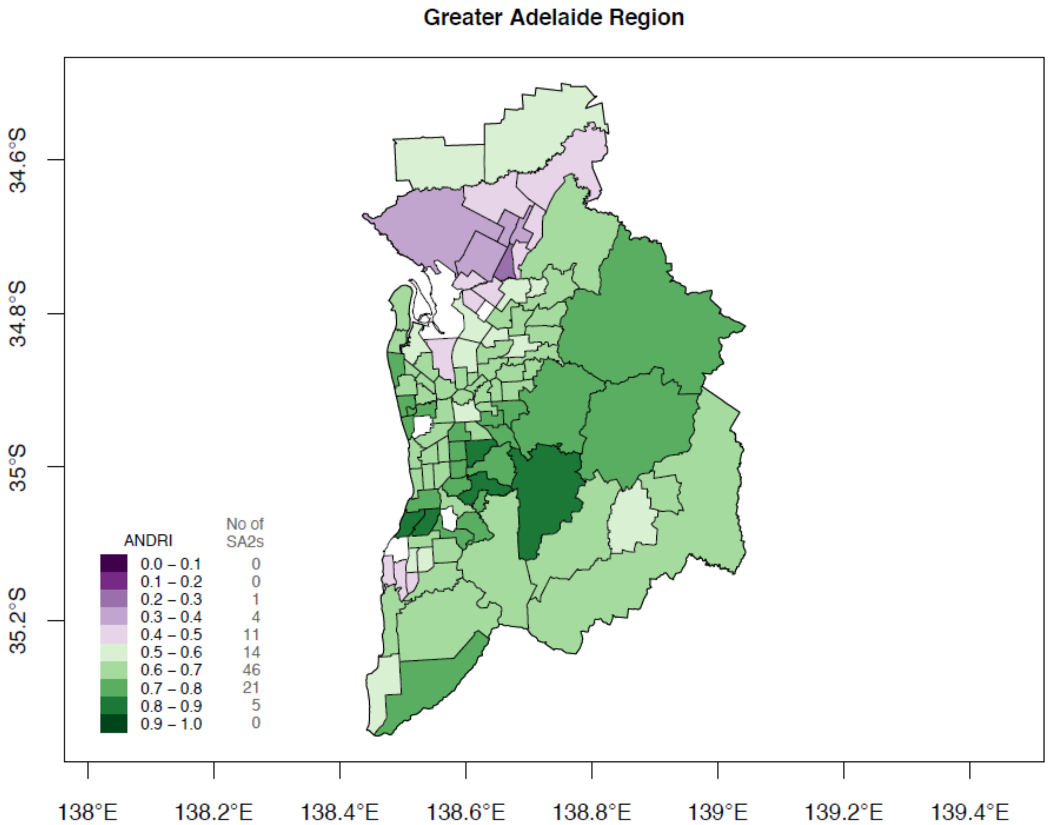
Appendix 1. Australian Disaster Resilience Index, QLD.



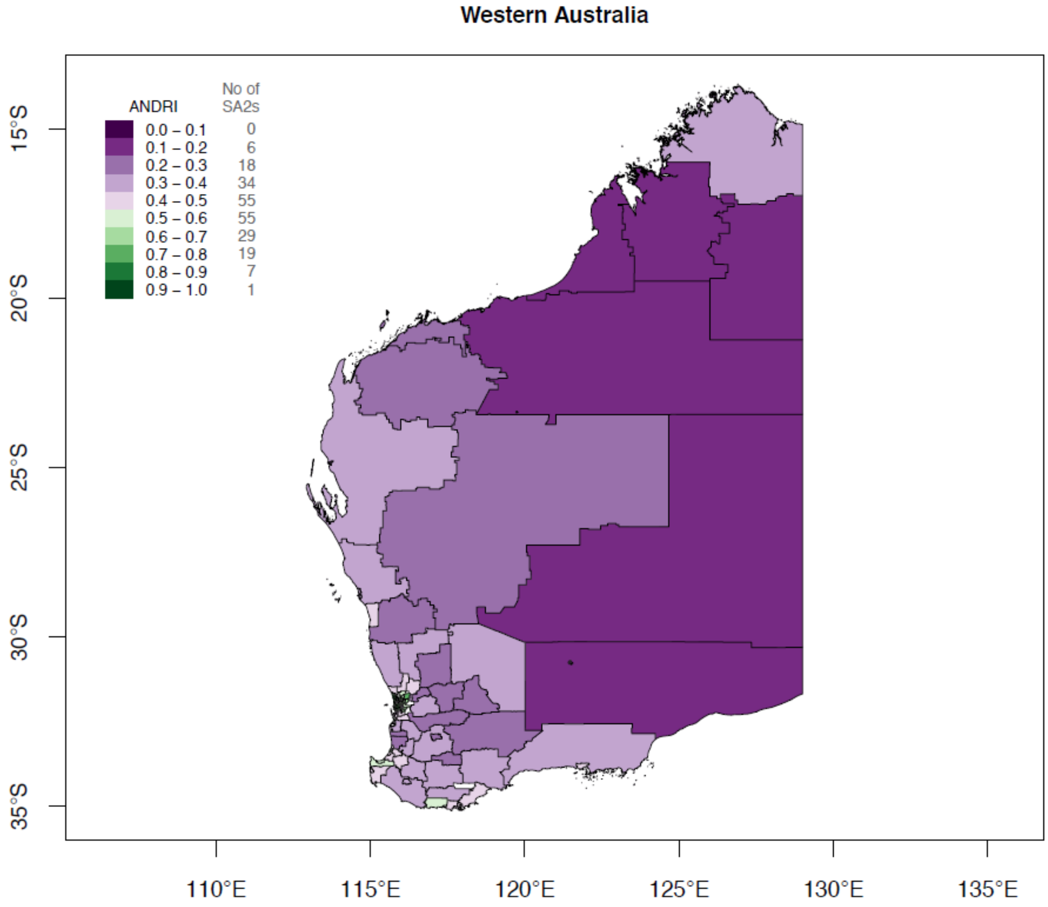


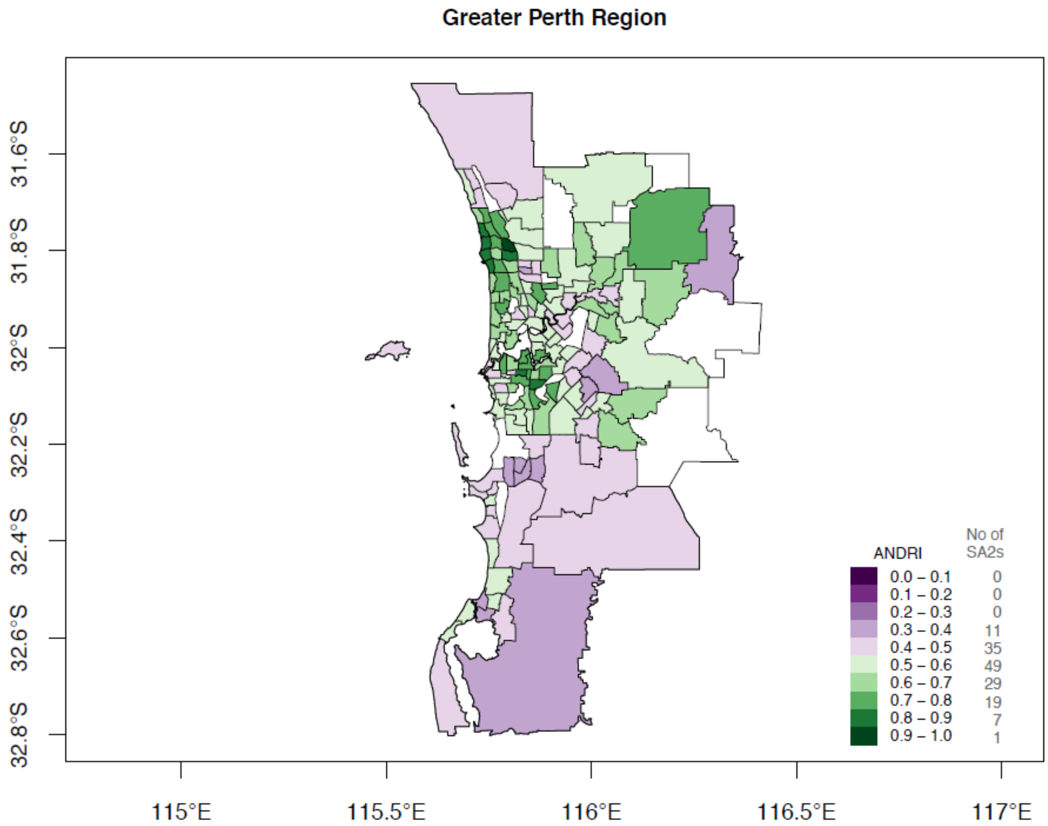
Appendix 1. Australian Disaster Resilience Index, SA.



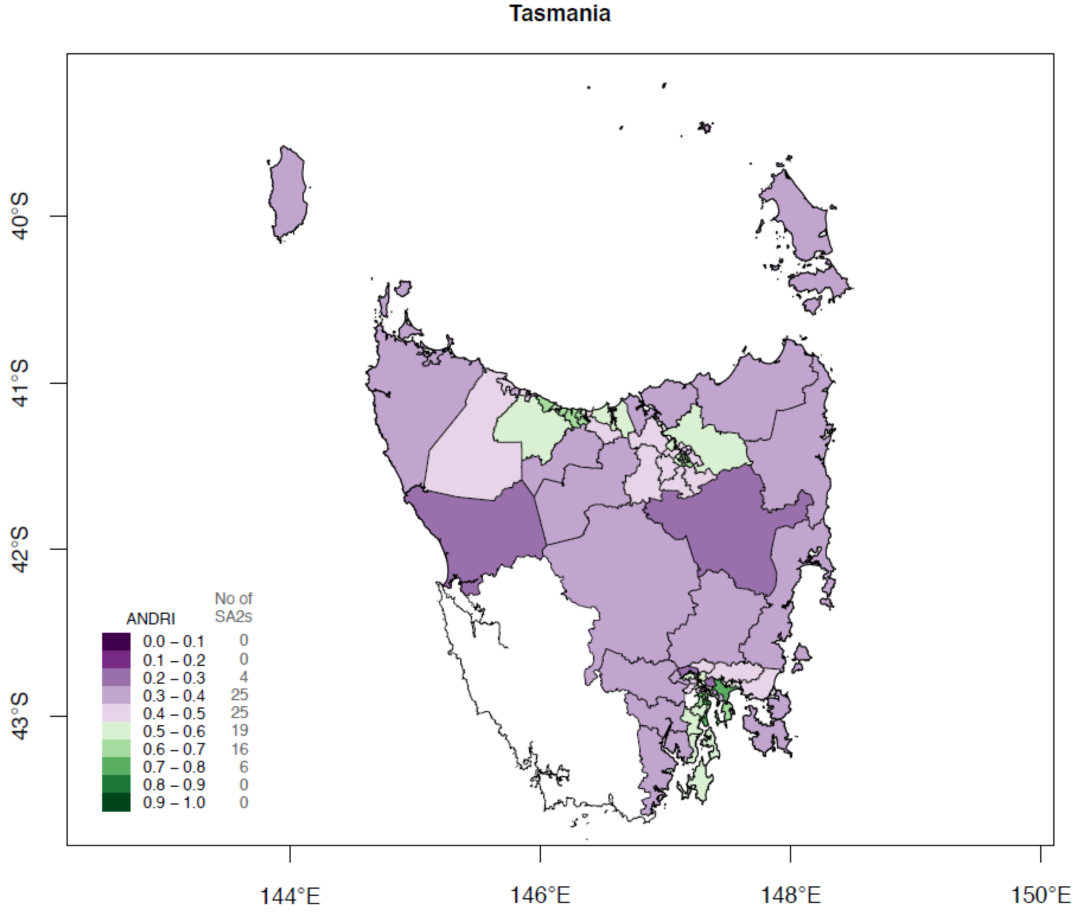


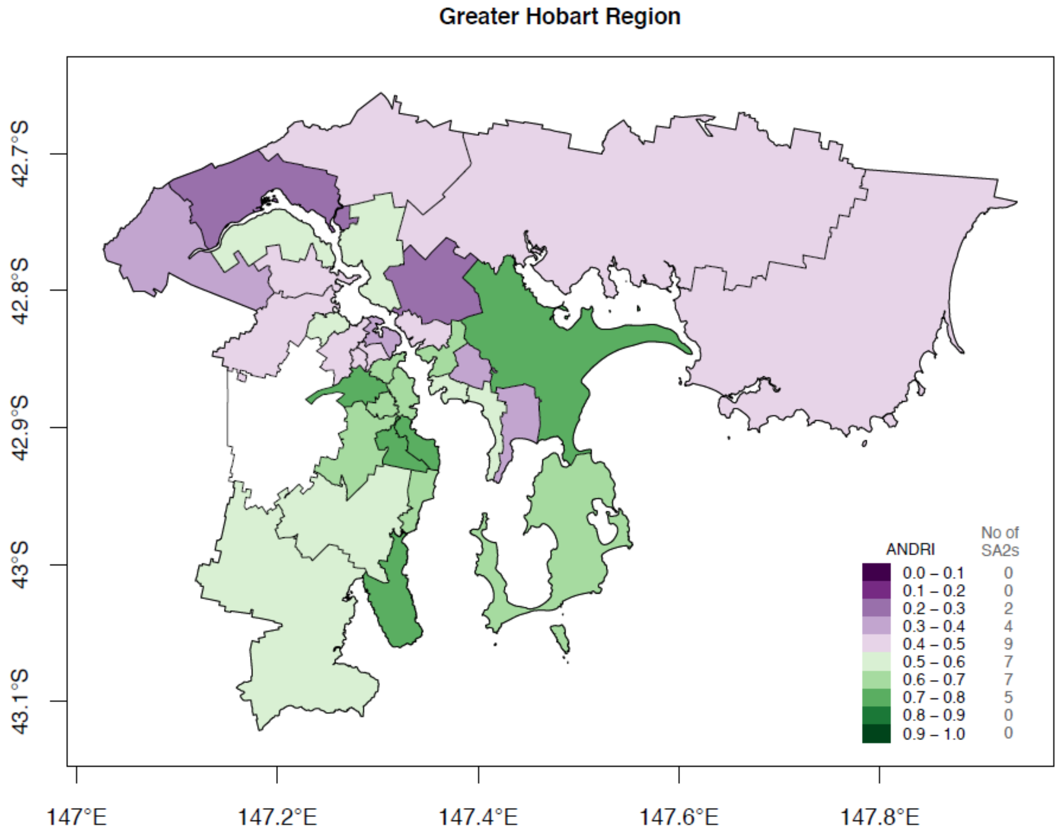
Appendix 1. Australian Disaster Resilience Index, WA.



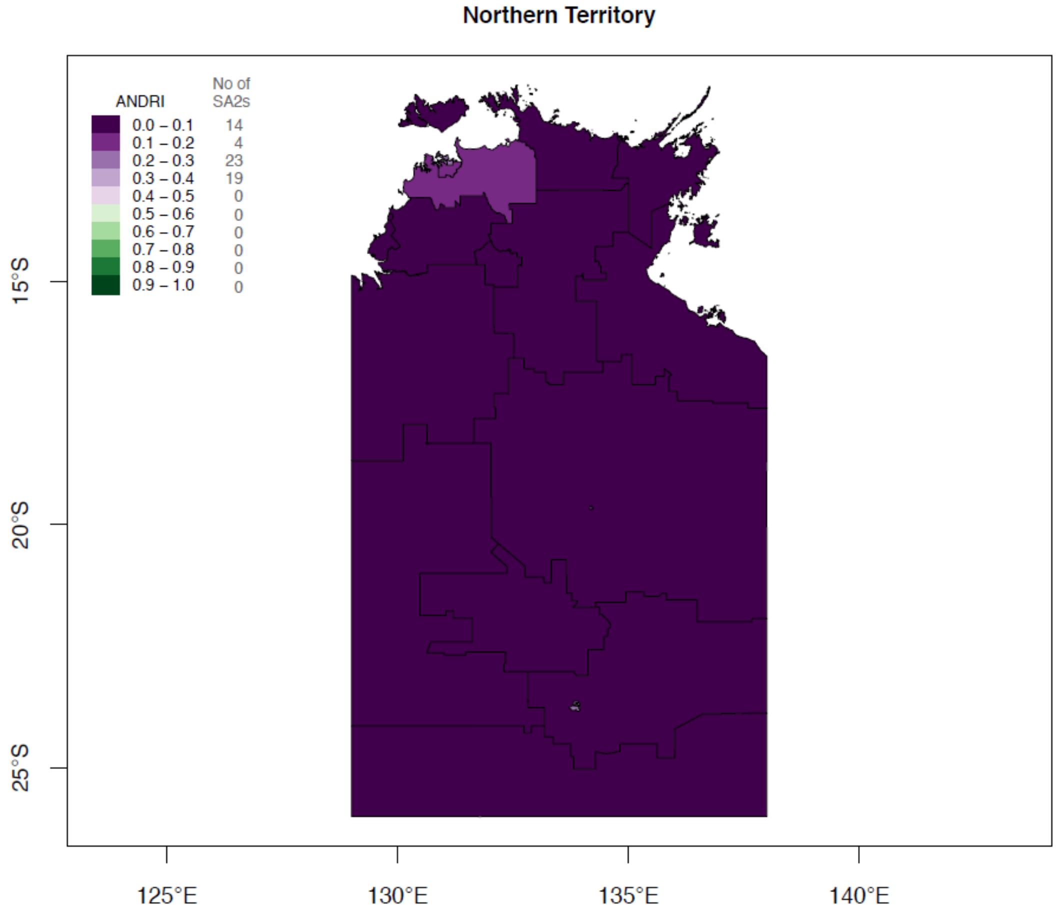


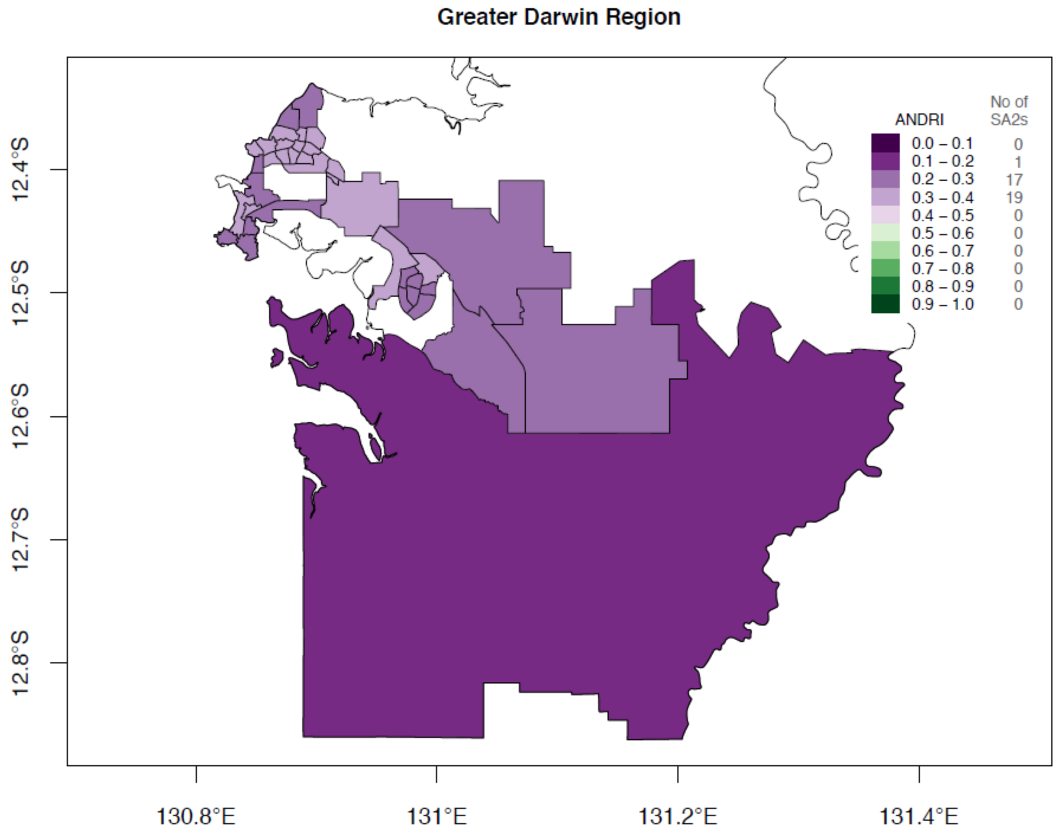
Appendix 1. Australian Disaster Resilience Index, TAS.





Appendix 1. Australian Disaster Resilience Index, NT.





Appendix 1. Australian Disaster Resilience Index, ACT.