

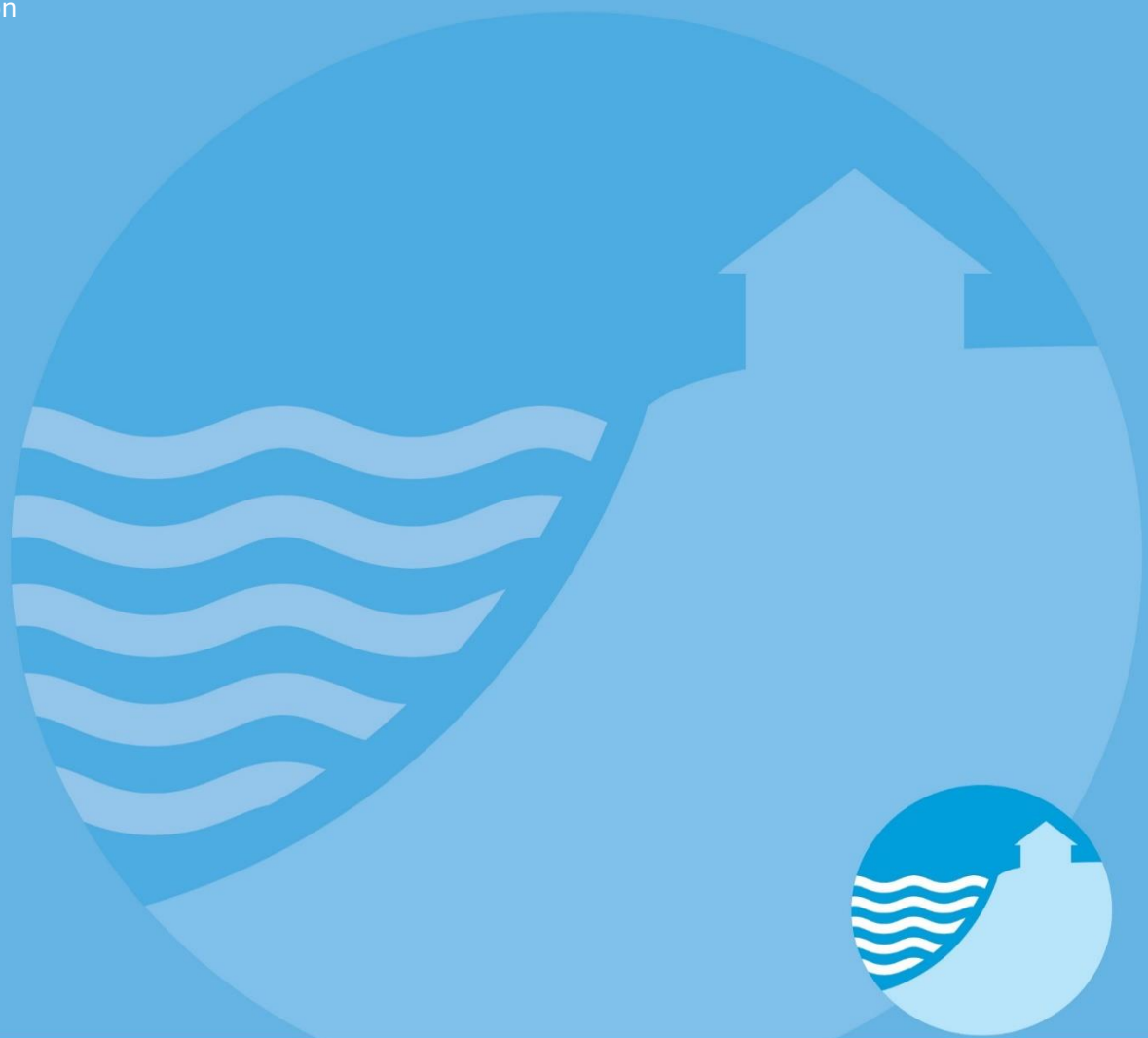
Evaluating Social Vulnerability to Climate Change in Coastal Aotearoa New Zealand. Pitfalls and Opportunities.

A report for the Resilience to Nature's Challenges National
Science Challenge

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Coastal

RESILIENCE
TO NATURE'S
CHALLENGES

Kia manawaroa
– Ngā Ākīna o
Te Ao Tūroa

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Executive Summary

Estimates suggest that 65% of Aotearoa New Zealand's population live within 5km of the coast (Ministry for the Environment, 2019). Sea-level rise and other coastal hazards (such as erosion, inundation, and storms) are projected to magnify and become more frequent and/or severe around Aotearoa with climate change (Lawrence et al., 2018; Ministry for the Environment, 2020a). In order to pursue appropriate, robust, and equitable climate adaptation to coastal hazards in Aotearoa it is essential to develop clear understandings of the regions, communities, and social groups that are most vulnerable to adverse effects.

This report examines indicators and assessments that are used to analyse social vulnerability to climate change and support climate adaptation in Aotearoa New Zealand, and identifies opportunities to leverage innovative international practice to enhance Aotearoa's approach to analysing social vulnerability in coastal locations. Applied in the context of climate change, social vulnerability means the propensity of a social group or individual(s) to be harmed by climate change on account of their relative positioning within social, cultural, economic and political systems, with greater harm generally associated to groups experiencing one or more forms of marginalisation (Adger, 2006; Barnett, 2020; Howitt et al., 2012). Social vulnerability indicators comprise a set of qualities, characteristics, or markers that are known to contribute to greater social vulnerability to climate change. They are applied to identify social vulnerability 'hotspots' or populations of concern (groups of people, communities, neighbourhoods, regions, and even countries) and assist decision-makers in prioritising the focus of climate adaptation efforts, including in coastal locations (Atyia Martin, 2015; Birkmann et al., 2022; B. E. Flanagan et al., 2018).

Social vulnerability indicators and assessments are increasingly employed in Aotearoa in the context of climate change risk assessment and adaptation planning. This report provides an overview of Aotearoa's existing indicators and assessment frameworks and reviews them in light of international indicators, especially those developed for coastal locations. It is clear that the current suite of social vulnerability indicators have evolved from a small number of core approaches.

We note that the current indicators are useful, but have some limitations that practitioners can mitigate through incorporating additional questions to extend the approaches. In particular, we draw attention to the innovative approaches that are being taken to understand social vulnerability to climate hazards in coastal locations internationally, and suggest how these could be tailored to an Aotearoa context. This includes accounting for shifts in vulnerability due to social change over time and the interaction of local and global socio/ecological systems, as well as considering the interplay of social characteristics that lead to diverse experiences of climate vulnerability within communities and regions. Anyone applying a social vulnerability assessment process can consider various ways to improve current practice, by reflecting on how to manage the challenges of the current methods. This includes asking questions such as (but not limited to):

- 1) What hazard or climate driver is of concern? Different hazards may require different approaches.
- 2) Which of the existing approaches and examples best align with the outcomes practitioners are trying to achieve? For example, is the purpose of the assessment to identify "hot spots" for further investigation, or it to understand social vulnerability at a community scale?

- 3) What types of data can be accessed to inform the indicators, and importantly what is missing? Is the missing data critical and do these data gaps weaken the chosen method?
- 4) What are the weaknesses of the chosen approach and how can they be mitigated? Can dynamic elements be added?
- 5) Is community ground-truthing helpful? Does the community have any experience of this hazard or climate driver in question?

Contents

Executive Summary	2
1. Introduction	4
1.1 The concept of social vulnerability	5
1.2 How is social vulnerability to climate change measured or described?.....	6
1.3 This report.....	7
2. Indicators of social vulnerability to climate change in coastal locations.....	7
3. Assessing social vulnerability to climate change in Aotearoa: the context within which vulnerability indicators sit	8
4. Indicators of social vulnerability to climate change in (coastal) Aotearoa	9
4.1 Social vulnerability indicators for flooding in Aotearoa New Zealand (Mason et al., 2019, 2021).....	10
4.2 Auckland Council Heat Vulnerability Index (Joynt & Golubiewski, 2019)	10
4.3 Auckland Council Vulnerability Assessment (Fernandez & Golubiewski, 2019).....	10
4.4 Otago Climate Change Risk Assessment (Tonkin & Taylor Ltd, 2021)	11
4.5 Wellington Regional Coastal Vulnerability Assessment (Steele et al., 2019)	11
4.6 Christchurch City Council Climate Resilience Strategy	11
4.7 Comprehensive Vulnerability Assessment (Khan, 2012)	12
5. Limitations of social vulnerability indicators and assessments in Aotearoa.....	12
5.1 Small number of indicators	12
5.2 Static, deficit-focussed portrayal of vulnerability.....	13
6. Enhancing Aotearoa’s social vulnerability indicators to support robust and inclusive adaptation at the coast.....	16
6.1 Greater emphasis on dynamism	16
6.2 Engaging with diversity and adaptive capacities	18
6.3 Choosing a social vulnerability assessment method	20
7. Conclusions.....	21
8. References cited	21

1. Introduction

This report forms part of the Resilience to Nature’s Challenges National Science Challenge Enabling Coastal Adaptation programme. It provides an overview of indicators and assessments used to evaluate and understand social vulnerability to climate-related hazards in coastal (and non-coastal) regions of Aotearoa New Zealand, and identifies opportunities for enhancing our understanding of coastal vulnerability by drawing on innovative approaches to indicators that are employed in international coastal contexts. The purpose of this document is to provide

decision-makers with an overview of the current options available, when considering how to approach social vulnerability measures and identify avenues to improve practices.

1.1 The concept of social vulnerability

Social vulnerability to climate change is a contested concept that is defined, measured, and analysed differently throughout the academic literature and in policy contexts - refer to Box 1 (Adger, 2006; Eakin & Lynd Luers, 2006; Faas, 2016; O'Brien et al., 2007). Social vulnerability can be understood in a general sense in this context as the propensity of a social group or individual(s) to be harmed by climate change on account of their positioning within society (Adger, 2006). As opposed to focussing solely on risks arising from exposure to biophysical climate hazards (such as sea level rise), social vulnerability examines how social context (including inequalities, social and cultural norms, and economic and political systems) play a key role in shaping climate risk for different groups of people (Barnett, 2020; Howitt et al., 2012).

Box 1: Definitions of social vulnerability

Major international organisations define social vulnerability to climate change in a range of ways.

The Intergovernmental Panel on Climate Change (IPCC) conceptualises vulnerability to climate change as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a wide variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (IPCC, 2019, p. 826). Sensitivity or susceptibility refer to factors that shape how much and how seriously a group or individual is affected by climate change, while adaptive capacity or capacity to cope and adapt refers to the ability to take actions that offset harm from climate change (Adger, 2006).

The United Nations Framework Convention on Climate Change (UNFCCC) employs an older definition from the IPCC, and states that vulnerability is, “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity” (UNFCCC, 2022).

The United Nations Development Programme (UNDP) states that social vulnerability is the “differential capacity of groups and individuals to deal with hazards, based on their positions within physical and social worlds” (Dow 1992), whereby groups have dissimilar access to and control over resources, varied levels of risk exposure, and diverging abilities to manage and respond to hazards (Katic, 2017, p. 11).

The International Institute for Environment and Development (IIED) and UN Office for Disaster Risk Reduction (UNDRR) add that, “vulnerability is structured by social, economic, and political factors, particularly access to resources, social capital, and decision-making power. Vulnerability is highly differentiated by gender, sex, age, ability, ethnicity, locality, wealth, Indigenous group, and marginalisation” (Barrett et al., 2021, p. 11).

1.2 How is social vulnerability to climate change measured or described?

Social vulnerability to climate change is typically measured and described in two ways – quantitatively and qualitatively.

1.2.1 *Quantitative social vulnerability using indicators*

Social vulnerability is commonly measured through indicators or similar types of assessments. Indicators comprise a collection of qualities or characteristics of a place or population that are known to contribute to a particular outcome, in this case, social vulnerability to climate change. Indicators use demographic and other related datasets to generate quantitative statements about social vulnerability and its spatial distribution over a geographical region (Lee, 2014). Indicators enable identification of social vulnerability ‘hotspots’ or populations of concern (groups of people, communities, neighbourhoods, regions, and even countries) that will be adversely affected by climate change (Birkmann et al., 2013; Cutter et al., 2003; B. E. Flanagan et al., 2018; Met Office Hadley Centre, 2015). They are often employed as a decision support tool to ensure climate adaptation and hazard mitigation resources are channelled to appropriate locations (Atyia Martin, 2015).

Social vulnerability indicators have been developed for an extensive range of geographical locations and climate hazards worldwide. Despite their broad application, the design and focus of most indicators aligns with a small number of ‘foundational’ works including Cutter et al.’s Social Vulnerability Index or “SoVI” (2003); Turner et al.’s Expanded Vulnerability Analysis framework (2003; 2003); the MOVE framework developed by Birkmann et al. (2013); the Social Vulnerability Index (or SVI) (Centres for Disease Control and Prevention (CDC), 2015, 2022; B. Flanagan et al., 2011; B. E. Flanagan et al., 2018); and Holand et al.’s Socioeconomic Vulnerability Index (SeVI) and Built Environment Index (BeVI) (2011). A more complete overview of the foundational indicators is available in Johnson and Blackett (2023).

The key components of foundational indicators (including measures of population age structure, income, education level, and housing type within a region) are employed to quantify social vulnerability to climate change around the world, including in Aotearoa New Zealand (hereafter, Aotearoa). A handful of social vulnerability indicators and assessments have been developed for analysing vulnerable locations and populations in Aotearoa and supporting adaptation to climate-related hazards including flooding, increases to air temperature, coastal erosion, inundation, and sea-level rise (Christchurch City Council, 2021; Fernandez & Golubiewski, 2019; Joynt & Golubiewski, 2019; Khan, 2012; Mason et al., 2021; Steele et al., 2019; Tonkin & Taylor Ltd, 2021). Typically the same set of indicators is applied to all hazards.

1.2.2 *Qualitative social vulnerability studies*

Social vulnerability is also conceptualised through grounded, place-based studies which draw on communities’ lived experience of climate change. Qualitative studies largely focus at a community or regional scale, and incorporate narratives and observations drawn from interaction with local residents, often associated with particular social group. There are numerous examples of qualitative social vulnerability studies. For example, studies of gendered vulnerability to flooding in Ghana and Nigeria (Adams & Nyantakyi-Frimpong, 2021; Ajibade et al., 2013), older peoples’ vulnerability to cyclones in Australia (Astill & Miller, 2018), vulnerability of rural farmers and communities to drought and other climate extremes in Iran, Brazil, and Tanzania (Githinji & Crane, 2014; Keshavarz et al., 2013; Nelson & Finan, 2009), and Indigenous peoples’ vulnerability to extreme weather, sea-level rise, erosion in the Arctic, Caribbean, and Aotearoa (Johnson et al., 2022; Marino, 2015; Smith & Rhiney, 2016).

Qualitative studies of social vulnerability to climate change are typically highly detailed, population- or location-specific and can be difficult to generalise to other social groups and larger scales. This presents barriers to integration of qualitative data into adaptation policy-making.

1.3 This report

This report synthesises existing quantitative approaches to measuring social vulnerability to climate change in Aotearoa and coastal locations worldwide, and identifies some options through which Aotearoa can better support sustainable, just, and inclusive adaptation to climate change at the coast.

The report begins with a brief overview of international indicators used to measure social vulnerability to climate change in coastal locations (section 2). Section 3 then provides an overview of how social vulnerability indicators and assessments fit within Aotearoa's wider efforts to understand climate risk and drive forward adaptation. Section 4 details Aotearoa's indicators and their key components, and section 5 discusses their inherent limitations. Section 6 identifies opportunities to draw on international coastal indicators and Aotearoa-based research to enhance our understanding of social vulnerability to climate change and pursue appropriate and fair climate adaptation strategies. Section 7 concludes.

2. Indicators of social vulnerability to climate change in coastal locations

Indicators have been developed to assess climate vulnerability of coastal communities in a wide range of geographical locations, including the Pacific Islands, Asia, Europe, North and South America (Grasso et al., 2013; Kirby et al., 2019; Kleinosky et al., 2007; Lavoie et al., 2018; Pacific Community (SPC) et al., 2016; Tasnuva et al., 2020; Wu et al., 2016). Unlike some indices that consider only demographic or social characteristics, coastal vulnerability indices largely take an 'integrative' approach to measuring vulnerability (Bevacqua et al., 2018; Eakin & Lynd Luers, 2006). Integrative approaches combine indicators of geophysical, social, and economic systems (for example, wave/wind metrics, education and unemployment data, appraisals of coastal infrastructure) with the aim of providing a holistic assessment of vulnerability at the coast (Bevacqua et al., 2018; Bukvic et al., 2020; Nguyen et al., 2016; Roukounis & Tsihrintzis, 2022).

Within coastal-focussed indices, the suite of indicators used to quantify social vulnerability is largely comparable with indices developed for non-coastal locations, and reflects the key components of the most well-known and influential social vulnerability indices, including the SoVI, the SVI, the SeVI/BeVI. Some of the most frequently-used indicators for assessing social vulnerability to climate hazards in coastal locations include:

- **Population density and the presence of sensitive land uses such as residential, commercial, or agricultural** (Boruff et al., 2005; Grasso et al., 2013; Nguyen et al., 2016; Oulahen et al., 2015; Su et al., 2015; Tasnuva et al., 2020). High population density and residential land-use means many people could be exposed to coastal hazards and at risk of bottlenecks if trying to evacuate the area quickly during a rapid-onset hazard like flooding. Commercial and agricultural land-uses can increase the

likelihood of significant economic losses as a result of hazards (e.g. reduction to farm productivity because of saline intrusion into soil).

- **Poverty and lack of access to resources, public services, or early warning systems** (Chang et al., 2018; Colburn et al., 2016; FEMA, 2021; Kirby et al., 2019; Steele et al., 2019; Tasnuva et al., 2020; Tuccillo & Spielman, 2022). Low-income households can experience difficulties accessing items and materials to prepare for and cope with climate hazards (e.g. to strengthen their home against erosion or sea-level rise) and often have limited savings to help with recovery/adaptation. Inability to access early warning systems and public support services (such as emergency payments) can leave households unprepared for sudden-onset hazards like cyclones and impede recovery in the aftermath.
- **Older or younger age** (B. Flanagan et al., 2011; Hardy & Hauer, 2018; Hemmerling & Hijuelos, 2017; Kashem et al., 2016; NOAA Fisheries, n.d.). Because of their physiology, children and older people are more likely to have lower mobility than the teenage/working-aged adult population (which can prevent rapid evacuation of a coastal area). They are generally more susceptible to physical risks associated with coastal climate hazards (such as drowning, injury, illness), and it is also more likely they will require assistance from others to move away from coastal hazards which can put more people in harms way.
- **Migrants** (B. Flanagan et al., 2011; Hemmerling & Hijuelos, 2017; Khan, 2012). People who have migrated to coastal areas recently may be unfamiliar with the area and its hazards (which can increase their exposure to coastal hazards like erosion or storms). If new migrants are not proficient in the local language, they may encounter difficulties understanding emergency communications, such as cyclone warnings, that could leave them exposed to danger.
- **Occupation, particularly those working in exposed or resource-dependent industries** (Chang et al., 2018; Grasso et al., 2013; Hemmerling & Hijuelos, 2017; Kirby et al., 2019; NOAA Fisheries, n.d.). For instance, people working in the primary industries (such as fishing, aquaculture, coastal agriculture and horticulture) are not only at risk of being directly exposed to extreme events during the course of their work, but their livelihood is highly sensitive to variations in climate and extreme weather.
- **Limited education** (Boruff et al., 2005; B. Flanagan et al., 2011; Handwerker et al., 2021; Oulahen et al., 2015; Tasnuva et al., 2020; Wu et al., 2016). Educational attainment often aligns with income, and households whose members have limited formal education may have very modest or irregular income which can make it harder to cope with, recover from, and adapt to changing climatic conditions. Limited formal education may also impede understanding of hazards and lower the chances that people will take action on official communications about coastal hazards.

For a more comprehensive list of indicators readers are referred to Johnson and Blackett (2023)

3. Assessing social vulnerability to climate change in Aotearoa: the context within which vulnerability indicators sit

Indicators have become a common feature of social analysis, policy development and evaluation in Aotearoa. In particular, indicators are used to assess and understand national and regional wellbeing (Stats NZ, 2022; The Treasury, 2021; Waikato Wellbeing Project, 2023), social

deprivation (Atkinson et al., 2014, 2019; Exeter, 2017), and community resilience to hazards, emergencies and other perturbations (Le De et al., 2020; Pearson et al., 2013; Stevenson et al., 2018, 2019). However, there are still relatively few indicators for quantifying social vulnerability to climate change.

The New Zealand government undertook its first National Climate Change Risk Assessment in 2020 (Ministry for the Environment, 2020a), and subsequently developed the inaugural National Adaptation Plan or NAP (Ministry for the Environment, 2022a). The National Climate Change Risk Assessment (NCCRA) identified risks that climate change poses to Aotearoa over the next 100 years. In the human domain, key risks include impacts to social cohesion and community wellbeing from climate-induced displacement of individuals, families, and communities, and the risk of exacerbating existing inequities or creating new inequities. Although the NZCCRA does not use indicators, it advances understanding of social vulnerability in Aotearoa by identifying groups that will likely experience greater risk from climate change (such as those of lower socio-economic status, women and children, Māori, and persons experiencing mental and physical health challenges).

Local government authorities (Councils and Territorial Authorities) around Aotearoa have statutory responsibilities to reduce risk from natural hazards and to work with communities in their area to adapt to climate change (Bell et al., 2017; Ministry for the Environment, 2021a, 2022b; New Zealand Government, 2019). As Bell et al. (2017) note, vulnerability assessments are a key process in developing a clear understanding of climate risk for communities or regions, and developing appropriate, sustainable, and inclusive strategies to reduce risk and adapt to climate change under deep uncertainty. In the sense advocated for by Bell et al. vulnerability assessments include understandings of the sensitivity or coping capacity (i.e. vulnerability) of people, infrastructure and assets in a community or region, which includes consideration for social vulnerability. Local authorities across Aotearoa conduct climate change risk assessments to develop their adaptation process (Ministry for the Environment, 2021a), and within this, several have commissioned dedicated indicator-based social vulnerability assessments (see below).

4. Indicators of social vulnerability to climate change in (coastal) Aotearoa

Despite increasing documentation of climate change risk and vulnerability in Aotearoa's coastal communities (Blackett & Hume, 2010; King et al., 2013; Ministry for the Environment, 2020b; Schneider et al., 2020; Stephenson et al., 2018), there are currently no indices for quantifying social vulnerability to coastal climate hazards at the national scale. Instead, there is one national-scale index measuring social vulnerability to flooding (Mason et al., 2021), plus a range of regional-scale indices for assessing social vulnerability to coastal inundation and erosion, and other climate impacts such as increasing air temperatures and heatwaves.

The indicators selected to measure social vulnerability to climate change in Aotearoa are broadly similar to those within international indices. Below, we provide a brief overview of the main features of Aotearoa-based indices.

4.1 Social vulnerability indicators for flooding in Aotearoa New Zealand (Mason et al., 2019, 2021)

The social vulnerability indicators for flooding in Aotearoa New Zealand (SVI) is the first attempt to provide a nationally-available dataset for flood vulnerability within each census mesh-block. A key aim of the SVI is to provide evidence to support emergency management, (flood) risk reduction, and land use planning. The SVI takes a diverse approach to social vulnerability that combines public health scholarship, disaster risk management, and elements of major international indicators and vulnerability frameworks such as the SoVI (Cutter et al., 2003), the MOVE framework (Birkmann et al., 2013). It comprises a suite of 14 indicators that mediate the balance between exposure, susceptibility, and resilience to flooding within a population.

Indicators of exposure are divided into direct or indirect, and include factors such as the number of people residing in an area, use of public transport, and residence in a remote community. Susceptibility is measured through indicators such as age and health status of households and regions. Resilience is conceptualised as the ability to cope with disasters and is measured through having access to sufficient finances, social connections, knowledge and so on. Wisner et al.'s (2012) 'circle of capacities' and the LSF inform the framing of resilience in the SVI, whereby more vulnerable populations will have reduced access to key social, economic, cognitive, political, and material capacities or capitals that enable coping and response amongst less vulnerable groups.

Although the SVI still produces a quantitative measure of social vulnerability (based on datasets including the census and Ministry of Health statistics) the indicators have been subject to a collaborative design and 'ground-truthing' process. Ground-truthing is recommended as best practice in the international literature on vulnerability indicators (Cardona et al., 2012) and is often seen as a way to bridge social vulnerability theory with people's lived experience. The SVI was developed and field tested in Porirua, a city in the lower North Island, and community members, the local iwi (tribe), local decision-makers, and staff from major organisations like the District Health Board all played a part in the selection of indicators.

4.2 Auckland Council Heat Vulnerability Index (Joynt & Golubiewski, 2019)

As part of Auckland Council's climate change risk assessment (CCRA), Joynt and Golubiewski developed the Heat Vulnerability Index (HVI). The HVI identifies and maps areas of Auckland where populations are more vulnerable to climate-related heat stress with a view to directing adaptation policy under Auckland's Climate Action Plan. Drawing on the 2013 census, the NZ Indices of Multiple Deprivation, the Household Economic Survey and NZ Land Cover database, the HVI is composed of ten indicators which are combined with different climate change scenarios. Several of the indicators (including deprivation, older and younger age, limited English proficiency, Indigenous/Pacific ethnicity, and rental tenure) closely resemble indicators that are employed in other major international vulnerability indices, including the SoVI.

4.3 Auckland Council Vulnerability Assessment (Fernandez & Golubiewski, 2019)

Like the HVI, the Vulnerability Assessment informs Auckland Council's climate change risk assessment (CCRA). The Vulnerability Assessment seeks to identify areas of Auckland more vulnerable to dry and hot days, heavy rainfall and precipitation change, wind, changes to humidity, and exposure to inundation. It combines climate change projections with data from

the NZ Deprivation Index, the 2013 census, land cover and road density data. The Vulnerability Assessment comprises two indices: the Impact Index (II) and the Adaptive Capacity Index (ACI). The Impact Index comprises indicators for exposure and sensitivity that are common measures of social vulnerability (including deprivation, unemployment rate, and percentage of one-parent households) while the Adaptive Capacity Index examines factors known to impact ability to cope and adapt (such as household income, rent burden, and access to economic assets).

4.4 Otago Climate Change Risk Assessment (Tonkin & Taylor Ltd, 2021)

The Otago Climate Change Risk Assessment seeks to identify the risks that climate change poses for communities throughout Otago (including coastal areas such as Dunedin and Oamaru) in order to inform planning by Otago Regional Council. It follows the same general template as the National Climate Change Risk Assessment, and examines risks to the human, natural environment, economic, built environment and governance domains. Key risks to the human domain include risks to Kāi Tahu sites, identity, and practices and non-Kāi Tahu cultural heritage sites; risks to community cohesion and resilience; risks to mental wellbeing and health; risks to physical health; and risks of increased inequities and cost of living.

Three social vulnerability indicators are used to assess the degree to which different communities in Otago are vulnerable to these risks. The indicators – deprivation, proportion of older adults, and social connectedness – were selected by drawing on Mason et al.’s SVI (above) and stakeholder consultations, and are used to quantify the sensitivity and adaptive capacity of communities within Otago, at the SA2 census block scale. SA2 blocks were scored for each indicator using data from the census 2018 and the New Zealand Index of Social Deprivation (the NZDep 2018), which enabled identification of areas most vulnerable to these risks. For instance, the SA2 blocks of Oamaru Central, Seddon Park, Wanaka Central, Mosgiel Central and Mosgiel East had large populations of older people (in 2018) and were therefore deemed to be more at risk of climate-related impacts to physical health. As the assessment states (Tonkin and Taylor 2021: 34), older people are more likely to have chronic health conditions that increase their susceptibility of adverse impacts from extreme events such as floods.

4.5 Wellington Regional Coastal Vulnerability Assessment (Steele et al., 2019)

Working at the level of Greater Wellington suburbs, the Coastal Vulnerability Assessment uses a range of indicators to assess the vulnerability of particular places. Whilst the report notes that the assessment was balanced between social, economic, cultural and environmental datasets, social vulnerability is not a particularly prominent feature. Indicators of vulnerability focus primarily on exposure of population centres, businesses, lifelines, infrastructure, and sites of ecological and cultural significance to climate hazards, although community deprivation and resilience does feature on the list of indicators (based off census 2013 data and the NZ Index of Multiple Deprivation 2013).

4.6 Christchurch City Council Climate Resilience Strategy

In its Climate Resilience Strategy, Christchurch City Council (CCC) states it is working to “complete comprehensive district risk assessments to deliver local data across all domains, including updates and monitoring of hazards, exposure, and vulnerability” (Christchurch City Council, 2021, p. 18). This includes developing indicators to monitor how the climate is changing and the rate of change, including a focus on coastal climate hazards such as sea-level rise and saline intrusion into groundwater. Additionally, CCC will support Ngāi Tahu Papatipu

Rūnanga to develop culturally-relevant indicators for monitoring the impacts of climate change on mahinga kai (food gathering/harvest areas) and other cultural resources. These indicators will complement Ngāi Tahu's existing climate change risk assessment (CCRA).

4.7 Comprehensive Vulnerability Assessment (Khan, 2012)

Khan's Comprehensive Vulnerability Assessment (CVA) seeks to identify social vulnerability to coastal and river flooding/inundation at the mesh block level in the Hutt Valley, near to Wellington. Khan notes that (at the time of writing) floodplain management plans often pursued a wholly risk-hazard approach that overlooked the spatial variation of social vulnerability to flooding, and instead focussed on the most physically exposed locations. The CVA comprises 38 indicators for social vulnerability to flooding. The indicators are categorised into demographic factors (like population distribution and density, age, disability and migration status); social factors (including family type such as single parents, language proficiency, ethnicity, and education); and economic (which includes income, unemployment, housing condition and access to assets like a car and telecommunications at home). The CVA was influenced by indicators employed in the SoVI (Cutter et al. (2003)) and uses the 2006 census and NZDep 2006 to quantify the indicators.

Each of these approaches are valid, however users need to be very aware of the limitations of the set of indicators they are applying. Helpfully, the limitations of all of the above approaches are quite similar.

5. Limitations of social vulnerability indicators and assessments in Aotearoa

There is a small pool of indicators and assessments exploring climate-related vulnerability in Aotearoa. Existing indicators and assessments are subject to two main limitations:

- 1) they consider only a small number of indicators, and
- 2) they replicate the focus on static, deficit-focussed portrayals of vulnerability found within the wider international suite of social vulnerability indicators.

These limitations could perpetuate inaccurate understandings of social vulnerability to climate change, with potential ramifications for the integrity of adaptation and risk reduction decisions and policies developed from indicator-based assessments. Below, we briefly explore these two limitations, before examining pathways to enhance Aotearoa's climate-related social vulnerability indicators.

5.1 Small number of indicators

Some assessments – notably the Wellington Regional Coastal Vulnerability Assessment and the Otago Climate Change Risk Assessment – consider a small number of indicators. Although there may be communities in Aotearoa with very little internal social or demographic variation, this is most often not the case. Focussing in on only two or three social vulnerability indicators (as these assessments do) is likely to obscure other factors that mediate social vulnerability to climate change hazards, and could potentially produce incomplete or inaccurate conclusions about vulnerability.

In the case of the Wellington Regional Coastal Vulnerability Assessment, the small number of measures of social vulnerability (assessed through community deprivation and resilience) belies a larger issue. The notion that people's vulnerability equates simply to their degree of hazard exposure has been heavily critiqued over the past fifty years (Adger, 2006; Eakin & Lynd Luers, 2006; O'Keefe et al., 1976), however this assumption still persists to some extent in Aotearoa (Jozaei et al., 2022). To date, many of Aotearoa's hazard impact, risk, or vulnerability assessments have been conducted by consultancies which tend to lean towards an engineering perspective on climate change and hazards whereby biophysical exposure (rather than social characteristics mediating sensitivity or adaptive capacity) is the primary focus. This is exemplified in the Wellington assessment, where the majority of indicators pertain to measures of exposure including population density, presence of important sites, lifelines, and infrastructure. Consequently, coastal suburbs with the highest concentration of exposed people and assets are deemed most vulnerable. If a wider range of social vulnerability indicators were used, a very different picture of vulnerability may have emerged.

5.2 Static, deficit-focussed portrayal of vulnerability

5.2.1 *Static vulnerability*

Both internationally and in Aotearoa, a host of qualitative literature attests to the dynamic, fluid nature of climate vulnerability (Ajibade et al., 2013; King et al., 2012, 2013; Matthewman & Uekusa, 2022; Oliver-Smith, 2022). Local, regional, and global shifts in socio-economic, demographic and institutional dynamics (such as political and economic regimes, policy interventions, population change, behaviour change, institutional learning, and adaptation to hazards) and their interlinkages with social, economic, political, epidemiological and environmental pressures are all known to influence the experience of social vulnerability (Amorim-Maia et al., 2022; Cameron, 2012; Eakin et al., 2014; Keskitalo et al., 2011; Lawrence et al., 2022; Liverman, 1990; Ministry for the Environment, 2020b; Nelson & Finan, 2009). These observations, however, have had limited impact on the design and development of social vulnerability indicators, which have been critiqued in the international literature for providing static "snapshots" of vulnerability that fail to account for changes over time and the influence of interacting scales, systems, and pressures (Fawcett et al., 2017; Fussel, 2007; Jozaei et al., 2022; Li & Wang, 2022; Ran et al., 2020; Roukounis & Tsihrintzis, 2022).

Internationally, indicators tend to draw on large-scale, publicly-available statistical databases like the census (Boruff et al., 2005; Hemmerling & Hijuelos, 2017; Kirby et al., 2019; Kleinosky et al., 2007; Tasnuva et al., 2020), tax and other government records (Manuel et al., 2015; Mavromatidi et al., 2018; Wu et al., 2016). This tendency is replicated in Aotearoa with many indicators using the census and other indices like the NZDep (Joynt & Golubiewski, 2019; Khan, 2012; Steele et al., 2019; Tonkin & Taylor Ltd, 2021). Even the most recent census, government data, or deprivation index can be several years old and effectively measures community vulnerability at a previous, fixed point in time (Armaş & Gavriş, 2016; B. Flanagan et al., 2011; Mason et al., 2021) which could lead to incomplete understandings of vulnerability if population dynamics have changed in the intervening years (Hardy & Hauer, 2018).

Additionally, as with international indicators, most Aotearoa-based indicators and assessments do not account for dynamic interaction between multiple scales and instead focus at the local or at most regional level (Fergen & Bergstrom, 2021; Fernandez & Golubiewski, 2019; Handwerker et al., 2021; Tasnuva et al., 2020; Tuccillo & Spielman, 2022). Indicators often target a scale that aligns with availability of statistical data (such as census mesh-blocks or SA2

areas in the case of Aotearoa, which roughly equate to neighbourhoods or suburbs in urban areas and collections of communities in rural areas). This local focus obscures understanding of how regional and national governance, planning, and even international factors like changes to global markets and the pandemic may affect social vulnerability on a local scale and how this may differ through time (Bukvic et al., 2020; Chakraborty et al., 2021; Guragain & Doneys, 2022; Karunaratne & Lee, 2020; Nguyen et al., 2016; Zou & Thomalla, 2008).

Li and Wang (2022) note that the overwhelming focus of most international indicators on a single spatial scale (be it a neighbourhood, city, county, or region) and a single pressure (like climate change) magnifies the static portrayal of social vulnerability. Most indicators neglect cross-scale linkages and the interaction of multiple pressures (climate change, pandemics, adaptation policies) on a system, all of which influence and change how vulnerability is experienced, and by whom (Li & Wang, 2022). This oversight is also present in Aotearoa-based indicators.

5.2.2 Deficit-focussed vulnerability

A further issue is that Aotearoa's social vulnerability indicators and assessments focus almost exclusively on the measurement of 'deficit-based' characteristics that increase vulnerability to climate change and hazards because people within that group lack something or are underprivileged in some way. This deficit focus is evident in coastal (and non-coastal) indicators worldwide but in simply reproducing this narrative, Aotearoa's indicators and assessments may unwittingly fail to capture the nuanced and diverse lived realities of social vulnerability to climate change, with consequent risks for adaptation decision-making.

Socio-economic deprivation is one of the key indicators that is used to measure social vulnerability to climate hazards in Aotearoa, because there is significant evidence that households with limited financial resources are more sensitive and less able to adapt (for instance, they may be unable to afford to protect their home against coastal erosion, and may not have the funds to relocate away from hazardous areas) (Blackett et al., 2010; Rouse et al., 2017; Schneider et al., 2020). Use of the NZDep Index, Index of Multiple Deprivation, and statistics on income thresholds below certain levels are common (Fernandez & Golubiewski, 2019; Joynt & Golubiewski, 2019; Khan, 2012; Mason et al., 2021; Steele et al., 2019). Sometimes presence of high numbers of older people, single parent households, renters, unemployed persons, and those in receipt of a government benefit are used as proxies for deprivation (Mason et al., 2021; Ministry for the Environment, 2021a; Tonkin & Taylor Ltd, 2021).

Other deficit-focussed indicators that are frequently used in Aotearoa include: older age (over 65), physical and mental impairment, disability, limited education and English proficiency, being new to the area (immigrants, recent migrants), living in poor quality or overcrowded housing, female gender, lack of access to a car or the internet at home, identifying with an ethnic minority, and being socially isolated (Joynt & Golubiewski, 2019; Khan, 2012; Mason et al., 2019; Ministry for the Environment, 2020a; Tonkin & Taylor Ltd, 2021). Again, selection of these indicators is based on substantial evidence (internationally and locally) linking these identifying characteristics with physiological, socio-economic, institutionally- and culturally-mediated disadvantages that increase propensity to harm from climate change and hazards (Adger, 1999; Barnett, 2020; Bohle et al., 1994; Johnson et al., 2022; Liverman, 1999; Sultana, 2014).

The key problem with the deficit focus is that it is reductive, and simplifies the complex and often incongruous lived experience of social vulnerability (Bee, 2014; Buchanan et al., 2016). In measuring the vulnerability of a community, neighbourhood, or region based on the statistical

presence (or absence) of vulnerability-enhancing social characteristics (such as poverty/low income, older age, etc), indicators treat these characteristics as monolithic. There is an implicit assumption that all members of a category known to enhance vulnerability will actually be vulnerable to climate hazards in reality, and that all members will experience vulnerability in the same way. This leaves little room to consider diversity of experience within these ‘vulnerable’ groups, including the abilities, assets, and capacities that people may possess and use to offset climate-related risk and vulnerability, including in coastal locations.

As Stephenson et al. (2018, p. 8) observe of climate vulnerability in Aotearoa,

“just because people have a low ranking in the SocDep Index¹ does not necessarily mean they are more vulnerable to climate change impacts – they may have skills, knowledge, and networks that provide resilience which others lack.”

This assertion correlates with qualitative research into hazard and climate vulnerability and response amongst groups in Aotearoa that have traditionally been framed as highly vulnerable.

Some research emphasises the strengths or capacities that otherwise vulnerable groups possess. For instance, many Māori households experience ongoing marginalisation, high rates of deprivation, and exposure to climate hazards (Carter, 2018; King et al., 2010; Rua et al., 2019), yet research shows that Māori social structures, knowledge, values, and practices enable coping and adaptation during sudden-onset disasters like earthquakes, coastal flooding, and volcanic explosions as well as slower-onset climatic change, including in coastal locations (Kenney et al., 2015; King et al., 2013; Pardo et al., 2015; Proctor, 2013). Similarly, while recent migrants may face linguistic, socio-economic, and cultural barriers that increase their vulnerability to hazards, they may also possess specialist knowledge about hazard adaptation gained in their home community, or high levels of personal resilience that enables coping during hazard-induced emergencies (Uekusa et al., 2022).

Additionally, there is evidence demonstrating internal variation within ‘vulnerable’ groups’ experiences of climate vulnerability, owing to the intersection of different identity categories. Most of this research explores social contexts overseas (Djoudi et al., 2016; Erwin et al., 2021; Gonda, 2017; Lawson et al., 2019; Walker et al., 2021), however Johnson et al. (2022; 2023; 2023) examine diverse experiences of wāhine Māori in Te Tai Tokerau (Northland) in relation to climate impacts and adaptation. For example, some wāhine and their households experience greater vulnerability to water shortage during drought whilst others are better able to adapt because of different levels of income, savings, and education, their physical location, household size, and health status (Johnson et al., 2022).

There is thus a potential disconnect between the conclusions indicators may draw about community/regional vulnerability, and what is actually the case in reality. This may have implications for the validity of adaptation policy developed based on indicator results alone.

Any organisation applying existing indicator sets should be fully aware of the limitations of the indicators they are applying and work to offset any of the weaknesses.

¹ The Social Deprivation Index, originally developed for the UK context by Forrest and Gordon (1995). Aotearoa-based equivalents include the NZDep and IMD.

6. Enhancing Aotearoa's social vulnerability indicators to support robust and inclusive adaptation at the coast

Coastal communities around Aotearoa increasingly experience climate-related hazards including erosion, inundation, fluvial and pluvial flooding, cyclones, and storms (Ministry for the Environment, 2021b, 2023). Current social vulnerability indicators do have the potential to provide useful information to support decisions about adaptation at the coast. However, if adaptation policy is to reduce vulnerability for those most at risk in nuanced and appropriate ways (including avoiding locking in or exacerbating inequities (Bell et al., 2017; Lawrence et al., 2018)), indicators will need to be enhanced.

Indicators will need to provide a more robust and accurate portrayal of the areas most vulnerable to the impacts of coastal climate change, and the reasons why. Accuracy could be enhanced by building in greater consideration for dynamic influences on vulnerability and developing methods to engage with diversity of experience within communities, including attending to people's adaptive capacities. It is likely that pursuing these two avenues will also result in more comprehensive sets of social vulnerability indicators, thus helping to offset current limits on understanding that arise from considering only a small range of indicators.

6.1 Greater emphasis on dynamism

Aotearoa's social vulnerability indicators and assessments could engage more thoroughly with the dynamic nature of vulnerability by integrating consideration for change through time and interactions between scales. There are a range of relevant international indicators that seek to understand vulnerability in coastal locations in light of interacting scales (Kashem et al., 2016; Meur-Férec et al., 2008; Tuccillo & Spielman, 2022) and social change over time (Boruff et al., 2005; Hardy & Hauer, 2018; Kirby et al., 2019; Manuel et al., 2015; NOAA Fisheries, n.d.; Su et al., 2015), and could provide a conceptual basis for local iterations.

Instead of using a static model of human systems and a dynamic model of physical change, it is possible to use an approach that combines changes in both systems. Examples include;

- 1) Hardy and Hauer's indicator for social vulnerability to sea-level rise in coastal Georgia (2018). This combines sea-level rise projections and population projections for socially vulnerable populations. The indicator reveals that, when compared with existing indicators, there will be many more socially vulnerable people exposed to sea-level rise and associated hazards in the region.
- 2) Kashem et al.'s (2016) work on vulnerability at the neighbourhood scale in coastal cities in the USA. Kashem et al. consider how the demographic composition of particular neighbourhoods has changed over time, and become home to socially vulnerable populations. This is due to interacting local, regional, and global influences (such as policy promoting development and services designed to attract retirees, and the increased need for cheap labour [provided by migrants] in an increasingly globalised world).
- 3) Meur-Férec et al. (2008) designed an indicator for measuring social vulnerability to coastal hazards in France that accounts for interacting social, economic, political, cultural, and psychological spheres over time. Indicators include pressure from real estate development, human recreational and economic activities increasing erosion, and factors mitigating risk from hazards (including policies, local initiatives, perception of risk, and remembrance of past hazards).

6.1.1 How might it be done?

Existing research on the dynamic forces that mediate social vulnerability to hazards and climate change around Aotearoa will be crucial in design and selection of indicators (King et al., 2012; Lawrence et al., 2022; Uekusa et al., 2022), as will ‘ground-truthing’ (checking or co-creating) indices with coastal communities to ensure relevance.

From a data standpoint, national wellbeing indicators maintained by Stats NZ (Ngā Tūtohu Aotearoa (2022) and The Treasury (the Living Standards Framework (2022) are one potential source of data that could be harnessed to develop dynamic frameworks similar to the international examples mentioned above. These indicators contain measures that could demonstrate interaction between local, regional, and global scales, and changes over time that are relevant to local or regional experiences of vulnerability. For instance, Ngā Tūtohu Aotearoa contains relevant quantitative measures of population dynamics (including geographical distribution of total population by regional council area and net migration to Aotearoa) that are updated more frequently than the census (annually and even monthly). Pairing these with local population statistics available from Stats NZ (2024) and developing a systematic way to track the changing distribution of vulnerable groups in indices at a regional or local scale could help drive forward more dynamic understandings of vulnerability.

Key questions to ask of experts and affected communities:

What other social trends are relevant that can or should be tracked?

What data can be obtained and monitored for changes?

What social changes impact on vulnerability?

Another way for indicators to better capture the dynamic nature of social vulnerability is through evaluating the effects of adaptation policy and actions on society. Some international vulnerability indices include measures of adaptation policy as an indicator of reducing vulnerability over time (Birkmann et al., 2013; Meur-Férec et al., 2008). Whilst adaptation policy may reduce vulnerability, it may also inadvertently increase vulnerability (Magnan et al., 2016; Schipper, 2020) through producing unintended negative consequences (Barnett & O’Neill, 2010; Glover & Granberg, 2021; Johnson, Parsons, et al., 2023). It is this capacity for adaptation policy to compound or even create new inequities amongst social groups that is key to a more dynamic assessment of vulnerability.

There are currently few attempts to measure, evaluate and analyse the efficacy and equity of adaptation decisions and policies as they relate to vulnerable populations in Aotearoa (Burgess & Chakraborty, 2023). However, local governments and other organisations throughout Aotearoa are increasingly employing a dynamic approach to climate adaptation that is based upon evaluation and monitoring and retains the flexibility to pursue different adaptation pathways to fit the uncertain and changing nature of climate risk and vulnerability (Allison et al., 2023; Bell et al., 2017; Lawrence et al., 2018).

Key questions to ask of experts and affected communities:

What are the social impacts of adaptation policy and actions?

What data can be obtained and monitored for impact?

6.2 Engaging with diversity and adaptive capacities

Capturing the diversity of experience within communities and attending to people's adaptive capacities and strengths is another important factor in enhancing the accuracy of Aotearoa's social vulnerability indicators and assessments and moving beyond their current deficit focus. Again, there are a range of innovative approaches in use overseas that could provide relevant insights and be adapted for use in Aotearoa.

- 1) A suite of international indicators consider adaptive capacities alongside vulnerability-enhancing characteristics. Some indices, for instance, feature both a vulnerability index and a resilience or adaptive capacities index (Bergstrand et al., 2015; Su et al., 2015; Wu et al., 2016). Bergstrand et al.'s coupled social vulnerability and community resilience indicators (2015) integrates social vulnerability and community resilience. Whilst their findings in the USA corroborate a general correlation between high vulnerability and low resilience, they also find evidence that some of the most socially vulnerable US counties actually have relatively high levels of resilience (mostly because of high social capital).
- 2) Other frameworks for assessing vulnerability contain indicators that both enhance and reduce vulnerability in the same suite (Birkmann et al., 2013; Pacific Community (SPC) et al., 2016; United Nations Children's Fund (UNICEF), 2021). The MOVE framework (developed and mostly applied in a European context) combines a focus on "lack of resilience" (limitations to mobilising or accessing resources to cope and recover); "adaptation/adaptive capacities" (the ability to learn, reorganise, and change practices in light of hazards, and therefore reduce vulnerability); and "risk governance" (decisions/actions taken by government or households to prevent, prepare for and manage disasters) (Birkmann et al., 2013).

Similarly, SPREP's Integrated Vulnerability Assessment (Pacific Community (SPC) et al., 2016) is an indicator-based tool that aids communities to evaluate their resilience to climate change and disasters. As well as considering factors that enhance exposure to climatic threats (geographic, demographic, local development and land use trends), indicators for vulnerability also assess the capacity and sensitivity of livelihood assets, and the adaptive and risk reduction capacity of institutions. This includes having access to sufficient natural assets (water, land, etc), infrastructural assets (housing, health services, education etc), financial assets (diversity of income, credit schemes, etc), and human assets (skills, knowledge, etc) to support and sustain livelihoods, and the ability of institutions to facilitate collective action towards adaptation/risk reduction, amongst other factors.

- 3) A further way to examine the diversity of experience with climate change in communities is by examining the interaction of social characteristics, and how this determines vulnerability. Atyia Martin's Social Determinants of Vulnerability Framework is a useful example that examines how intersecting social categories elevate vulnerability to coastal hazards in Boston, USA (Atyia Martin, 2015). This framework moves beyond monolithic portrayals of vulnerable groups and acknowledges diverse experiences of vulnerability within Boston communities through examining how social characteristics

cluster and intersect to produce (or offset) social vulnerability. Very few other indicators take this approach (; Tuccillo & Spielman, 2022)

The Social Determinants of Vulnerability Framework comprises a range of social identifiers (e.g. older age, social isolation, etc) and circumstances (e.g. illness, loss of employment, domestic violence) known to contribute to elevated vulnerability (Atyia Martin, 2015). Whilst the framework still aligns with the deficit focus and does not consider adaptive capacities, the point of difference is the way that vulnerability is conceptualised. The framework operates through link or network analysis and shows how social identifiers and circumstances coalesce to produce differential vulnerability across the city of Boston. Rather than treating a social category or identifier as elevating vulnerability in all cases, the framework shows how inter-relationships work to compound vulnerability. For example, the framework identifies vulnerability-enhancing linkages between gender, housing tenure, transportation access and health status. Consequentially, the analysis found that several neighbourhoods of Boston were more vulnerable to coastal hazards because they had a higher proportion of residents that were female renters with no car and an underlying health condition. This framing of vulnerability departs from normative approaches whereby being a renter alone is automatically considered to elevate vulnerability.

6.2.1 How might it be done in Aotearoa?

Although international frameworks can be helpful in expanding the focus of social vulnerability indicators and assessments in Aotearoa, it is vital that indicators seeking to consider diversity and measure adaptive capacities are tailored to the Aotearoa context. This can be achieved through drawing on relevant local place specific research (outlined above in section 5.2), nationally available measures of resilience, and ground truthing with communities. However, it is worth noting that ground-truthing vulnerability with communities may be more difficult if they have no current experience of the issue/hazard.

Frameworks for measuring wellbeing and resilience in Aotearoa (such as the LSF and New Zealand Resilience Index) contain useful indicators of strengths and capacities social groups may draw on to offset their vulnerability to climate change. For example, the LSF indicator “social support network” is a measure of the percentage of adults who report they have friends or relatives they can count on in times of trouble. Friends, relatives, and other social connections are known to enhance coping and adaptive capacity during emergencies such as wildfire and flood, as well as slower-onset climate hazards, as they may provide emotional support, a safe place to stay if evacuation is necessary, and may enable access to resources or opportunities to respond and adapt to new circumstances (Omolo & Mafongoya, 2019; Parsons et al., 2018). Likewise, Ngā Tūtohu Aotearoa contains the indicator “sense of control” which is a self-reported measure of the extent to which people over 15 feel they have control over their lives. Having some feeling of being in control of one’s life (i.e. agency) can help offset vulnerability, by enabling the individual/household to plan for how they will respond to, cope with, and adapt to climate-related hazards (Babcicky & Seebauer, 2021; Rao et al., 2019).

Key questions to ask experts and communities

What other factors affect vulnerability and enable adaptation, and how and when do these operate?

How can information on the relevant factors be gathered, described and monitored?

What changes in the other factors could occur over time?

New and emerging ideas include integrating personas (or fictional characters) into vulnerability assessment. Personas can be used to build in consideration of people's adaptive capacities and better account for the interactive, diverse nature of vulnerability within communities (in a similar manner to Atyia Martin's framework above). Personas are often employed in market research to explore the needs, desires, and experiences of potential users of a specific product or service (Pruitt, 2010). Although not widely utilised in climate research or vulnerability analysis (Morrison & Chisin, 2017), there is some evidence to suggest that personas have a role to play in highlighting the diverse experiences of climate change that exist in communities (Blackett et al., 2019; Davies et al., 2023).

Novel research is underway to create a series of personas that represent a cross-section of social groups found within Aotearoa's communities, and to model the personas' vulnerability to a variety of climate scenarios in an agent-based model (Johnson, Blackett, et al., 2023). Each persona is comprised of a unique combination of social/demographic identity-markers (such as ethnicity, mobility/health status, socioeconomic status, access to social networks, occupation, access to local/practical knowledge) which mediate varied degrees of sensitivity to hazards, and different capacities to respond and adapt.

Although current approaches to social vulnerability have limitations, they are still useful, provided the limitations can be managed or are clearly listed. Key to the evolution of social vulnerability indicators is the consideration of both dynamism and diversity in vulnerability assessment. Each is an essential step in developing adaptation policy that is fit for purpose, sustainable, robust, and fair.

To date, there are a number of useful ways for practitioners to progress more complex conceptualisations of social vulnerability. However, it is clear that climate change related social vulnerability assessments are an evolving field with more nuanced approaches beginning to emerge.

6.3 Choosing a social vulnerability assessment method

It is clear from the proceeding sections that social vulnerability assessments are more complex than they first appear. When applying a social vulnerability assessment practitioners can consider:

- 1) What hazard or climate driver is of concern. Different hazards may require different approaches.
- 2) What of the existing examples (internationally and in Aotearoa) best aligns with that they are trying to achieve. For example, is the purpose of the assessment to identify "hot spots" for further investigation, or it to understand social vulnerability at a community scale?

- 3) The types of data that can be accessed to inform the indicators, and importantly what is missing. Is the missing data critical and do these data gaps weaken the chosen method?
- 4) What are the weaknesses of the chosen approach and how can they be mitigated? Can dynamic elements be added?
- 5) Is community ground-truthing helpful? Does the community have any experience of this hazard or the climate driver in question?

7. Conclusions

The current suite of social vulnerability indicators have evolved from a small number of core approaches. They are typically numerical approaches applied across a wide geographical area. Nuance, dynamism and diversity of the ways in which vulnerability can be experienced are usually lost in these core approaches.

The current indicators are useful, but have some limitations that practitioners can mitigate through incorporating additional questions to extend the approaches.

New approaches that take greater account of adaptive capacity and the dynamic nature of social vulnerability are evolving. It remains an active area of research and experimentation, both nationally and internationally.

Anyone applying a social vulnerability assessment process can consider various ways to improve current practice, by reflecting on how to manage the challenges of the current methods.

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