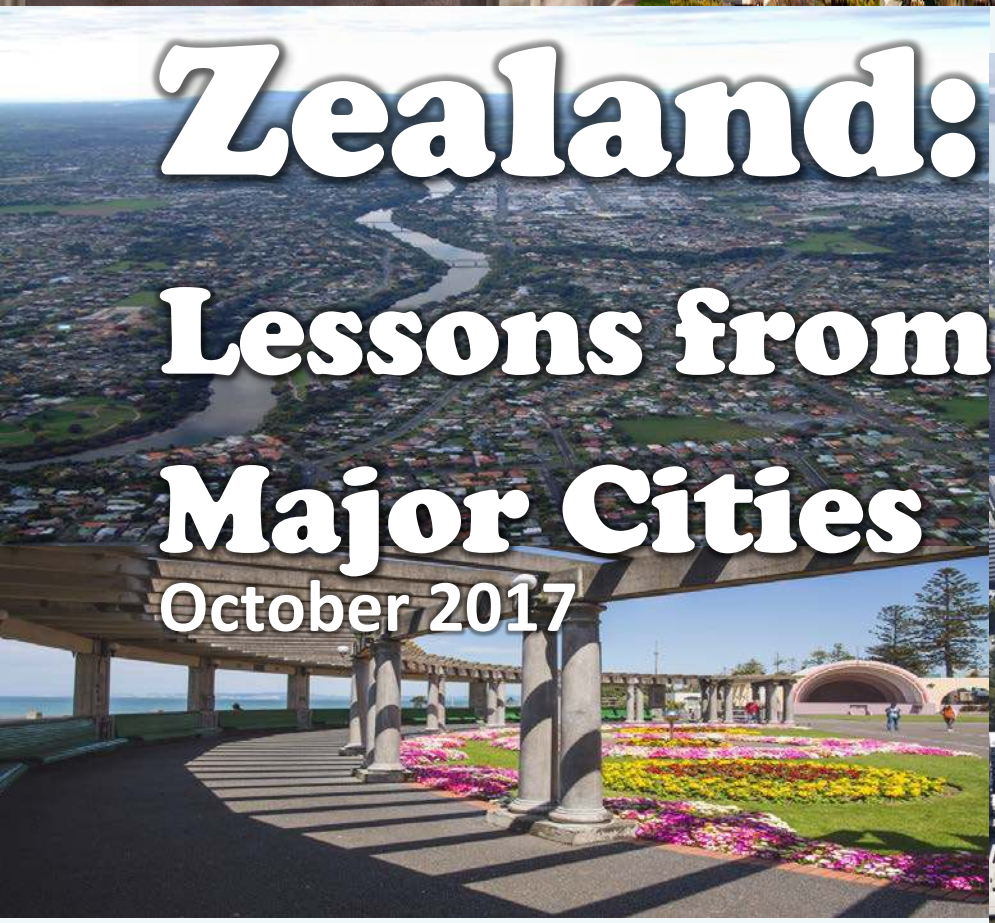
National SCIENCE Challenges
RESILIENCE TO NATURE'S CHALLENGES
Kia manawaroa – Ngā Ākina o Te Ao Tūroa

Building Urban Resilience in New Zealand:

Lessons from our Major Cities

October 2017



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Foreword

The last few years have reminded us that New Zealand and New Zealanders are exposed to relatively high risks from natural hazards. Our earthquakes, floods, landslides, droughts and fires have featured strongly in news headlines both nationally and internationally. This report is part of a science research project funded by the New Zealand Government under the Ministry of Business, Innovation and Employment National Science Challenges programme to improve New Zealand's resilience to such hazards.

The Resilience to Nature's Challenges Research Project, or RNC, includes four main study areas; Urban, Rural, Edge (areas subject to sea level rise) and Māori, and this report is the first main report from the Urban section. Resilience is a broad concept, and includes preparations to reduce the impact of a hazard and increase the ability to return to normal economic and social functionality as soon as possible with minimum of disruption and cost. It is broader than building stronger infrastructure and emergency management.

This report assesses the resilience status and current planning in each of our 7 largest cities. While RNC work to date does not include specific recommendations for each city, it provides a good level basis for comparison, identification of gaps, the ability for each city to compare their plans with others and the potential for cooperation.

By distributing the report to the relevant councils, the Ministry of Civil Defence and Emergency Management (MCDEM) and other interested parties such as lifelines and civil defence groups it is hoped to assist the good work each is currently undertaking.

In the next phase of RNC it is intended to develop a system for collaboration and knowledge sharing amongst cities, and a number of methodologies, termed toolboxes, to assist the resilience planning in New Zealand cities. Toolboxes include economic and hazard assessment, governance and cultural aspects, and infrastructure improvement.

Finally, I would like to thank all those people from the councils, civil defence groups and MCDEM for their willing participation in the research and writing of this report.

Ian Fraser
Chair, Governance Group, Resilience to Nature's Challenges Research Programme.

Executive Summary

Improving the resilience of New Zealand's cities is a national priority.

The Ministry of Civil Defence and Emergency Management is developing its National Disaster Resilience Strategy, and the Ministry of Business Innovation and Employment has launched the Resilience to Nature's Challenges (RNC) National Science Challenge, which is a collaborative national research effort to understand and strengthen the country's response resilience challenges.

This report has been produced under the RNC's Urban Toolbox Programme to evaluate the current state of resilience of New Zealand's seven biggest cities: Auckland, Wellington, Christchurch, Hamilton, Tauranga, Napier and Dunedin. The report involved experts and key stakeholders from local councils, civil defence groups, lifelines groups, academic institutions, and private organisations, and presents firsthand information on each city's resilience strengths, gaps, challenges, and future directions to improve resilience.

Auckland, New Zealand's biggest city, faces many challenges from natural hazards as well as stresses and strains such as population growth, housing shortage, homelessness and traffic congestion. With the fast-changing community dynamics in Auckland such as increasing diversity, heterogeneity within communities, and increasing number of homeless citizens, an in-depth understanding of its communities is necessary to build resilience. Auckland's infrastructure networks are vast, and there is a good understanding of critical infrastructure and key infrastructure convergence points due to the extensive work done by the Auckland Lifelines Group. There is more research planned for the future to understand effects from less known hazards such as volcanic ash fall, impacts of infrastructure disruptions outside the Auckland region, and how best to balance maximum efficiency and redundancy in infrastructure networks. There is also work ongoing to understand the economic impacts of disasters. The Auckland Council (AC) has made a commitment to improve the city's resilience and become the "world's most livable city". The Auckland Plan and the Auckland Civil Defence and Emergency Management five-year strategy, "Resilient Auckland" are providing a clear strategic direction to work towards these goals. Auckland Council is currently conducting city's resilience assessments using United Nations International Strategy for Disaster Reduction (UNISDR) tools in partnership with the University of Auckland to measure its current state of resilience and identify areas for improvement.

Wellington is a member of the international Rockefeller Foundation 100 Resilient Cities Network (100 RC), and has already been through a thorough process to conduct resilience assessments and identify the city's challenges using the Rockefeller City Resilience Framework (CRF). Wellington's resilience-building is guided by the Wellington Resilience Strategy developed as part of the 100 RC. The strategy sets out three goals, ten programmes and 30 focus areas in response to the city's resilience challenges around its transforming society, high earthquake risks, and sea-level rise. Community resilience-building in Wellington addresses household resilience, reducing homelessness, preparing for an aging population, supporting small businesses and developing community cohesion. Economic resilience considers assessing the viability of economic hubs outside the central city, business continuity planning and understanding workforce trends. Infrastructure resilience in Wellington focuses on dry and safe homes, insurance literacy, access to water services, and improving the flexibility, robustness and resilience of transport and energy services. Gearing Wellington's governance structures towards resilience through assessing the adequacy of its regulatory tools, reviewing the Wellington Lifelines Group and maintaining monitoring and evaluation of resilience goals is also proposed in the Strategy.

Christchurch is also a member of the 100 RC and have developed the Resilient Greater Christchurch Plan as the city's resilience strategy. The Plan sets four goals and 11 programmes around connecting people, community participation, helping the city prosper, and improving understanding of risk, following resilience assessments using the Rockefeller CRF. Christchurch's main hazard risks include flooding, seismicity and tsunamis. The city also faces stresses from climate change, changing demographics, affordable housing and social equity. The Canterbury Earthquakes were a catalyst in changing the communities and culture in Christchurch. The importance of social networks and strong neighbourhoods was understood. The economics and industry profiles altered as businesses relocated from the CBD or closed down. As a result of the rebuild, construction became the top industry. The rebuild included an extensive rebuild of infrastructure, which provided the opportunity to improve the resilience of critical assets, infrastructure networks and the built environment. The Plan sets out that a meaningful Treaty partnership with Ngāi Tahu and consistency

and collaboration across all tiers of government are essential to support resilience-building in Christchurch.

Hamilton does not have a city-level resilience strategy, but has resilience strategies in place for individual council units such as the three water networks and transport. The Hamilton City Council (HCC) has conducted a resilience assessment using the UNISDR Local Governments Self-Assessment Tool. The city's hazards include flooding and liquefaction, along with vulnerabilities resulting from relying on a single water source for water and electricity, and stresses from its high unemployment rate, population growth and climate change. HCC identified that there is a gap in understanding and building community resilience in Hamilton, but are working with communities to build community relationships across the city. There is also no evidence of consideration given to the economic impacts of disasters, and therefore investment is needed to develop an economic framework for the city. Infrastructure resilience is dependent on the ability to connect the eastern and western parts of the city that lie on either side of the Waikato River. HCC has signed the Local Government Leaders Climate Change Declaration, and has adopted eleven Sustainability Principles as an overarching guide for the city. HCC undertook their contribution to this report as an opportunity to self-evaluate their resilience processes and identify gaps and challenges. Their findings have led them to understand the importance of formalizing resilience-building and are beginning to have discussions on how these can be incorporated into Council operations.

Tauranga's resilience vision has been led by the previous Bay of Plenty Civil Defence Emergency Management Group Plan, which addressed resilience-building under the 4Rs (reduction, readiness, response, recovery) and monitoring and evaluation. The Tauranga City Council (TCC) has now begun to have formal resilience discussions and is in the process of developing a city-level Resilience Strategy. Tauranga's priority hazards are flooding and coastal storms, with some anticipated stresses and strains from population growth, aging population, isolated populations, and concentration of economic activities in certain areas. Tauranga has well-developed, publically available hazard information, and the Bay of Plenty Civil Defence Emergency Management group work closely with communities to build resilience through education on hazards awareness and promoting household preparedness. TCC also supports community cohesion projects for resilience-building. The Bay of Plenty Lifelines Group and TCC have been working on infrastructure resilience, in particular against climate change, and maintenance of assets. The Bay of Plenty Economic Growth Strategy sets out the region's vision for economic development but TCC highlighted that the economic effects of disasters need better understanding.

Similar to Tauranga, Napier's resilience vision is also set by its regional CDEM group. Hawke's Bay CDEM's focus is to develop "a resilient Hawke's Bay Community" built around the 4Rs. Napier's most devastating hazard risk is from earthquakes and tsunami, followed by volcanic ash, human pandemic (which poses a risk for the other cities as well), flooding and stormwater. The city's populations are vulnerable due to the majority of people living on flood plains and Napier being situated below sea-level. Stresses include aging population, below-average family incomes, population changes, variable levels of community preparedness to disasters, and the high number of tourists visiting from cruise ships. The CDEM group works with communities to engage people, provide public education, and connect communities to build resilience. Napier's economy is integrated with Hastings, therefore economic resilience requires a regional focus. The Matariki-Hawke's Bay Regional Economic Development Strategy and Action Plan sets out core objectives for economic development, but better of understanding of economic impacts of disasters can assist in building economic resilience. Napier City Council's Long Term Plan includes an Infrastructure Strategy which includes infrastructure resilience as a key component. Resilience is proposed through active participation in civil defence planning and activities, regular investigations of options for system redundancy, identification of critical assets, and insurance. The governance systems in Napier support resilience, but developing a city-wide resilience strategy with multi-stakeholder input is suggested for the future.

Resilience in Dunedin has been incorporated in a number of strategies developed by the City Council, but the city does not have a formal city-wide resilience strategy or resilience measurement at the moment. Dunedin's hazards include floods, earthquakes, severe weather, tsunami, storm surge and rural fire, and climate change. There are currently no identified significant stresses and strains affecting the city. Community preparedness for disaster events varies between neighbourhoods. Dunedin's Social Wellbeing Strategy promotes community resilience, while the Otago CDEM group works with communities to develop community resilience plans. Dunedin has economic advantages from its academic institutions, growing pool of high-tech enterprises and talent, high quality amenities and lifestyle. Dunedin's Economic Development Strategy has set out a plan to overcome the city's identified economic challenges

over the next decade. The strategy focuses on building up the city's economic viability, but does not specifically address disaster resilience. Dunedin City Council's long term planning has flagged climate change as a critical consideration, and therefore infrastructure planning takes this into account. The Otago Lifelines Project has worked on addressing criticality of infrastructure network components and interdependencies. Otago civil defence underwent a recent re-structuring to form Emergency Management Otago, which is taking steps to develop a consistent approach to resilience-building in Dunedin and the Otago region as a whole.

This report serves as a learning document for understanding the resilience of New Zealand's major cities. Through knowledge sharing, the intent is to provide ideas of resilience practice across New Zealand. The document is the starting point for collaborative communication between cities as they work towards best resilience practices.

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Acronyms

100 RC	100 Resilient Cities
2GP	Second Generation District Plan
AC	Auckland Council
ACC	Accident Compensation Corporation
AMP	Activity Management Plan
Auckland CDEM	Auckland Civil Defence and Emergency Management Group
BCP	Business Continuity Plan
BERL	Business and Economic Research Limited
BOP	Bay of Plenty
BOP CDEM	Bay of Plenty Civil Defence Emergency Management Group
CBA	Cost-Benefit Analysis
CBD	Central Business District
CCC	Christchurch City Council
CCTV	Closed Circuit Television
CDEM/Civil Defence	Civil Defence Emergency Management
CDRRR	Centre for Disaster Resilience, Recovery and Reconstruction
CERA	Canterbury Earthquake Recovery Authority
CRF	City Resilience Framework
CRO	Chief Resilience Officer
DCC	Dunedin City Council
DHB	District Health Board
ECan	Environment Canterbury
EQC	Earthquake Commission
GDP	Gross Domestic Product
GIS	Geographic Information System
GNS	GNS Science
HB	Hawke's Bay
HB CDEM	Hawke's Bay Civil Defence Emergency Management Group
HB LASS	Hawke's Bay Local Authority Shared Services
HCC	Hamilton City Council
HFA	Hyogo Framework for Action
HPUDS	Heretaunga Plains Urban Development Strategy
ICT	Information and communications technology
IIMM	International Infrastructure Measurement Manual
LGSAT	Local Government Selft-Assessment Tool
LiDAR	Light Detection and Ranging
LIM	Land Informatino Memorandum
LUI	Local Urban Indicators
MBIE	Ministry of Business Innovation and Employment
MCDEM	Ministry of Civil Defence and Emergency Management
MERIT	Measuring the Economic Resilience of Infrastructure Tool
NCC	Napier City Council
NIWA	National Institute of Water and Atmospheric Research
NZTA	New Zealand Transport Agency
ORC	Otago Regional Council
Otago CDEM	Otago Civil Defence Emergency Management Group
RNC	Resilience to Nature's Challenges
SCADA	Supervisory Control and Data Acquisition
SCIRT	Stronger Christchurch Infrastructure Rebuild
SF	Sendai Framework
SH	State Highway
SME	Small to medium enterprises
TCC	Tauranga City Council

UDS	Urban Development Strategy
UN	United Nations
UNISDR	United Nations International Strategy for Disaster Reduction
WCC	Wellington City Council
WOF	Warrant of Fitness
WRC	Waikato Regional Council
WREMO	Wellington Region Emergency Management Office

Māori Terminology

Hapū	Community, a division of a Māori people
Iwi	A Māori community, tribe
Kaitiakitanga	Guardianship or management
Kaupapa	A principle, or policy
Manaakitanga	Hospitality
Marae	Communal or sacred place
Mātauranga Māori	Māori knowledge
Ngāi Tahu	Principle iwi of the southern region of New Zealand
Papatipu Rūnanga	Collective iwi consisting of Ngāi Tahu whanau groups
Pou	Pillars
Tangata Whenua	Māori people of a particular locality
Tikanga	Culture, custom, ethic, etiquette

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Introduction

A Resilient New Zealand

New Zealand is at an interesting point in time, having been faced with increasing natural hazards and stresses and strains from issues such as transportation, housing, urbanization and climate change, affecting its communities. With the commitment to the United Nations Sendai Framework for Disaster Risk Reduction 2015-2025[1] there is a drive to achieve a vision of resilience which focuses on managing, minimising and preparing for risks rather than managing disasters.

At a governance level, the Ministry of Civil Defence and Emergency Management (MCDEM) is striving towards "a Resilient New Zealand" with a national multi-stakeholder effort to review its current strategy and develop a new National Disaster Resilience Strategy[2] replacing the National Civil Defence Emergency Management Strategy[3].

The Resilience Challenge

The Resilience to Nature's Challenges National Science Challenge[4] or Resilience Challenge (RNC) funded by the Ministry of Business Innovation and Employment (MBIE) is one of the most ambitious initiatives undertaken to develop and apply new scientific solutions to transform New Zealand's resilience.

The RNC will build new knowledge and tools that underpin a broad-spectrum resilience in our unique rural, urban, coastal and Māori communities to natural hazards, including earthquakes, volcanoes, landslides, tsunami, weather, coastal and rural fire hazards. There is also special emphasis on extreme-risk sites – where multiple hazards combine to threaten community sustainability.

The RNC's overarching mission is to partner with multiple stakeholders to generate new co-created research solutions to inform how New Zealand will build a transformative pathway toward resilience.

RNC research has developed the following meta-definition for resilience[5]:
"The ability to absorb the effects of a disruptive event, minimize adverse impacts, respond effectively post-event, maintain or recover functionality, and adapt in a way that allows for learning and thriving, while mitigating the adverse impacts of future events".

The RNC currently operates under ten interdisciplinary programmes[6] (figure 1). The science is headlined by four "Co-Creation Laborotaries" where research users and stakeholders join with researchers to co-design and co-create resilience research solutions in the Urban, Rural, Edge, and Māori environments. The four Laboratories are supported by six "Resilience Toolboxes", programmes in which resilience-specific technical solutions will be developed and applied across the greatest priority areas of engagement represented by the Co-Creation Laboratory programmes.

The Urban Programme

This report was produced under the RNC's Urban Co-Creation Laboratory[5]. The mission of the Urban Laboratory is to integrate, implement and build onto the knowledge and tools created in the Resilience Toolboxes to enable cities in New Zealand to adapt and transform with urban change whilst building their resilience to natural hazards. This research reaches to the centre of the Resilient New Zealand vision by targeting solutions to our increasingly

[1] http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf
[2] http://www.civildefence.govt.nz/cdem-sector/national-disaster-resilience-strategy-development/#whyreview
[3] http://www.civildefence.govt.nz/assets/Uploads/publications/national-CDEM-strategy-2008.pdf
[4] https://resiliencechallenge.nz
[5] http://www.resorgs.org.nz/Publications/national-science-challenges-resilience-to-natures-challenges-short-term-project-working-paper-delivery-1.html
[6] See Chapter "National Resilience and The RNC" for more information.

urban population base and lifestyles. This Laboratory will provide the tools and strategies for our fast-growing and rapidly changing urban areas to thrive in the face of natural hazards, despite changing needs, populations and urban forms. There will be a particular focus on Auckland to address its unique challenges with Auckland being the fastest growing economic urban environment in New Zealand hosting more than 60% of New Zealand's growth over the next 30 years.

There are five projects within this programme[5]: Resilient Cities Network Development, Resilient Auckland Planning, Resilient Auckland Communities, Resilient Auckland Businesses, and Resilient Auckland Infrastructure.

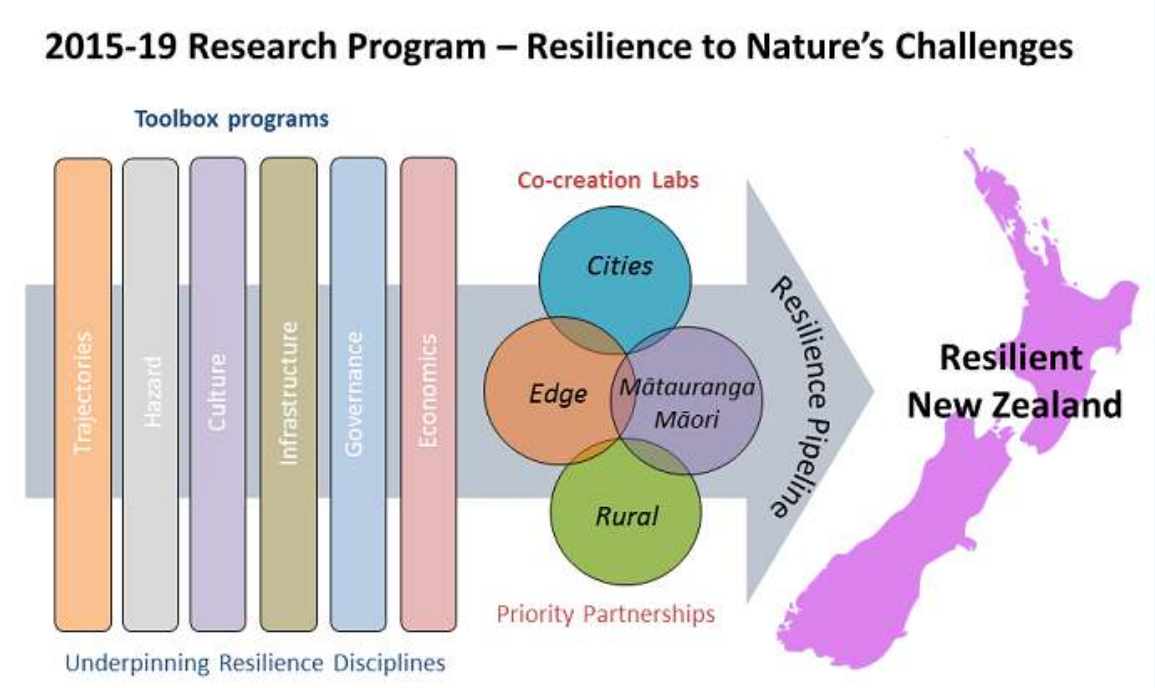

Figure 1: RNC Research Programmes

Resilient Cities Network Development Project

The "Resilient Cities Network Development" project aims to develop a consensus of solutions that will create resilient New Zealand cities and establish a network that includes and connects cities throughout New Zealand. Activities ongoing under this project include:

- Examining the current state of resilience of New Zealand's biggest urban cities and producing this report to publicize lessons and findings
- Developing a national city to city resilience network
- Assessing Auckland's resilience using the United Nations Office for Disaster Risk Reduction (UNISDR) Scorecard and New Local Urban Indicators (LUI) tools

About this Report

The aim of this report is to capture the current state of resilience of our biggest cities. This report addresses the current resilience activities, gaps, challenges and future directions of these seven cities in one collaborative document bringing together key information into one place. The intention of this report is to:

- Raise awareness on resilience amongst New Zealand cities, especially those that were a part of the report
- Highlight current strengths and weaknesses
- Promote learning and knowledge sharing between cities
- Identify key people involved in resilience to assist in developing a national resilience network
- Create a benchmark to track urban resilience progress over the coming years
- Identify knowledge gaps and challenges that the RNC could assist in

New Zealand's seven biggest cities by urban area and population were chosen to examine their current state of resilience (table 1).

Table 1: New Zealand's seven biggest cities (Source: Statistics NZ[7])

	Urban City	Population	Area (km^2)	Population Density ($people/km^2$)
1	Auckland	1,495,000	1,086	1,376.6
2	Wellington	405,000	444	912.2
3	Christchurch	389,700	608	641.0
4	Hamilton	230,000	877	262.3
5	Tauranga	134,400	178	755.1
6	Napier-Hastings	131,000	375	349.3
7	Dunedin	118,500	255	464.7

The RNC toolbox structure (figure 1) and the MCDEM national resilience structure (figure 2) were referred to determine the resilience areas from which information will be sought for the report. Upon consultation with the RNC toolbox leaders, it was agreed the following resilience areas were chosen for investigation in each city:

- Current Resilience Strategy – whether the city has a strategy for improving its resilience
- Resilience measurement – whether any tools are used to measure the city's resilience
- Shocks, stresses and strains – natural hazards and non-hazard related stresses and strains experienced by the city
- Hazards knowledge and awareness – the level of knowledge and awareness of the city's natural hazards
- Community resilience – the level of resilience and cohesion of the city's communities
- Infrastructure resilience – the resilience of key infrastructure assets and infrastructure networks in the city to withstand and recover from shocks, stresses and strains
- Governance for resilience – whether the governance systems that the city operates under (local and regional government and their legislation) assists in resilience-building in the city
- Economics of resilience – the resilience of the city's businesses and industries to withstand and recover from shocks, stresses and strains
- Future – the city's future direction towards resilience-building

[7]http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/SubnationalPopulationEstimates_HOTPAtJun16.aspx

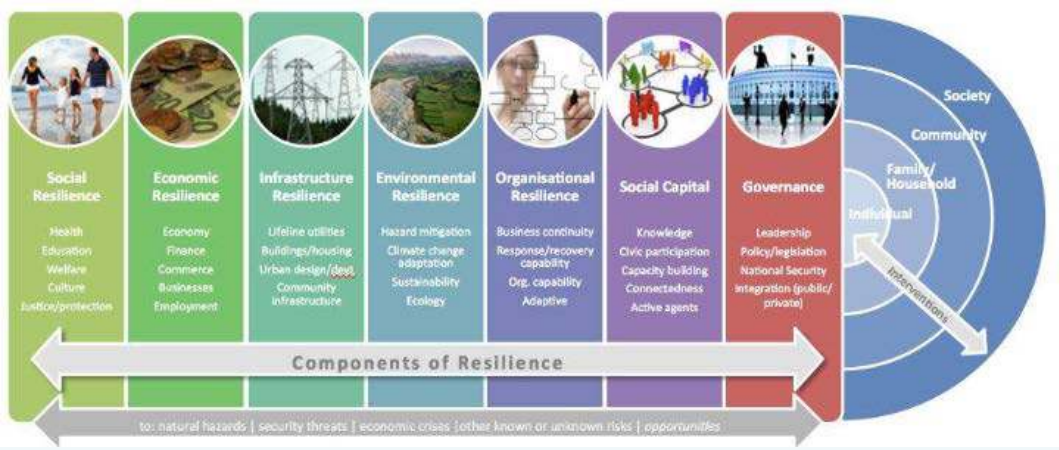

Figure 2: MCDEM National Resilience Framework (Source: Horrocks, 2014[8])

For each resilience area, simple guiding questions were designed to understand the current status of resilience, challenges, knowledge gaps, and suggestions and recommendations for the future. An extensive database of experts in each city from local councils, CDEM groups, academics and other sources were established and invited for this exercise.

Auckland, Hamilton and Dunedin cities were led by representatives from the Auckland Council, Hamilton City Council and Dunedin City Councils respectively who volunteered to coordinate the exercise. All three cities opted to collect written submissions from experts who are directly involved in the respective resilience areas addressed by the report within and outside of the Council. The written submissions were peer-reviewed by experts in collaboration with all authors.

Wellington and Christchurch are part of the Rockefeller Foundation's international 100 Resilient Cities Network (100 RC)[9]. Both cities underwent thorough resilience assessments and produced Resilience Strategies[10,11]. As advised by the Resilience Officers appointed for the two cities as part of the 100 RC, the resilience information for Wellington and Christchurch were obtained from the respective Resilience Strategies. The sections were peer-reviewed by the Resilience Officers, experts and practitioners from each city.

Resilience information for Tauranga and Napier were obtained through conducting in-person and telephone interviews with primarily City Council and regional civil defence group staff whose roles were in the areas identified in the report. The interviews were transcribed and written, after which they were peer-reviewed by all interviewees to ensure accuracy.

This report provides a unique look into how our biggest cities are working towards improved resilience in order to meet changing demands and thrive in the future. Auckland is committed to overcome its challenges, embrace its diversity and become a resilient city with strategic direction from the Auckland Plan[12] and the Auckland Civil Defence and Emergency Management five-year strategy, "Resilient Auckland"[13]. Wellington and Christchurch are making strides implementing their Resilience Strategies with support from the 100 Resilient Cities Network. Hamilton is evaluating its resilience gaps and challenges and making important decisions on how better resilience can be adopted for the future. Tauranga has started focused discussions around resilience and is taking steps towards developing a city-level resilience strategy. Napier is putting systems in place to improve the efficiency and effectiveness of the recently re-structured Napier City Council to contribute towards better resilience.

[8] Horrocks, J. (2014) Concept of National Resilience: DRAFT. Acting Manager Analysis & Planning, Principal Advisor Emergency Management, Ministry of Civil Defence & Emergency Management. Personal Communication May 8, 2015.
[9] http://www.100resilientcities.org/#/-_/
[10] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy
[11] http://www.100resilientcities.org/strategies/city/greater-christchurch#/-_/
[12]http://www.aucklandcouncil.govt.nz/EN/planspoliciesprojects/plansstrategies/theaucklandplan/Pages/theaucklandplan.aspx?utm_source=shorturl&utm_medium=print&utm_campaign=Auckland%2BPlan
[13] http://www.aucklandcivildefence.org.nz/about-us/our-group-plan-2016-2021/

Dunedin and the Otago region as a whole are also moving towards developing a consistent approach to building resilience with the restructuring of Otago CDEM[14] last year.

The core purpose of this report is to bring the conversation about resilience to the forefront and give our cities the opportunities to self-evaluate, learn from each other and work together to become stronger and more resilient.

[14] http://www.otagocdem.govt.nz/media-releases-and-news/2016/october/new-structure-strengthens-otago-civil-defence

Auckland

Current Resilience Strategy

Auckland Council has embraced 'resilience' as a core kaupapa (principle) guiding the work that the organisation does, how it works with partners and stakeholders, and engages with communities. The approach to integrating this principle is holistic and multi-faceted. It is driven at a strategic level in various plans and strategies, and at an operational level by a network of resilience champions working across the organisation and with communities to embed resilience into everything the city does.

Auckland's approach to resilience is framed by three United Nations agreements which all have critical actions that build qualities of resilience:

- *Sustainable Development Goals*: promoting economic growth concurrently with addressing social needs (such as education, health and job opportunities), climate change and supporting environmental protection;
- *Paris Climate Agreement*: reducing greenhouse gases, increasing sustainability and adapting to climate change impacts; and
- *Sendai Framework*: reducing disaster risk and losses in lives, livelihoods and health, and losses across the natural, economic, social and cultural environments.

Guided by these United Nations frameworks, Auckland has developed its own suite of resilience strategies:

The Auckland Plan is the guiding document for the city for the next 30 years. It sets Auckland's vision, high level objectives and describes actions to be taken to achieve that vision. The plan is currently undergoing a refresh, with 'resilience' now a key guiding principle to the plan. The plan acts as an integrated, cross-functional approach to building resilience across the four 'pou'(pillars): built, economic, social and natural, with emphasis on their interconnectedness.

The Development Strategy provides direction for Auckland's growth and development over the next 30 years. This contributes to achieving a well-functioning Auckland to improve the overall quality of life for people and communities. Implemented through the statutory Unitary Plan, The Development Strategy balances growth and intensification with other considerations of resilient cities, such as sustainability and environmental protection, infrastructure, accessibility and connectivity.

The Auckland Civil Defence and Emergency Management Group Plan places resilience at the center of everything the CDEM Group does. It highlights the role of communities and outlines specific actions being taken towards building resilience in Auckland.

The Auckland Council Community Empowerment Approach to building empowered communities informs a multitude of community resilience building activities across Auckland.

Auckland's approach to building resilience is truly multi-faceted. Some facets are well advanced, embedded and broadly understood and supported. Some, like the community empowerment approach to building resilience from the grassroots, are still in their infancy. To help the city better understand where it needs to further improve, Auckland CDEM is currently undertaking an assessment of Auckland's resilience using the United Nations International Strategy for Disaster Reduction (UNISDR) Local Urban Indicators Tool; the results of which will be used to inform strategy and delivery into the future.

Resilience Measurement

While building resilience in Auckland, it is important to measure progress. Firstly, measurement shows where the gaps, weaknesses, and strengths currently exist and secondly, it provides a baseline to monitor and keep track of progress. Auckland CDEM has the primary responsibility for assessing Auckland's resilience.

Auckland CDEM regularly conducts research into resilience to assess its various aspects using a variety of methods as well as making use of national benchmarking frameworks. In recent months Auckland CDEM, in collaboration with The University of Auckland and Centre for Disaster Resilience, Recovery, and Reconstruction (CDRRR), has been reviewing a number of assessment tools and frameworks to test their application and usability for use in Auckland.

Existing assessment tools for measuring resilience were evaluated on the basis of social, economic, environmental and infrastructure priorities. The assessment concluded that no one tool is perfect and so both the UNISDR Scorecard and New Local Urban Indicators (LUI) tools are being tested and developed to achieve the desired framework specific to Auckland. Both tools also enable Auckland to monitor its resilience in line with other cities globally for further collaboration.

The UNISDR Scorecard, developed by IBM and AECOM, is a single, comprehensive integrated tool that measures many different aspects of disaster resilience. It assesses and categorises the current status of disaster resilience by reviewing policy and planning, social and environmental, organisational, financial, infrastructural, and informational aspects. The Scorecard is designed in ten sections, based on the "Ten Essentials" of the Sendai Framework (2015-30) and developed for use at a local level. The Local Urban Indicator tool (LUI) was informed by learnings from the implementation of Local Government Self-Assessment Tool (LGSAT) and the Disaster Resilience Scorecard. This is a new assessment tool that has not released officially and Auckland has the privilege as one of the first cities to run it. This tool enables the city to capture a snapshot of 'how the city is doing' in relation to disaster resilience, allowing for actions to be developed to respond to gaps or weaknesses identified.

The Auckland CDEM Group has been working with the University of Auckland to run the LUI and Scorecard. Learnings from the development and application of these tools will soon be made available. In addition, Auckland CDEM conducts a quarterly council commissioned survey using best-practice methodology to gain an accurate understanding of Aucklanders' preparedness and community resilience in an emergency management context.

Shocks, Stresses and Strains

The Auckland 'super city' arose from the merger in 2010 of one regional Council and seven city and district Councils. Many aspects of Auckland are 'super' in size, but are pushing against the region's natural environmental limits and its economic and social boundaries. The Auckland region is 4,894km2, with approximately 70 per cent as rural land. Of this, 27 per cent is classified as elite and prime land, critical for food production and security. A lot has been lost due to urbanisation and rural fragmentation pressures. The remaining 30 per cent of urban area houses 90 per cent of Aucklanders.

Population is a significant stressor that is unique to Auckland. Currently 1.57 million people, one third of New Zealand's population, call Auckland home. They identify with over 200 different ethnic groups with currently more than 40 per cent born overseas.

Auckland is the economic powerhouse of New Zealand, with over one third of the national gross domestic product value derived from Auckland businesses. Auckland's vast infrastructure is critical to the functioning of its communities and economy. While Auckland is committed to maintaining and building resilient networks, lifeline failures still pose a significant risk to the region because of the potentially high consequences when major failures occur.

Auckland's natural environment is comprised of vast freshwater catchments and extensive coastal landscapes. These are regularly monitored but show signs of degradation due to human activity.

The region is susceptible to a wide variety of hazards. They range from rare events such as volcanic eruptions, earthquakes and tsunami, to more regular events, such as flooding, electricity outages and fire. The impact of climate change, sea level rise and Auckland's growth are likely to worsen the impact of specific disasters. This stress may increase the time it takes to recover from a disaster, and typically lead to more severe impacts.

What are the possible future trends of these shocks, stresses and strains?

Environmental impacts

The state of Auckland's natural ecosystems is degraded and development will add further pressure, affecting both quality of life and compromising the ecosystem services provided (including capacity to adapt to the impacts of climate change). How the natural environment is managed in the face of anticipated growth will be crucial in shaping the future of Auckland. There is a great opportunity to reduce greenhouse gas emissions as Auckland transforms from a fossil fuel-dependent, high energy-using, high-waste society to a mobile, quality, sustainable and compact city.

Social impacts
It is estimated that Auckland's population will grow by between 736,000 and 1,000,000 people by 2043, increasing the diversity and density of the region and adding further pressure to the natural environment in Auckland if not managed appropriately.

Income inequality has steadily risen in Auckland. The spatial and generational effects of this inequality are creating access, mobility, housing, infrastructure, employment and economic issues are already and may further deepen inequality and undermine the wellbeing of Auckland communities.

Economic Impacts
A significant proportion of Auckland's economy comprises small and medium sized manufacturing activity, particularly outside of the CBD. Greater automation due to changing technology and changing local/global needs for the goods manufactured will affect employment in these areas. A focus on economic diversification to ensure these employees have the skills to adapt to the future of work is therefore critical.

Examples of current risks in Auckland

Electricity and gas
The Auckland region has some of the highest load densities combined with relatively low levels of local generation in New Zealand. Most of Auckland's electricity is supplied via the transmission grid from south of the Bombay Hills. 30 per cent of electricity is generated inside the region mainly from Southdown and Otahuhu natural gas-fired power stations. Auckland's gas is supplied via high pressure gas transmission pipelines from the Pohokura and Maui Gas Fields and other fields in Taranaki. A major failure at certain key sites such as the Rotowaro compressor station may result in significant restriction of gas throughout the upper North Island. The two most critical gas delivery sites in Auckland are the Westfield and Papakura gate stations which act as points of supply in the region and feed the local downstream gas distribution networks.

Water services
Auckland's metropolitan water supply is supplied mostly from the Hunua dam, Waitākere dam and the Waikato River. The system holds one to two days' supply of treated water at average demand. Future regional growth and redundancy will be met by development of the Waikato water source. Failure of these watermains would cause widespread regional water outages or restrictions.

Transportation
Transportation in Auckland comprises of ports, airports, road and rail networks that are of national importance. The Ports of Auckland in the city and the smaller port at Onehunga are accountable for about a third of the region's economic activity. The Auckland airport is the gateway for around 75 per cent of New Zealand's overseas visitors with approximately 14 million passengers and 214,300 tonnes of freight passing through each year. Auckland's rail network is a single north-south trunk line with minor branches connecting to the city and the Port of Onehunga. Around 43,000 passengers commute by rail each day. The roading network is made up of state highways and local roads.

Fuel
Most of Auckland's fuel comes from the New Zealand refinery at Marsden Point via the refinery to Auckland pipeline. Petrol and diesel are then distributed from the Wiri oil depot, which stores between two and six days' supply of fuel for the region. Aviation fuel is sent to Auckland Airport through the Wiri to airport pipeline.

Infrastructure
Infrastructure outages may originate from failures within and outside the Auckland region. The potential for infrastructure failures is mitigated by building in redundancy into the infrastructure networks, but 100 per cent service reliability is neither affordable nor practicable and there will always be residual risk. Many millions of dollars are being invested into infrastructure to boost redundancy across all infrastructure providers including developments of multi modal options that increase the resilience of the Auckland transport network.

Hazard Knowledge and Awareness

Auckland has a good overall understanding of the range and types of hazards that occur within the region and some knowledge of the expected magnitude and duration of each hazard. What is less consistently understood is the likelihood and timing of some hazards. The city's understanding benefits from good regional LiDAR data; although this needs to be updated frequently. The following provides a summary of current hazards knowledge in Auckland. The risks and vulnerabilities from these hazards have not been discussed.

Volcanic Hazards - There is a general understanding of the nature of the main hazards likely to be associated with volcanic eruptions in Auckland. Significant uncertainty exists over warning times, where and when the next eruption will occur, and how the event will unfold.

Seismic Hazards - There is a good understanding of the national seismic hazard model, but the impact of local and regional fault structures including those in Hauraki and Port Waikato are less well known. Local velocity models, fault mapping/characterisation and liquefaction susceptibility knowledge needs to be improved and research is currently underway.

Tsunami - Distant and regional tsunami sources are well understood for Auckland's needs. Local sources are assumed relatively minor but needs further work to prove this. Ocean propagation information is good. Tsunami evacuation maps are based on empirically conservative models and need to move to probabilistic hydrodynamic models with better inundation modelling. Bathymetry data needs updating.

Coastal Inundation – Auckland has a regional understanding of coastal inundation based on static (bath-tub) inundation modelling for a range of scenarios including with sea level rise. This provides a sound understanding of inundation of Auckland's open coasts but more detailed hydrodynamic modelling is required for complex flood systems such as low lying estuaries. Uncertainty remains with the rate and timeframes for future sea-level rise. Present modelling considers 1m and 2m sea level rise.

Coastal Erosion - Auckland has a reasonable understanding of coastal erosion which considers the influence of 0.5m sea-level rise. Data is in tabular form to 2100 but has not yet been mapped. A probabilistic (Monte-Carlo) analysis is required. The relationship between coastal erosion and land instability is less well understood.

Land Instability - Auckland has a good understanding of the land instability process, there is lots of data available but it is not easily accessible or centrally located. EQC and GNS each have partial inventories of landslides. The impact of climate change on land instability is poorly understood. More detailed landslide inventories and susceptibility mapping are needed.

Drought – Auckland has a general awareness of drought and the role of climate change at a national level. Defining a common measure for drought is underway and this may lead to the development of hazard thresholds. There is limited understanding of the influence of climate change on drought at the local level. Climate records are short and only available for certain areas.

Fire – There is good understanding of fire behaviour and the influence of weather. Similarly to drought the effect of climate change and its relationship to fires is not well understood. Population growth and urban sprawl is leading to increased ignition sources and an increase in the rural urban interface which is putting more people at risk from wildfire. People are also tending to build in areas where there is more vegetation and so more research is required to understand the impact of this increasing risk.

Severe Winds - There is reasonable confidence in forecasting large weather systems which cause widespread severe winds. However, forecasting localised wind events, such as thunderstorms and tornadoes, remains challenging, with very short forecast lead times. There is an awareness of how climate change may affect large weather systems, but very little understanding of the potential impacts of severe winds, or how climate change may affect localised wind events.

Flooding – Auckland has predictive information on the effects of extreme event flooding for the entire Auckland region. The flood information covers floodplains, overland flow paths and areas at risk of flooding due to blockage. The rapid pace of land development makes reducing future flood risks a challenge. Predicting flooding is difficult due to the relatively small catchments and very little time between rain falling and houses flooding in an extreme event. Work is well advanced using rain radar and advection modelling to try and predict flooding.

Space hazards - Space hazards such as solar flares or meteor impacts are expected to have the same likelihood and consequences as elsewhere in the world, so no local studies have been undertaken. Work may be required to improve the city's resilience.

Compounding and cascading hazards – Compounding and cascading hazards are generally not well understood. The key challenges in identifying and assessing hazards in Auckland are the costs and funding associated with undertaking research and the lack of a national dataset repository. The current approach to assessing hazards is leading to research being undertaken without prioritisation for maximum benefit. Probabilistic impact assessments and mitigation strategies broadly need development to prioritise and parametrise hazards research most usefully. It is also important to note that hazards are not bound by city and therefore it is necessary to work more closely with neighbouring regions and nationally.

To improve the hazards knowledge in Auckland needs a coordinated long-term approach to hazard prioritisation and funding. Auckland CDEM is developing a 10 to support this. The partnerships between research institutions and end-users need to be strengthened and speak in a common language. This could be improved by developing and conforming to a common data standard for hazards.

Community Resilience

As one of the world's most ethnically diverse cities and with a population of 1.57 million (increasing by 3per cent per annum), Auckland faces particular challenges and opportunities in building resilient communities. Almost 40per cent of Aucklanders were born overseas, and the city harbours at least 200 ethnicities. Over the past thirty years, the percentage of Asian people has increased from 3.3per cent to 23.1per cent and is expected to rise to 30per cent by 2021. Auckland is also home to the largest Pasifika population in the world and to two thirds of the country's Māori population. The city's linguistic diversity is significant, with Chinese, Samoan and Hindi in the top five most spoken languages.

What kinds of opportunities does this cultural, ethnic and linguistic mega-diversity offer for fostering community resilience? At present, Auckland Council does not seem to have a clear overview of the state of community resilience to disasters in Auckland. Many communities get their sense of belonging through faith, culture, language or recreational and vocational activities, rather than just being place-based. Moreover, there are many qualities that contribute to a community's capacity to deal with a disaster and without being tested by a real event, this remains highly speculative.

The 2016 Kaikoura earthquake demonstrated how Māori communities assist those in need when a disaster strikes, demonstrating the core traditional value of manaakitanga. Kaikoura's Takahanga Marae provided food and shelter to hundreds of earthquake victims stranded in the tourist town. The Te Puea and Manurewa Marae in Auckland offered similar generosity and support in the winter months of 2016 when they opened their doors to hundreds of homeless citizens. In the 2011 Christchurch earthquake, Chinese Social Services reached out to their communities and individual citizens by providing counselling services and other resources. These examples provide valuable insights for Auckland CDEM about the levels of support and capacity available from within its communities to care for people in disaster events.

Many of Auckland's diverse populations are also equipped with experience in emergency management from overseas. For example, many Pasifika communities have first-hand experience with disaster prevention and management in their former homelands or have supported their relatives in the aftermath of disasters, e.g. after the 2009 Tsunami and 2012 Cyclone Evan in Sāmoa, the 2015 Cyclone Pam in Vanuatu or following the 2016 Cyclone Winston in Fiji. This unique expertise could be harnessed through participatory processes and partnerships with these communities and emergency services. These Pacific Island examples also provide valuable lessons of community support during a response such as the use of schools, churches, temples and community halls as shelters.

Linking into the groundswell of community support during a response and assisting with co-ordination or resources is an important aspect of a community spontaneously taking the lead in supporting itself during a formal response by emergency services. Auckland CDEM has the challenge of finding the best ways of reaching out to Auckland's diverse local communities to engage with them in ways that are culturally and linguistically appropriate across all areas of emergency management from awareness of hazards as well as during and after an event. This requires an in-depth understanding of these communities and their values as well as their strengths

and needs in emergency events. It is also important to understand each communities preferred media channels, (e.g. use of social media and favourite radio channels), as well as other significant modes to facilitate communication and information sharing during disasters.

Auckland needs to get a better grasp of the heterogeneity within certain communities. Auckland's African community, for instance, ranges from wealthy, mostly white South Africans at one end of the socio-economic spectrum to refugees from conflict countries, such as Somalia, Eritrea or the Democratic Republic of Congo at the other. It is likely that these groups would have different resilience strategies, previous experiences, vulnerabilities and needs when facing a disaster event.

In terms of understanding the levels of community resilience throughout Auckland, the needs of the most vulnerable communities should be better understood – e.g. the rising number of homeless citizens. There are also gaps in understanding and addressing the needs of disability communities. While these communities are often some of the most resilient and well-organised, there is a need for better mechanisms to be put in place in terms of communications with emergency services and appropriate provisions for support in a disaster event. There is potential for needs to be well catered for if emergency services co-ordinate well and work in a participatory and inclusive approach in close cooperation with social services, NGOs and faith-based organisations that commonly reach out to these communities.

A recent survey by Auckland CDEM found that 57 per cent of Aucklanders are prepared for a disaster event. While this is relatively high, any complacency in this area could be due to the fact that natural hazards are perceived to be less likely to happen when compared to other parts of New Zealand. Yet it may also be related to the widespread perception that other stressors, such as unaffordability of housing, transport, social and economic inequalities are considered more important and in isolation. However, in balancing out this challenge, it is important to note that a large and complex number of factors contribute to community resilience. Evidence from Japan, India, the US and Fiji shows that social cohesion is a pivotal factor in how well a community can get access to needed information, tools and assistance in a disaster event, which is crucial for a speedy recovery. Any on-going assessment of the state of community resilience throughout Auckland needs to take into account the many community-led initiatives all around Auckland which connect communities and build their resilience not just for emergency events.

Existing social networks can be further strengthened by the adoption of a 'no-regrets' or 'low-regrets' approach, where adaptation and prevention strategies are chosen given their net benefits to communities, even when disasters do not occur in the near future. The use of festivals, community-led events and public spaces as 'community learning spheres' can provide opportunities to not only heighten the awareness of climate change, hazards and risks, but also foster greater social cohesion within and across placed-based communities (e.g. suburbs, neighbourhoods), population-based communities (e.g. minority ethnic groups, rainbow communities) and communities of interest (e.g. faith-based groups, sports clubs). The more a community thrives and connects in everyday life, the better it is likely to do during and after a disaster event.

Infrastructure Resilience

Auckland has a good understanding of critical infrastructure resilience especially at points where infrastructure networks converge in potential natural hazard areas, and some understanding of the interdependencies of those networks. Most lifelines utilities have undertaken some assessment of resilience within their own particular network and the Auckland Lifelines Group members have undertaken an assessment of organisational resilience using the tool provided by the Ministry of Civil Defence and Emergency Management. It is not clear how well the sector understands interdependencies; the National Infrastructure Unit provides limited guidance on this in their 2015 National Infrastructure Plan, but it is clear that more work needs to be done in this area.

The national Civil Defence exercise Tangaroa in 2016 identified a challenge in terms of post-disaster knowledge of road network condition. At present, there is no 'real time' way of finding out which roads are currently closed or damaged other than state highways, and no way of easily sharing this information with lifeline utilities or their contractors. This means that access for repairs to other critical utilities cannot be taken for granted, or even planned for immediately post event. This may also influence lifelines and other critical services in terms of staff availability and getting generators and fuel to sites of power outage.

There are some gaps in data to help people understand the hazards they need to prepare for, particularly around ground risk. In response, Auckland Council has developed a 10 year research programme for natural hazards

across the region. Auckland Council is also undertaking the Natural Hazards Risk Management Action Plan to quantify the city's natural hazard risk and identify a series of targeted, prioritised actions. Funding is being sought for the 10 year research programme to increase base knowledge and to coordinate research efforts across organisations as much as possible.

Auckland is also vulnerable to critical infrastructure failures from other regions affecting fuel, power and potentially water. This is addressed in response plans, but a current gap is potentially the cross regional approach.

Once hazards are understood, there is sometimes an understanding gap in terms of what makes infrastructure resilient, and how to implement it. For example, there are gaps around the knowledge of volcanic ash impacts and how to plan for them, cascading failures across multiple lifelines, and the consequences of increased vulnerability caused by aging infrastructure in a densifying city. While some of these hazards may be well understood, there is a gap in embedding that knowledge into infrastructure standards and approaches.

As noted above, there is a challenge in relation to infrastructure effects outside the Auckland region, and how they affect its resilience. There is a strategic conflict between having networks working at maximum efficiency, and having some redundancy to allow for resilient responsiveness, because of the potential additional cost of resilience (redundancy). It is unclear whether the return on investment of resilience is understood fully by all of industry, including local and national government in New Zealand. There is often difficulty in agreeing priorities between decision makers due to the level of uncertainty around hazard events.

There is also a cost challenge in terms of having access to good data, and having real time data systems that work effectively across a range of entities, some of which may be in commercial competition with each other. Having a live data system that works cross-entity is also vital and efforts are ongoing to attract funding for this purpose.

As noted above, Auckland Council is producing data and guidance on technical standards which incorporate resilience. The data relies on having a common understanding of building resilience needed in Auckland, and what investment Auckland Council is prepared to make to create it. Auckland Lifelines Group has a range of recommendations for each hazard. The Natural Hazards Risk Management Action Plan and the CDEM Group Plan are the next steps to defining outcomes and priorities, but there will need to be ongoing support and investment across infrastructure utilities in response. This is a 'bottom up' action, which needs to be balanced at policy level with governance approaches to resilience and its cost. Having a cross-regional approach to lifelines and to supplier planning pre- and post-event would also be useful.

Governance for Resilience

Effective governance is critical to the initiatives that will make Auckland more resilient and, ultimately, more liveable. The Auckland Council model of local government helps meet both regional and local needs, and gives the city the resources it needs to grow and develop. Auckland Council has two complementary decision-making parts, the governing body and local boards. The governing body and the local boards are autonomous and make decisions within their respective areas of responsibility. Although they make different types of decisions, it is critical that there is an effective working relationship between the governing body and the local boards.

The Civil Defence Emergency Management Act 2002 requires two groups to be established to effectively manage Civil Defence matters. The CDEM Group Committee is comprised of governing body elected representatives and members from the Independent Māori Statutory Board, with observers from key CDEM partners and stakeholders responsible for providing strategic direction and leadership.

The second group, Auckland's Coordinating Executive Group, comprised of senior representatives from CDEM agencies, acts in an advisory role to the CDEM Group committee. The Coordinating Executive Group's responsibilities are to provide for the planning, coordination and implementation of CDEM in Auckland. Under a new structure implemented in 2017, Auckland's Coordinating Executive Group arrangements take into account Auckland's size, scale and complexities. The structure includes representatives from the transport, and economic/business sector to support improved planning, performance and accountability. In addition, Auckland CEG has created task groups across the different environments (built and lifelines, social and cultural and natural) to implement long-term integrated work programmes across the region.

Auckland's unique local government structure, comprising the Governing Body, the Independent Māori Statutory Board, local boards and advisory panels, is a significant resource for cross-region collaboration and local

consultation. These groups, particularly local boards, play an active role in working with Auckland's communities to better understand risk and build greater resilience.

To effectively manage risk reduction and cost, many partners are needed: city leaders and senior officials, local government representatives, infrastructure agencies, CDEM Group partners, business and insurance sectors, special interest groups and private enterprises to promote an all-of-society ownership of resilience. Outside of the statutory requirement of the CDEM Act, Auckland is advancing a platform of and for resilience champions to support risk reduction and increased resilience through collaboration, innovation and the delivery of responsive and sustainable resilience building activities.

Even though Auckland's governance arrangements are relatively solid, there are always improvements that can be made to contribute to Auckland's resilience. For example, it is essential that Auckland's leaders better understand the benefits of investing in disaster risk reduction and ensure that it is an integral part of regional and local planning and development. Comprehensive risk assessments should inform and be integrated into land-use planning, development and design to ensure Auckland is working towards eliminating these risks if practicable, and if not, reducing the magnitude of their impact and likelihood of them occurring. Working together to implement comprehensive, sustainable and affordable disaster risk reduction activities will visibly contribute to improved economic and social well-being in Auckland.

Economics of Resilience

The economic impact of disasters goes far beyond simple rebuild costs. Business confidence; the relocation of financial and business hubs; population displacement; to name a few examples, all have the potential to affect the economy of a city over the short, medium and long term. That said, understanding what potential economic effects a disaster may have on a city is not well understood. In Auckland, there has been some recent work carried out looking into the potential effects of climate change on the city's economy but it has been found that developing robust indicator frameworks for disaster resilience is not an easy task. Indicator frameworks tend to measure what has already happened rather than what may come. To complement the UNISDR Scorecard and New Local Urban Indicators (LUI) tool Auckland CDEM will work with the economic and business sector to implement tools that help predict the likely effects of a disaster to aid city planning and resilience programmes.

Market Economics has recently developed a model to understand and assess 'slow-creep' hazards such as climate change as well as large natural hazard events. A spatial version of this model has been developed for Auckland and has been applied elsewhere across the country, including in response to the Kaikoura Earthquake, to assess the economic impacts of disruption events. That said, the use of these economic tools is in their infancy and require refinement to include a number of different potential indicators including human and social costs of disaster events.

The collaboration of various organisations and institutions will be required to develop a truly multi-dimensional model that can be used to assess the resilience of cities. Market Economics and Auckland Council have started on this journey and are currently working on identifying common resilience and vulnerability measures to be analysed within economic models. Clearly more needs to be done but the groundwork has been laid to better understand the resilience of Auckland to disaster events.

To make Auckland an internationally prosperous city, a clear, collaborative and achievable strategy is needed; one that will help bring about a major change in the way Auckland does business. Auckland's businesses, with their investment, innovation and people, are the heart of the city's economic growth.

Auckland's Economic Development Strategy developed by Auckland Council sets out tangible steps to follow to make this happen over the next ten years. The Strategy which was launched in 2012 identified the following priority areas:

1. Grow a business-friendly and well-functioning city;
2. Develop an innovation centre of the Asia-Pacific hub;
3. Become internationally connected and export-driven;
4. Enhance investment in people to grow skills and local workforce; and
5. Develop a vibrant, creative international city.

The Strategy aims to strengthen collaboration, provide and develop supporting infrastructure, and attract, build and retain talent and business capability in Auckland. It also aims to make it easier to be innovative, showcase Auckland's strengths and benefit from the sectors of competitive advantage.

Economic resilience can be strengthened by developing supporting policies that are aimed at mitigating both the risks and consequences of disasters and demonstrate Auckland's economic strategies. The representation of the business and economic environment in Auckland's new CDEM governance arrangements confirms its critical role in building resilience. In addition, active support from a wide range of agencies across Auckland is required, particularly business organisations and industry associations to enhance Auckland's business and economic resilience.

Future

When Auckland Council was created from the merger of one regional and seven city and district Councils in 2010, the city's future was always going to be different. Now the largest unitary authority in Australasia, the Council is able to deliver projects and infrastructure that before amalgamation would have been unthinkable. City planning has changed too. The legislation that facilitated this transition; the Local Government (Auckland Council) Act 2009, required the 'preparation and adoption of a spatial plan for Auckland'. The purpose of this new plan was to set the strategic direction for Auckland, enable coordinated decision making and provide the basis for aligning the organisation's planning, funding and implementation. The plan was also to 'recognise and describe Auckland's role in New Zealand'. The idea, modeled on examples from overseas and in particular the London Plan, was a first for New Zealand. Published in 2012 the Auckland Plan set the direction and the overall vision for the city. Although not stated explicitly, various aspects of resilience (social cohesion, accessibility, environmental protection, cultural connectivity to name a few) were woven into the plan and helped to guide the establishment of the new Auckland. The Plan, now in its fifth year, is under review and resilience has been embraced as a key concept. The city is now explicit in its intentions: resilience is being used to guide the planning and implementation of Auckland Council, its partners and stakeholders.

So, what does the future hold for the biggest city in New Zealand? Auckland moved from resilience planning and strategy to delivery and implementation of resilience with the adoption of the Auckland Plan in 2012. Some national research points to Aucklanders' relatively low 'resilience scores', compared nationally, but it is clear that this research views factors such as 'dynamism' and 'diversity' as a 'risk' to resilience. Auckland views its diversity as is one of its greatest strengths – a significant indicator of the city's growth and development. The city continues to grow at a rapid rate for many reasons that make it an attractive place to live. Of course, Auckland does have its challenges: housing availability and affordability, congestion, infrastructure funding, environmental pressure. But, Auckland is responding to make the city more resilient, and will continue to respond to these challenges into the future.

The Auckland CDEM five-year strategy, 'Resilient Auckland', states that everyone must work together to build a resilient Auckland. Working together is where Auckland excels. Partnership and collaboration are things that Aucklanders are familiar with. Innovation is another. Building resilience takes all of these things and more.

Wellington

Current Resilience Strategy

Wellington became a member of the Rockefeller Foundation's 100 Resilient Cities programme (100 RC)[15] in 2014 and published its Resilience Strategy[16] centred around the Rockefeller City Resilience Framework[17] in March 2017.

The development of the Wellington Resilience Strategy underwent a two-phase process. The first phase consisted of a series of workshops engaging with central government, iwi, local Councils, academia, the commercial sector and online engagement through social media. A Preliminary Resilience Assessment[18] was developed in June 2016 as a result of this phase. Phase two consisted of more workshops which led to the development of the Wellington Resilience Strategy.

While the Resilience Strategy focuses on Wellington City, it is also presented in the context of the wider region. The implementation of the Strategy will be overseen by a Steering Group consisting of members from Central Government, social and housing sectors, Wellington, Hutt City and Porirua City Councils, Civil Defence, the insurance and commercial sectors and academia who will report to the Wellington, Porirua and Hutt City Councils. The Steering Group will monitor progress and undertake a three-year review in 2020 to provide recommendations to improve the strategy based on lessons learned and in review of future resilience challenges.

The Wellington Resilience Strategy presents three goals, ten programmes and 30 focus areas to work towards improving the resilience of Wellington based on key resilience challenges identified for the city[19]:

Goal 1: People are connected, empowered and feel part of a community

Programme	Focus Areas
1.1 Everyone thrives – Enable Wellingtonians to have an opportunity to enhance wellbeing for themselves and their communities	i. Improve access to household resilience items ii. Prepare for an ageing population iii. Reduce homelessness
1.2 Community resilience – Build on existing strengths to develop innovative programmes that connect and empower communities to improve their wellbeing	iv. Help communities build resilience v. Support community spaces in taking on wellbeing and post-disaster roles vi. Develop sustainable food networks vii. Develop disaster risk management plans for heritage areas
1.3 Economic resilience – Support business communities to improve preparedness and strengthen economic activity	viii. Increase economic resilience of central city and outside hubs ix. Help improve business continuity planning x. Improve understanding of workforce trends

Goal 2: Decision making at all levels is integrated and well informed

Programme	Focus Area
2.1 Governance – Ensure that resilience is integrated into governance	xi. Introduce regulatory tools for resilience xii. Review Wellington Lifelines Group

[15] http://www.100resilientcities.org
[16] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy
[17] https://www.rockefellerfoundation.org/report/city-resilience-framework/
[18] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[19] See section 3.2

	xiii. Maintain monitoring and evaluation of resilience goals
2.2 Information – Make information on all aspects of living in Wellington easily accessible	xiv. Give Wellingtonians information they need to make decisions xv. Develop a virtual reality model of the central city built environment
2.3 Adaptation – Raise awareness about the potential effects of climate change and sea level rise to better emphasise the need for decisions to be made	xvi. Develop a communications and engagement strategy for the Adaptation Plan xvii. Encourage climate adaptation actions
2.4 Recovery – Develop a framework for successful recovery from any disruption	xviii. Undertake recovery planning for the Wellington region xix. Carry out post-earthquake housing study

Goal 3: Our homes and natural and built environments are healthy and robust

Programme	**Focus Area**
3.1 Homes and telecommunication – Support initiatives that contribute to Wellington homes forming the cornerstone of the city's resilience	xx. Help make homes warm, safe and dry xxi. Support insurance literacy campaign xxii. Understand the scale of the non-weathertight homes problem xxiii. Assess the capacity for large-scale remote working
3.2 Water and natural environment – Ensure that Wellingtonians always have access to water services, in a way that enhances our natural environment	xxiv. Improve water systems through ecological interventions xxv. Explore options for sewage sludge disposal xxvi. Ensure emergency water supply for Wellington Hospital xxvii. Invest in water and sewage resilience and awareness
3.3 Transport and energy – Work with infrastructure owners to ensure flexibility and robustness of transport and energy services in Wellington	xxviii. Supply flexible energy supply xxix. Support widespread adoption of electric vehicles xxx. Leverage transportation investment to improve Wellington's resilience

Resilience Measurement

Upon Wellington joining the Rockefeller Foundation's 100 Resilient Cities programme[20], the Rockefeller City Resilience Framework[21] was used to conduct a preliminary resilience assessment of the city[22]. Over 600 stakeholders from the Wellington region were identified from utilities companies, Councils, NGOs, volunteers, health workers, scientists, academics, businesspeople and others to engage in the process of conducting the resilience assessment. Figure 3 shows a representation of the results from an online survey conducted to determine Wellington's resilience priorities.

[20] http://www.100resilientcities.org
[21] https://www.rockefellerfoundation.org/report/city-resilience-framework/
[22] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf

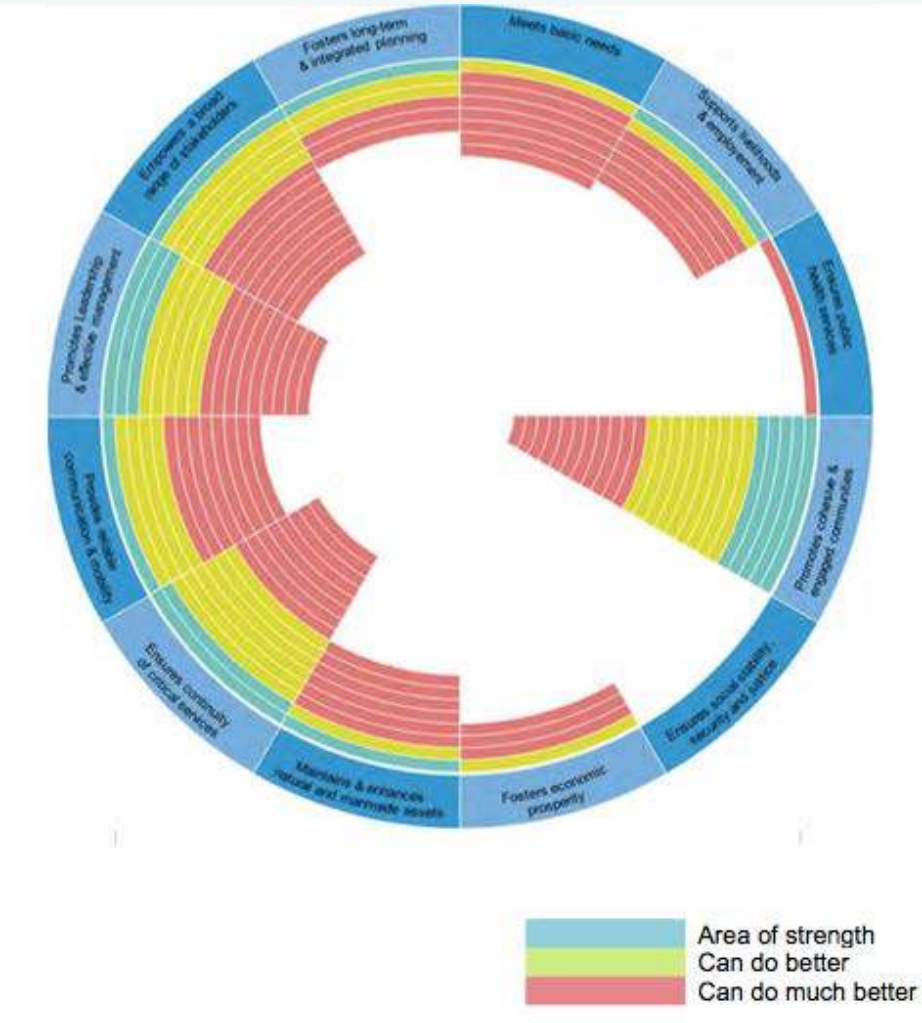

Figure 3: Wellington's Resilience Priorities
(Source: 100 Resilient Cities Preliminary Resilience Assessment Wellington)

The assessment identified actions that are currently: "building the resilience of Wellington", "work that is directly (or indirectly) related to resilience", and "areas worth investigating further". The exercise was helpful in avoiding replication, highlighting initiatives and creating linkages between different efforts. The areas worth investigating further were identified as priorities for improvement.

The work conducted in phase 1 of developing the Wellington Resilience Strategy[23] included an assessment of the resilience of Wellington's assets. The vulnerability of Wellington's assets to earthquake risks had already been assessed and reported by the Lifelines Group[24]. It was viewed that overall, the condition and management of hard physical assets was considered good or very good[25] for the majority of shocks such as floods, wind and fires, but that there was still a high degree of vulnerability to earthquakes and sea level rise. The assessment exercise showed that natural and social areas required the greatest attention for improving resilience.

The resilience assessment conducted also included public perceptions of resilience based on the City Resilience Framework. The results showed that promoting cohesion and engaged communities, and promoting leadership and effective management were areas of strength in Wellington with room for improvement, while meeting basic needs and fostering economic prosperity were not considered areas of strength by any of the participants. Other areas that needed attention included maintaining and enhancing natural and manmade assets, ensuring continuity

[23] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy
[24] http://www.gw.govt.nz/assets/Emergencies--Hazards/Emergency-Planning/12-11-13-WeLG-report-to-CDEM-Joint-Committee-restoration-times-FINAL.pdf
[25] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf

of critical services, providing reliable communication and mobility, empowering a broad range of stakeholders, and supporting livelihoods and employment.

Once the Wellington Resilience Strategy is in place, monitoring will be conducted by a Steering Group who will report to the Wellington, Porirua and Hutt City Councils. The Steering Group will report annually and undertake a full review of the implementation of the Strategy after three years.

Shocks, Stresses and Strains

Wellington's shocks and stresses were reviewed through a workshop and several focus groups with infrastructure providers from electricity, water, roading and telecommunication sectors; Council officers from the social and environment sectors; and the research community[26].

The shocks and stresses with the highest risk levels were identified as earthquakes and storms, followed by a medium risk of flooding (coastal and river), tsunami, water contamination, disease, terrorism and infrastructure failure. Urban fires were rated as a low risk hazard. The workshops identified that although there has been a focus on seismic and seismic-related events, there was a need to understand climate change and sea level rise as significant future risks.

Stresses experienced by Wellington were identified through a workshop attended by key players in the science and research communities where hypothetical future scenarios were presented to identify potential future stresses not currently considered. Possible stresses identified included lack of social cohesion, inequity and tension, economic downturn, underperforming urban form, transport and communication infrastructure, and failure of democracy. Other stresses such as ageing population, economic conditions, poverty and inequality in income were also recognized.

The Wellington Resilience Strategy[27] collated the above findings and presents three key resilience challenges for Wellington:

1. *Wellington's society is transforming*

Wellington has a growing population, which is ageing, becoming more diverse and less equitable. Wellington's homes suffer from being cold, wet and unaffordable. There are increasing new migrants who are struggling to find employment. The Wellington Resilience Strategy aims to address these issues through initiatives to:

- End street homelessness
- Prepare for an ageing population
- Help communities build resilience
- Develop sustainable food networks
- Assess viability of economic hubs outside the central city
- Help make homes warm, safe and dry,
- Understand the scale of the non-weathertight homes problem
- Support flexible energy supply
- Support widespread adoption of electric vehicles
- Integrate resilience into transport projects

[26] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[27] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy

2. The earth is moving in Wellington

Wellington is in constant anticipation of a significant seismic event which makes the energy, transport, water, telecommunication infrastructure, local Government and businesses vulnerable. The Wellington Resilience Strategy addresses building resilience to earthquake risks by highlighting the need to:

- Improve access to all resilience products
- Support community spaces in taking on wellbeing and post-disaster roles
- Help improve business continuity planning
- Review Wellington Lifelines Group
- Maintain monitoring and evaluation of resilience goals
- Enable Wellingtonians to make decisions
- Develop a virtual reality model of the central city built environment
- Undertake recovery planning for the Wellington region
- Carry out post-earthquake housing study
- Support insurance literacy campaign
- Assess the capacity for large-scale remote working
- Ensure emergency water supply for Wellington Hospital
- Invest in water and sewage resilience and awareness

3. The sea is rising

Wellington's coastlines and low-lying parts of the city are affected by extreme weather events, along with flooding, land slips and damages to natural and built assets. There is a need to understand climate change's physical, financial, cultural and social implications. The Resilience Strategy aims to manage coastal hazards and climate change effects with actions to:

- Develop disaster risk management plans for heritage areas
- Improve understanding of workforce trends
- Assess regulatory tools (including enforcement) for resilience
- Develop a communications and engagement strategy for the Adaptation Plan
- Encourage climate adaptation actions
- Improve water systems through ecological interventions
- Explore options for sew sludge disposal

Hazard Knowledge and Awareness

Wellington has a long history of being affected by earthquakes due to the active fault lines that pass through and near the city. Wellington was first affected in 1848 by the Marlborough earthquake which damaged many homes and buildings made of brick and stones[28,29]. Wellington was again affected in 1855 by a magnitude 8.2 earthquake caused by movement along a fault in Palliser Bay, the most powerful ever recorded in New Zealand[30]. Another earthquake in Wairarapa affected Wellington again in 1942[31]. More recently, the 2016 Kaikoura earthquake had

[28] http://info.geonet.org.nz/display/quake/M+7.4+-+7.7,+Marlborough,+16+October+1848
[29] http://www.teara.govt.nz/en/historic-earthquakes/page-2
[30] http://www.teara.govt.nz/en/historic-earthquakes/page-3
[31] http://www.teara.govt.nz/en/historic-earthquakes/page-9

significant impacts on the port and multi-storeyed buildings in Wellington's CBD. Therefore, earthquakes have been identified as the biggest risk to Wellington.

Wellington Region's Civil Defence Emergency Management Group Plan 2013-2018[32] includes a comprehensive hazard analysis identifying all potential hazards in Wellington requiring CDEM Group management. All hazards have been prioritised based on risk analyses. The levels of risk have been determined by evaluating the degree of impact on the social, built, economic and natural environments in Wellington. The prioritisation of hazards by risk is as follows:

- Very high priority: Earthquake
- High priority: Flood, local source tsunami, human pandemic, distance source tsunami, landslide
- Moderate priority: Drought, animal pandemic, storm, terrorism
- Low priority: Fire, lifeline utility failure, hazardous substance incident, transport incident
- Very low priority: Volcanic eruption

Wellington's characteristic geography and exposure to different risks makes resilience in Wellington problematic from a perspective of access and egress, as population increases and the roads lose capacity and functionality. Wellington is dependent on the rest of the region and therefore needs to have the ability to govern itself within a regionally integrated resilience system. These issues are fundamental to Wellington's exposure to hazard and climate change risks.

The Preliminary Resilience Assessment for Wellington[33] and the Wellington Resilience Strategy[34] echo the Group Plan in identifying earthquakes and climate change related hazards as key resilience challenges for Wellington. The Resilience Strategy proposes initiatives to build resilience to these hazards[35].

Community Resilience

The Wellington Resilience Strategy[36] identifies Wellington's transforming society as a key resilience challenge. The Strategy has a broader focus than simply resilience to nature's challenges and includes general wellbeing. The Preliminary Resilience Assessment conducted in Wellington[37] highlighted that there are issues such as lack of social cohesion, inequity and tension resulting from poor integration of climate refugees, ageing population, unemployment due to mismatch of supply and demand for skills, poor connectivity and housing affordability affecting Wellington's communities. Wellington's population is growing, ageing and becoming more diverse. A primary goal of the Wellington Resilience Strategy is to improve community resilience and develop a resilience culture in Wellington through making sure "people are connected, empowered and feel part of a community".

The Wellington Region Emergency Management Office (WREMO) has a Community Resilience Strategy[38] which supports the Wellington Region CDEM Group Plan 2013-2018[39]. This Community Resilience Strategy outlines how the WREMO's Community Resilience Team will engage with Wellington's diverse communities and apply tools to empower community members to survive and thrive after an emergency event. The strategic objectives of the strategy are to build capacity, increase connectedness and foster cooperation. The strategy and the Community Resilience Team are underpinned by 13 community engagement principles in-line with the strategic objectives. The role of the Community Resilience Team is to focus on building relationships with community leaders and facilitate opportunities that improve the communities' ability to prepare for, respond to and thrive after an emergency event.

[32] http://www.getprepared.org.nz/sites/default/files/uploads/2013%20-%202018%20Group%20Plan.pdf
[33] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[34] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy
[35] See section 3.2
[36] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy
[37] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[38] http://www.getprepared.org.nz/sites/default/files/uploads/Community%20Resilience%20Strategy%202012.pdf
[39] http://www.getprepared.org.nz/sites/default/files/uploads/2013%20-%202018%20Group%20Plan.pdf

Community Resilience Tools employed by the Community Resilience Team include: Civil Defence Volunteer Training, Preparedness Enablers, Public Education, Emergency Skills Training, Tsunami Blue Lines, Supporting Social Agencies with Vulnerable Communities, Resilient Schools, Emergency Text Alerts, and Community-Driven Opportunities to Build Capacity. Tools for increasing connectedness and fostering cooperation include Networker and Connector, Community Events, Social Media, Resilience and Crisis Mapping, Community-Driven Response Planning, It's Easy: Prepared Neighbours, Emergency Assistance Centres, and Knowledge Generation and Transfer.

The Wellington region has been designated an International Centre of Excellence in Community Resilience through the United Nations funded Integrated Research on Disaster Risk programme.

The Wellington Resilience Strategy adds to community-building resilience initiatives by highlighting 10 goals:

1. Improve access to household resilience items
2. Reduce homelessness
3. Prepare for an aging population
4. Help communities build resilience
5. Support community spaces in taking on wellbeing and post-disaster roles
6. Develop sustainable food networks
7. Develop disaster risk management plans for heritage areas
8. Assess viability of economic hubs outside of the central city
9. Help improve business continuity planning
10. Improve understanding of workforce trends

These 10 goals for community resilience are complemented by other goals for decision- making and for healthy and robust built environments and infrastructure.

A key challenge is to develop effective strategies to increase the resilience of buildings, especially heritage buildings, given that for the owners of these buildings the cost of strengthening them outweighs the benefits on most occasions, for example increased rents. A related challenge is to enhance a community culture of making homes more resilient to nature's hazards.

Broadening the resilience focus from an emphasis on response and recovery to readiness and risk reduction is necessary. This may require costly changes to make buildings, houses and infrastructure more resilient to earthquakes and the effects of climate change which is a challenge. A further challenge is to spell out how resilience goals will be implemented. For example, considering exactly how will the goal 'prepare for an aging population' be implemented.

Infrastructure Resilience

Wellington houses infrastructure with national importance. The Wellington airport is the busiest domestic airport in New Zealand, while the port also carries large volumes of freight and passengers. Wellington is the nexus of State Highways 1 and 2 as well as long-distance train lines. Locally, Wellington's lifelines and key assets include water, wastewater, power, telecommunications, gas, fuels, buildings, homes, social areas and natural areas.

The vulnerability of Wellington's assets to earthquake risk has been evaluated by the Wellington Lifelines Group[40] in its Lifeline Utilities Restoration Times for Metropolitan Wellington Following a Wellington Fault Earthquake report in 2012[41].

[40] http://www.getprepared.org.nz/welg
[41] http://www.gw.govt.nz/assets/Emergencies--Hazards/Emergency-Planning/12-11-13-WeLG-report-to-CDEM-Joint-Committee-restoration-times-FINAL.pdf

Analyses conducted in the event of worst-case earthquake scenarios showed that one of the key issues facing Wellington in the event of an earthquake would be land access due to the current state highway network configuration. At present a major earthquake event could cut off land access for 120 days, but the Lifelines Group analysis showed that this would be reduced to 40 days if the Transmission Gully Motorway was constructed. A detailed analysis of the restoration of transport links after a major earthquake in Wellington was also conducted by the Lifelines Group in 2013[42]. Water restoration times varied based on distance to water sources, and power restoration times were predicted to vary between 20 to 95 days depending on the area. The analysis also found that the hilly terrain in Wellington made quick restoration challenging. The Restoration Times report states that good progress is being made with earthquake-proofing Wellington's lifelines, but the topography which determines the layout of utilities and the seismicity of the region mean that vulnerabilities will remain even once infrastructure is seismically upgraded. The report concludes that gaining a better understanding of vulnerabilities and finding ways of overcoming them will be the goal of lifeline utilities groups and the Wellington Region Emergency Management Office.

A workshop conducted to understand the resilience of Wellington's assets for Wellington's Preliminary Resilience Assessment[43] identified that the overall condition of Wellington's hard physical assets and their management was considered good to very good. It was determined that physical infrastructure was capable of withstanding the majority of hazards such as floods, wind and fires, however remaining very vulnerable to earthquakes. The workshop highlighted the fact that the resilience of infrastructure assets seemed to focus more on asset management rather than "levels of service". Working towards improving levels of service after an event was considered as a more suitable focus for future infrastructure resilience. It was also found that the effects of climate change on the city and its infrastructure were not well understood. Wellington's social and natural assets such as the coast, reserves, harbours, green urban spaces, and physical assets that support the community which are critical to the region's resilience were also identified as needing more attention.

The Wellington Resilience Strategy[44] identified the following infrastructure resilience priorities:

- Homes and telecommunication – Support initiatives that contribute to Wellington's homes forming the cornerstone of the city's resilience by making homes warm safe and dry; supporting insurance literacy; and understanding the scale of the non-weathertight homes problem
- Water and natural environment – Ensure that Wellingtonians always have access to water services through improving water systems; exploring options for sewage and sludge disposal; ensuring emergency water supply for Wellington Hospital; and investing in water and sewage resilience and awareness
- Transport and energy – Work with infrastructure owners to ensure flexibility and robustness of transport and energy services in Wellington through supplying flexible energy supplies; supporting widespread adoption of electric vehicles; and integrating resilience into transport projects

Governance for Resilience

One of the three central goals of the Wellington Resilience Strategy[45] is that "decision making at all levels is integrated and well informed". The first programme contributing to this goal is making sure that resilience related to disaster recovery as well as risk reduction is integrated into governance.

Examination of the governance structures in Wellington in developing the Wellington Resilience Strategy has shown that Wellington's current governance models and methods of prioritising investment are based on relatively short payback periods, and do not often encourage a proactive long-term approach to building resilience.

The Preliminary Resilience Assessment[46] conducted after joining the 100 Resilient Cities[47] network revealed governance related issues such as Central Government moving out of Wellington and having an inefficient

[42] http://www.getprepared.org.nz/sites/default/files/uploads/WLG%20Transport%20Access%20Report%202013.pdf
[43] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[44] http://wellington.govt.nz/about-wellington/wellington-resilience-strategy
[45] To be released in March 2017
[46] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[47] http://www.100resilientcities.org

fragmented local Government would have adverse impacts on the resilience of the city. The findings from the stakeholder workshops showed that resilient governance and decision making would include:

- Having a clear vision and courage to make long term decisions
- Factoring in resilience
- Regional consideration, not just Wellington City
- Community participation
- Multidisciplinary co-operation
- Involvement of mana whenua

The Resilience Strategy highlights the importance of understanding the criticality and interconnectedness of different assets and consider how they depend on each other to ensure that the basic needs of Wellingtonians can be met following a major shock as well as cope with long-term changes impacting on the functionality of the city. The Strategy identifies that the best time to invest in resilience is before a shock occurs and by anticipating changing climate impact. This can be achieved by considering a range of plausible future conditions identifying critical thresholds. Undertaking this will need to be inclusive and integrated aimed at understanding the specific vulnerabilities of different systems and groups of people to enable future investments in assets and the community and for recovery planning when unanticipated shocks occur.

The Strategy proposes that Wellington's governance structures can be geared towards resilience through:

- Assessing the adequacy of regulatory tools (including monitoring and enforcement) for enabling resilience – The New Wellington City Project led by the Wellington City Council is assessing regulatory options to reduce exposure to liquefaction, flooding, sea level rise and other hazards, and building resilience into the city's decision making. This project seeks to reflect on lessons learned from the Christchurch earthquakes to inform Wellington's planning to reduce exposure to risk and to adapt to natural hazards and thus reduce the effects of natural disasters by anticipating and preparing for response and build adaptive capacity.
- Reviewing the Wellington Lifelines Group – The Wellington Lifelines Group along with Wellington City, Porirua and Lower Hutt Councils are working on evaluating and communicating the vulnerabilities of Wellington's lifelines to leaders and decision makers to prompt and prioritise action. This project aims to make water, energy, telecommunication and transport services able to withstand significant shocks as well as build adaptability and capacity to manage hazard risks, stresses and strains through clever designs and enable communities and the economy to thrive every day. A study using the Modelling the Economics of Resilient Infrastructure Tool (MERIT) is being conducted to enhance the understanding of where to focus investments in preparation for various shocks to reduce risks and maximise benefits for disaster resilience.
- Maintain monitoring and evaluation of resilience goals – This is also part of the New Wellington City Project to maintain the momentum generated by the Resilience Strategy development process through a formal governance structure to oversee the implementation and review of the Strategy by the Resilient Wellington Steering Group. The Steering Group will make recommendations on improvements to the Strategy in 2019 to add/remove projects, objectives, shocks and stresses and other recommendations.

Economics of Resilience

Wellington contributed to 13.5% of the country's GDP in 2015[48] and has seen economic growth in the last few years with increasing population and increased activity in the tourism sector[49]. The central city area in Wellington

[48] http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/RegionalGDP_MRYeMar15.aspx

[49] http://wellington.govt.nz/~/media/your-Council/news/files/2016/wellington-city-quarterly-economic-monitor-march-2016.pdf

is the primary economic hub. Wellington has around 26,000 businesses with a predominance of tech, scientific and professional jobs, and has the highest median household incomes[50].

Business and Economic Research Limited (BERL) reported that a significant earthquake in Wellington could result in New Zealand losing 1-2% of its current GDP and Wellington losing up to 15% of its GDP per year[51]. Evaluations performed using an earthquake scenario estimated up to 50 days to restore water to the CBD, 95 days to restore power, and up to 120 days to progressively restore road access[52,53] which can have adverse impacts on economic recovery after an event.

Key focus areas for improving economic resilience that arose during the preliminary resilience assessment[54] in Wellington included:

- Acknowledging the role of the CBD and evaluating the challenges Wellington's economy would face
- Creating a diverse economy
- Growing the resilience of individual businesses and communities with the collaboration and support of Wellingtonians
- Building the capability and capacity for Wellington's economy to adapt to stresses in preparation for shocks

The Wellington Resilience Strategy[55] addresses economic resilience as one of its programmes under Goal 1: People are connected, empowered and feel part of a community. In the Strategy, building economic resilience in Wellington focuses on supporting business communities to improve preparedness and strengthen economic activity through:

- Assessing the viability of economic hubs outside the central city and improve infrastructure to support independent economic viability of these hubs – The New Regional Project led by the Wellington City Council (WCC) partnered with the Chambers of Commerce will be assessing the capacity of hubs outside the central city in the event that the central city is compromised. The project will bring together Councils, business and community groups to assess the economic capacity of Karori, Johnsonville, Tawa, Lower Hutt, Upper Hutt and Porirua. This project will also assist in building economic redundancy through the region and generate opportunity to diversify Wellington's economy and prepare for future demands and a changing workforce.
- Helping improve business continuity planning – Ongoing work on business continuity planning by small-to-medium enterprises (SMEs) in Wellington will be scaled up, led by the Chambers of Commerce in partnership with WCC and WREMO. There are currently 100 SMEs participating in this programme per year. The aim is to increase participation to 1000 SMEs per year to support businesses to be better prepared to face shocks and resume operations as quickly as possible afterwards to provide Wellingtonians access to the services that they need. Business continuity planning will also help SMEs to examine their business-as-usual processes and identify opportunities to make improvements to increase efficiency and competitiveness.
- Improving the understanding of workforce trends – The New Wellington City Project led by WCC partnered with the Chambers of Commerce will be working with a range or partners to undertake a study to better understand future workforce trends and investigate ways to prepare for them. Short to medium term economic predictions, offerings of existing tertiary learning institutions, re-training existing labour as job demands change and existing resources will be evaluated to capitalise on future opportunities. The

[50] http://wellington.govt.nz/~/media/about-wellington/resilient-wellington/files/100-resilient-cities-preliminary-resilience-assessment.pdf
[51] BERL (Sanderson, K., and Fareti, N.) (2015) Wellington – essential to New Zealand's Top Tier: Its resilience is a national issue, BERL, December 2015, p. 3.
[52] http://www.gw.govt.nz/assets/Emergencies--Hazards/Emergency-Planning/12-11-13-WeLG-report-to-CDEM-Joint-Committee-restoration-times-FINAL.pdf
[53] http://www.getprepared.org.nz/sites/default/files/uploads/WLG%20Transport%20Access%20Report%202013.pdf
[54] See footnote 4
[55] To be released in March 2017

project aims to reduce Wellington's overreliance on government services and take opportunities to diversify the economy.

Future

Wellington's Resilience Strategy is the blueprint for the city to survive, adapt and grow in the face of the shocks and stresses of the 21st century. Some of the actions in the Strategy are short-term and tactical, while others are longer time and more strategic in nature. All of them have people at the centre.

With the Strategy finalized, the future focus for the city will be to work on successful implementation of the plan. An Implementation Plan for the Strategy is currently being produced to assign responsibilities, time frames and resources to ensure that the projects outlined in the Strategy can be delivered. A Resilience Steering Group has been formed organized of leaders from central and local Government, Civil Defence, insurance and commercial sectors, social and housing sectors, and academia who can empower key sectors to integrate resilience into their operations.

Progress of implementation of the Strategy will be monitored regularly, followed by a 3-year review in 2020 to evaluate and improve the Strategy.

Christchurch

Current Resilience Strategy

The Resilient Greater Christchurch Plan[56] pioneered by the Rockefeller Foundation's 100 Resilient Cities programme[57] outlines Christchurch's current resilience strategy. The Plan has been developed following a two-year process of consultation with community groups of diverse backgrounds and cultures, and in partnership with Waimakariri District, Selwyn District and Christchurch City Councils, Environment Canterbury, Ngāi Tahu[58], NZ Transport Agency and Crown Research Institutes. The 2007 Greater Christchurch Urban Development Strategy, 100 Resilient Cities and the Resilience Advisory Group also influenced the development of the Plan.

Christchurch's current resilience strategy is based on two cross-cutting guiding principles which have emerged from background work and dialogue with key influencers. These principles are intended to be implicit to some degree in each programme (Figure 4):

1. A meaningful treaty partnership with Ngāi Tahu and
2. Consistency and collaboration across all tiers of government.

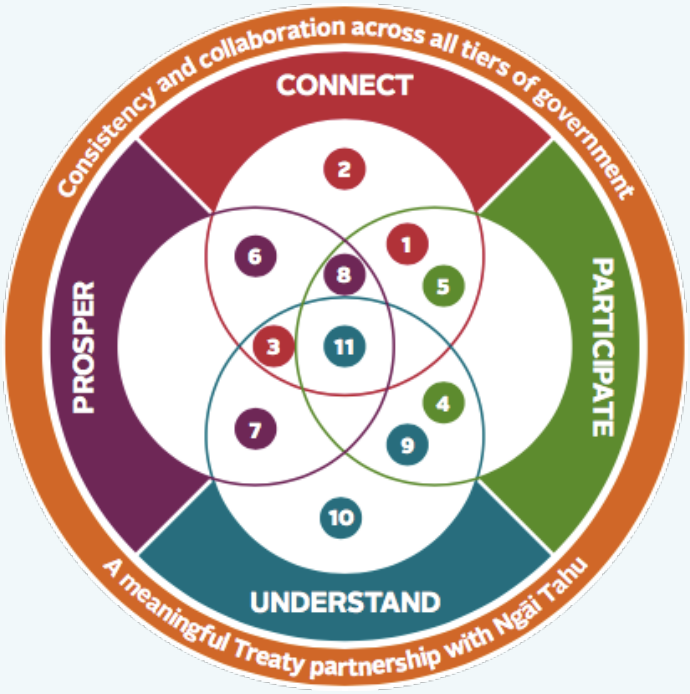

Figure 4: Resilient Greater Christchurch Guiding Principles and Goals

The Resilient Greater Christchurch Plan sets four goals and 11 programmes in total under these goals to build Greater Christchurch's resilience:

[56] http://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf
[57] http://www.100resilientcities.org
[58] The largest iwi (Māori tribe) in the South Island

- Connect: (1) Connect People, (2) Create adaptable places, (3) Improve the quality, choice and affordability of housing
- Participate: (4) Build participation and trust in decision-making, (5) Support community organisations and leaders
- Prosper: (6) Connect internationally, (7) Foster a culture of innovation, (8) Sustain the vitality of the natural environment
- Understand: (9) Improve the community understanding and acceptance of risk, (10) Manage the risks we face, (11) Securing our future in the eastern parts of Christchurch

The aforementioned eleven programmes are further broken down into actions, which are proposed to overcome nine interconnected resilience challenges and opportunities identified as part of a preliminary resilience assessment[59], carried out using "The City Resilience Framework[60]" as a reference assessment tool

The nine interconnected resilience challenges and opportunities are briefly outlined below and described in detail in the Resilient Greater Christchurch Plan.

- ***Community and social cohesion*** - Building and supporting community networks was regarded as a key aspect to improve resilience. A specific challenge is the elevated number of migrants (approximately 2300 skilled migrants between 2012 and 2014[61]) that arrived in Christchurch to work on the post-earthquake rebuild. Greater Christchurch needs to embrace this new diversity, integrate the new workforce into the wider community and encourage the new social cohesion to remain once the rebuild work is completed.
- ***Securing the future in the eastern parts of Christchurch*** - The eastern suburbs of Christchurch are home to the city's most socially and economically disadvantaged individuals. These areas were unfortunately severely affected by the earthquakes with widespread liquefaction. The future resilience challenges in the Eastern suburbs of Christchurch is ensuring that the local communities are well supported and included in the land-use and hazard planning decision-making process.
- ***Understanding risks and tools for mitigation*** - After the Canterbury earthquake sequence Christchurch's hazards and risks have been further investigated. The challenge now is to keep on investigating possible risks, including multi-hazard interactions and cascading events, and identify ways of mitigation, including better understanding of the role of insurance.
- ***Housing affordability and accessibility -*** The earthquakes exacerbated the problems that Christchurch already faced in providing affordable, good quality, warm and healthy homes. Housing deprivation increased between 70-112% since the earthquakes as a result of the severe damage to properties and of the increased rent and house prices. Statistics in 2016 have shown that house prices and rents have started to decrease again as the housing stock is returning back to pre-earthquake levels and people's incomes are growing. Future resilience in Christchurch means ensuring continued access to quality housing.
- ***Urban form of Greater Christchurch***: Christchurch has a unique opportunity to use the rebuild to build back better reflecting the city and region's growing population and changing demographic. Effective urban planning during the rebuild can improve resilience by helping mitigate future stresses caused by homelessness, unemployment, traffic congestion, accessibility to services and environmental pressure.
- ***The role of innovation***: With Greater Christchurch's changing community and economy it is important to understand the specific impact of technological changes and develop coordinated actions to grow the innovation ecosystem. Innovation must be supported by the use of new technology and the creation of new opportunities to make the region attractive to young people and migrants.

[59] Conducted in During the period of from December 2014 to September 2015
[60] Developed by Arup and The Rockefeller Foundation, accessible at https://www.rockefellerfoundation.org/report/city-resilience-framework/
[61] http://www.stats.govt.nz/browse_for_stats/population/Migration/international-travel-and-migration-articles/international-migration-canterbury-1996-2014.aspx#Total_migrant

- ***Community leadership***: The Canterbury earthquake experience demonstrated the existence of a variety of successful community groups and leaders that initiated organised responses to assist the response and recovery. Building future resilience includes maintaining and developing further the culture of community response and connectedness, creating a culture of possibility.
- ***Building trust between the community and decision-makers***: Residents desire to be involved in decisions affecting their neighbourhoods and communities. Decision making processes need to be inclusive. Solutions discussed and agreed with communities need to be multi-disciplinary and need to integrate technology and social aspects. Towards Greater Christchurch's resilience it is necessary to bring in local government approaches to engage with people and community, and advocate for the community to work with agencies.
- ***Connection with our natural environment***: The symbiotic relationship between land, water and people is at the heart of building a resilient community. Post-earthquake generation and resilience-building offers an opportunity to improve the vitality and resilience of Christchurch's waterways and surrounding landscapes.

Resilience Measurement

The Resilient Greater Christchurch Plan[62] was developed from a two-phase process. Phase One was commenced in December 2014, which included a consultative scoping exercise involving a broad range of stakeholder organisations. The City Resilience Framework was used as a tool to help define what resilience meant for Greater Christchurch and workshop sessions explored the shocks and stresses facing Greater Christchurch, the experiences from the Canterbury Earthquakes and the resilience priorities for the future.

The Preliminary Resilience Assessment[63] report published in September 2015 exhibited the findings from Phase One. Phase Two involved the development of the Resilient Greater Christchurch Plan based on focus areas identified in the Preliminary Resilience Assessment. In collaboration with key stakeholder agencies, subject experts and the support of 100 Resilient Cities[64] the final version of the resilience plan was formalised in July/August 2016.

The resilience goals for Greater Christchurch were presented under 11 programmes and respective actions under each programme. The resilience measure for Greater Christchurch is the progress of these programmes and actions listed in pages 102-113 of the Resilient Greater Christchurch Plan.

As at now, the majority of the actions under each programme are under development in the next 2-3 years, with a few committed and underway at the moment. The actions currently committed and ongoing include:

- Community Led Grants – Providing funds by Council to organisations working to build resilience and support community recovery.
- Development and implementation of new centre development plans by respective district Councils to incorporate urban design principles to improve community connectedness and overall wellbeing.
- Urban Development Strategy Review – Review of sub-regional land use planning and wellbeing strategy to integrate a high level of resilience for funding, service and regulatory planning processes (commencing in 2017).
- Transport Innovation Fund – A contestable fund started by the Christchurch City Council to stimulate local ideas to encourage and improve the use of sustainable transport modes (initial pilot in progress).
- Collaboration with communities to create healthy, safe and welcoming facilities and places with independent accessibility and crime prevention strategies by Councils.

[62] http://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf
[63] http://www.ccc.govt.nz/assets/Documents/The-Rebuild/About-the-Rebuild/Resilient-Cities-PAM7918-WEB.pdf
[64] http://www.100resilientcities.org

- Consistent monitoring of residential development across Greater Christchurch Council administrative areas including existing housing stock, newly built homes, land supply and proposed developments (working group to commence in 2017).
- Provision of more public sector, private sector and academic data in Open Source formats to the community for greater transparency to inform people as well as spark new innovations.
- Setting up of Time Banks by community groups to share and exchange local community skills and resources.
- Community Group/Resource Mapping of community groups to assist with training, upskilling, and sharing skills and resources.
- Guangdong Strategy – establishing a strategic city/region relationship with China and support visits from Chinese investors.
- Attraction Strategy – developing initiatives to attract skilled migrants, visitors and investment into the area by the Canterbury Development Corporation.
- Investigating opportunities to increase the capacity and services provided by active connectors in Greater Christchurch to support investors.
- Grants and support for the establishment of community gardens.
- Mahinga Kai Network – supporting collaborative community engagement to support projects that restore habitats and develop knowledge and education resources to sustain restored resources.
- Government engagement and coordination in approaches around risk literacy, risk management and risk transfer; legislative and national policy directions; and central government funding for projects.
- Health impact assessments being conducted to inform and refine projects to reduce and minimise potential health impacts of proposals.
- Facilitation and encouragement of community resilience plans building on community from day to day use of community groups.
- Christchurch City joining the UN Compact of Mayors to measure, report, set targets and plan on reducing greenhouse gas emissions.
- Regeneration of the residential red zone and New Brighton areas (to commence in 2017).

Shocks, Stresses and Strains

The potential shocks faced by Christchurch include seismicity, tsunamis and flooding. Christchurch suffered from a series of earthquakes in 2010 and 2011 from localised faults extending the east-west axis across the South Island. Another sequence of earthquakes took place in 2016, 95km from Christchurch affecting Kaikoura and North Canterbury. The Alpine Fault which extends down the spine of the South Inland has been identified as the primary seismic threat in the future, with a 30-65% chance of a magnitude 8.0 earthquake in the next 50 years.

There is frequent seismic activity around the Pacific which presents constant potential threats from tsunami waves. Christchurch's coastal areas are low-lying and flat which increase exposure to tsunami risk.

Flooding is the most common hazard faced by Christchurch communities since Greater Christchurch sits on a floodplain. Currently flooding is caused mainly from the Waimakariri River, but in the future coastal flooding, storm surges and inundation are also expected to cause major issues. Ground subsidence from the earthquakes has also increased the severity and frequency of flood events.

The chronic stresses faced by Christchurch include climate change, changing demographics, affordable housing and social equity, globalisation, and health. Climate change is causing warmer temperatures resulting in more frequent droughts and fire risks, fewer but more intense rainfall events which increase flood risks, and reduced ground water and soil moisture. Lower river flows reduce the amount of sediment carried downstream to be deposited along the coast to replace what is being eroded by rising sea levels and storm surges. The changing climate may also result in new threats, pests and diseases to establish in the region requiring new responses.

Great Christchurch's demographics are changing with the aging population and workforce. The increasing retiree population places pressure on health, social care and state pension systems. As a result of the loss of this older age group, there will be a loss of knowledge and skills. Trends in the past few decades have not shown a natural population replacement in Christchurch. The region currently relies on inflows of skilled migrant labour.

Housing and social equity problems were exacerbated following the 2010/2011 earthquakes. With an increasing gap between average incomes and average house prices, the younger generations have been unable to purchase homes and forced to rent. However, rental housing in Christchurch often suffers from lack of insulation and basic heating, resulting in health implications for poorer households. The lack of access to affordable, quality housing is increasing the social divide in the region. Low income households suffer from poorer health from being in poor quality housing and being unable to afford healthy nutritious food. These households are also disproportionately affected by sudden shocks and events.

Greater Christchurch is susceptible to the forces of global markets. The economy is currently controlled by the NZ $40 billion reconstruction funding. The external economy is focused on agriculture and tourism, which constantly face international threats and competition.

The 2016 Urban Development Strategy Update stated that life expectancy is increasing in Greater Christchurch. Increased life expectancy however results in having to control and treat more types of chronic health conditions such as Type Two diabetes, cancer, cardiovascular disease and dementia. Obesity and inactivity are also chronic health issues faced by communities. Following the earthquakes, psychological wellbeing has emerged as a significant long-term threat to health in the region. Many people suffer from trauma, as well as increased stress due to unresolved insurance settlements, being dislocated, and having to live in a recovering city.

Hazard Knowledge and Awareness

There is a good overall understanding of Christchurch's hazardscape, with no obvious large gaps. Christchurch's most common exposure to natural hazard involves flooding. Extensive analysis of the Avon and Styx Rivers and their tributaries has given Christchurch City Council (CCC) a good understanding of flood hazard. However, localised subsidence of parts of the eastern suburbs of Christchurch during the Canterbury Earthquakes sequence resulted in exposure of some suburbs- notably the Flockton Basin -to increased flood hazard/risk, more frequent and more damaging flooding. Further analysis and flood management programmes are in place to combat this hazard.

Detailed analysis of the floodplains of the Heathcote and Halswell Rivers by CCC and Environment Canterbury (ECan) has highlighted the need for an integrated approach to development within these catchments. Historically the Waimakariri River, to the north of Christchurch city, has broken out causing flooding though the central city- including Cathedral Square. The Waimakariri is now managed with stopbanks, to keep 300-500 year floodwaters within or redirect them back into the current riverbed.

Earthquake hazard in Christchurch in recent years has reached the headlines. Surface-rupture, ground shaking, liquefaction, earthquake-induced land sliding and boulder-roll/rockfall are all factors that need to be considered. There are no known active fault ruptures at surface within the area under the jurisdiction of the CCC. All earthquakes have occurred on faults that remain buried. Therefore, there are no mapped fault lines or setbacks to building within Christchurch City[65].

The Christchurch area has a heightened seismic hazard regarding aftershock and ground shaking, and therefore the "z-factor" for building design was increased in 2011 from 0.22 to 0.30. This means that new buildings are built to be seismically more resilient. In addition, the earthquakes damaged many unreinforced masonry buildings beyond repair, and their subsequent demolition leaves a building stock that is now on the whole stronger and more resilient to seismic hazard.

[65] Hikurangi Subduction Zone and Wairarapa Fault tsunami modelling for the Canterbury coast. *Prepared for Environment Canterbury by NIWA* Environment Canterbury report number R15/130, October 2015. Prepared by: Alison Kohout, Emily Lane, Jade Arnold, Julian Sykes

Liquefaction susceptibility has also become far better studied and understood, particularly due to the sharing of soil and groundwater information on the Canterbury Geotechnical database[66]. Red zoning has removed development from the worst affected areas, and MBIE guidance for the rebuild has ensured much stronger, more suitable foundations where building on liquefaction-susceptible land.

Seismically-induced land sliding, rockfall and boulder roll have been a big issue in the Port Hills suburbs. CCC commissioned GNS to undertake a series of in-depth investigations to determine the extent of the problem[67,68]. This involves defining run out calculation of Annual Individual Fatality Risk. Again, red zoning has removed the worst of the risk, with engineering solutions mitigating risk elsewhere.

Several hydrostatic modelling investigations of tsunami risk have been undertaken by NIWA. It is believed that for Christchurch there is only a very small likelihood of a damaging tsunami generated by a local source. Regional source tsunami modelling for a "worst case" source earthquake indicates some inundation at Monks Bay, McCormicks Bay and Sumner, and a small amount of inundation in the low area near Lyttelton Port. Low lying bays at the south/eastern end of Lyttelton Harbour are also inundated. Distant source tsunami, generated at the Peru-Chile border is the main tsunami risk to Christchurch[69]. Modelling of the "worst case" source indicates significant inundation of New Brighton, around the estuary, Sumner and parts of Lyttelton Harbour. In both regional and distant cases, "worst case" means 2500 year recurrence interval source earthquake, 85% confidence level, arriving at Mean High Water Springs. Evacuation zones and planning are in place.

Recent events have shown that the Port Hills area is susceptible to fire hazard. Fire in the rural-urban interface is difficult to manage tend to be more difficult to manage than urban fires, and expose more assets/people than rural fires, and therefore are relatively high risk.

The recent Kaikōura -Hurunui earthquakes have highlighted another vulnerability: large earthquakes in other parts of the South Island can cut transport routes into Christchurch. Whilst the blocking by landslides of SH1 north of Kaikōura has been bypassed by using SH7, this has caused a 30% increase in the cost of transporting fast-moving consumer goods to the city from the North Island/Picton. Rail transport remains closed. This could be more extreme in the event of a large Alpine Fault Earthquake, where all Alpine passes may also be closed.

Overall, the need is not so much to do significant new investigations as to make the most of information that is already available- this is already sufficient for the purposes of the hazard management Christchurch city is trying to achieve. Challenges to hazard management faced by CCC include how to recognise what other information may be needed, funding any additional research, and, as for many places, the political will to ensure hazards are adequately managed in situations where developers and homeowners disagree with the requirements or availability of information.

Work to fill known gaps currently includes remodelling tsunami to include tsunami travel up rivers, and dune-breach scenarios; multihazards approach in eastern Christchurch, and a sponsored PhD study into land stability issues in loess sediments of the Port Hills/ Banks Peninsula.

Possible future work could include local source tsunami modelling, more comprehensive study of landslide hazard beyond the area damaged in the earthquake, and fire at the rural-urban interface, along with cascading hazards such as increased land instability with loss of vegetation.

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[66] Review of liquefaction hazard information in Eastern Canterbury, including Christchurch City and parts of Selwyn, Waimakariri and Hurunui Districts: ECan Report No. R12/83; ISBN: 978-1-927222-37-9. Report prepared for Environment Canterbury by H. L. Brackley (compiler); GNS Science Consultancy Report 2012/218. December 2012

[67] Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Stage 1 report on findings from investigations into areas of significant ground damage (mass movements).
C. Massey, M. Yetton, J. Carey, B. Lukovic, N. Litchfield, W. Ries, G. McVerry, GNS consultancy Report 2012/317, August 2013.

[68] Canterbury Earthquakes 2010/11 Port Hills Slope Stability: Risk assessment for Maffeys Road: F. Della Pasqua; W. Ries; C. I. Massey; G. Archibald; B. Lukovic; D. Heron
GNS Science Consultancy Report 2014/79, August 2014

[69] Updated inundation modelling in Canterbury from a South American tsunami. Prepared for Environment Canterbury by NIWA Environment Canterbury report number R14/78, November 2014 Authors/Contributors: Emily Lane, Alison Kohout, Antoine Chiaverini, Jade Arnold

Community Resilience

The damage and destruction caused by the 2010/2011 Canterbury Earthquake sequence was a catalyst for change in the communities and culture of Christchurch, and the shift of affected communities and businesses. Community connections were disrupted, community and business networks changed, and a new demographic was created with the large inflow of migrants who arrived to work on the rebuild. The 2013 census[70] shows that 21% of the population in Christchurch was born overseas, an increase of 1.4% since 2006. New migrants from the United Kingdom, China, Philippines, India, Australia and Ireland have arrived since the earthquakes[71], along with a 12.4% increase in the Māori population[72].

The felt effects of the earthquake highlighted the value and importance of social networks. Communities with strong neighbourhood connections responded much faster than those without, and local residents were able to assist each other and rely less on external help. Community-based support was also shown to enhance the wellbeing and sense of belonging in communities following the earthquakes. To build resilience prior to a disaster, and ensure a swift recovery then, it is vital to foster neighbourhood relationships and in particular, assist new residents – including migrants and rebuild workers – to integrate into existing communities and establish their own local networks. It is also important that government agencies and Councils support community organisations and leaders.

The Canterbury earthquakes demonstrated the need for better emergency preparedness and understanding of the risks facing Christchurch communities. Capacity building can include hazards education, sharing knowledge and resources to better understand and manage risks. The effects of the earthquakes also highlighted the vulnerability of socio-economically deprived communities including the eastern part of Christchurch, and the need for targeted support.

The Resilient Greater Christchurch Plan identifies four goals to build the resilience of Christchurch's communities: (1) Connect, (2) Participate, (3) Prosper and (4) Understand.

"Connect" refers to connecting people, creating adaptable places, and improving the quality and choice of housing. The Connect goal is being implemented under three programmes and 17 actions[73]. Initiatives supporting the Connect goal include: Selwyn Gets Ready website tool, Meet Your Street, Summer in Selwyn, Brave – A Daisy Poetry Promenade, The Aranui Community Trust Incorporated Society, Healthy Christchurch, Christchurch City Council Transitional Programme, You Me We Us Kaiapoi, Christchurch Central Recovery Plan, Nga Whāriki Manaaki – Woven Mats of Welcome, Urban Cycleway Projects, and Build Back Smarter.

"Participate" refers to building participation and trust in decision-making and supporting the community sector and community leaders. The Participate goal is run under two programmes and 9 actions[74]. Initiatives supporting the Participate goal include: Snap Send Solve, Eastern Vision, LinC Project, Student Volunteer Army, Friday Night All Stars and Lyttelton Harbour TimeBank.

"Prosper" refers to international connections for informing best practice and sharing lessons, fostering a culture of innovation and sustaining the vitality of our natural environment. The Prosper goal is being implemented under three programmes and 16 actions[75]. Initiatives supporting the Prosper goal include: Ministry of Awesome, Starts with a Smile, Christchurch Airport Open Sky Policy, EPIC, powerHouse, Edible Canterbury, Mahinga Kai Exemplar Project and Whaka-Inaka: Causing Whitebait.

"Understand" refers to improving community understanding and acceptance of risk, managing the risks faced, and securing the future in the Eastern parts of Christchurch. The Understand goal is being implemented under three programmes and 16 actions[76]. Initiatives supporting the Understand goal include: Canterbury Natural

[70] http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-greater-chch/cultural-diversity.aspx
[71] Page 18, Resilient Greater Christchurch Plan, http://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf
[72] http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-greater-chch/cultural-diversity.aspx
[73] Pages 105-107, Resilient Greater Christchurch Plan
[74] Pages 108-109, Resilient Greater Christchurch Plan
[75] Pages 110-113, Resilient Greater Christchurch Plan
[76] Pages 114-116, Resilient Greater Christchurch Plan

Hazard Risk Reduction Group, Collaboration for Business Resilience, Canterbury CDEM Group and Ōpawahō Heathcote River Network.

Infrastructure Resilience

The Canterbury earthquakes sequence caused extensive damages to Christchurch's distributed infrastructures, damaging: more than 1.5 million square metres of road; 659 kilometres of sewer pipes; 69 kilometres of water mains[77], further to impacting the electric power and telecommunication networks[78]. As far as buildings are concerned, 168,000 dwellings needed repair or rebuilding, while 1,100 buildings were demolished in the Christchurch city centre[79].

Lessons learnt about infrastructure resilience in Christchurch following the earthquakes included, among others:

- "Communities are dependent on infrastructure services and need to remain connected"
- "Water is fundamental to community survival"
- "Planning for other shocks or stresses benefited community preparedness – e.g. pandemic preparation helped to ensure that there was no outbreak of disease"
- "Investments of resources and time to promote and build resilience payed off" – e.g. the multi-disciplinary approach to lifelines engineering developed by the Christchurch Engineering Lifelines Group starting from 1997, greatly improved the overall resilience of infrastructure with most power, water, communication services, and air, road and rail travel remaining functional on the days following the earthquakes.

The Recovery Strategy for Greater Christchurch[80] set out by the Canterbury Earthquake Recovery Authority's (CERA) ruled the (demotion and) rebuilding of infrastructure, buildings and housing. The horizontal infrastructure rebuild targeted roads, freshwater, wastewater and stormwater networks and is currently 99% complete[81]. The vision for the horizontal infrastructure rebuild set out by the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) was to "*create resilient infrastructure that gives people security and confidence in the future of Christchurch*". This was achieved by: improving safety; demonstrating best long run value for money; fostering an open and honest dialogue with residents; promoting high level standards for customer service; protecting the environment; reducing future health hazards; and meeting the appropriate design standards[82].

Towards the rebuilding of more resilient housing lands were assessed for natural hazards and zoned, and the Building Act's seismic performance requirements were fully implemented in the reconstruction. The still on-going resilience-rebuilding, is targeting the creation of a better urban form to reflect the needs and aspirations of the community. With population growth and changing demographics, the rebuild needs to account for and mitigate future stresses such as homelessness, unemployment, traffic congestion, accessibility to services and environmental pressure.

After the large-scale damage and demolition process in Christchurch CBD, *"Anchor Projects"*[83] such as new public facilities including the Convention Centre, Metro Sports Facility and the Canterbury Earthquake National Memorial have been conceived to encourage future developments and attract people back into the central city. New public spaces such as gardens, parks, gathering spaces and paths are planned to make the central city greener

[77] Indicate here where the numbers come from
[78] Giovinazzi, S.,Wilson, T., Davis, C., Bristow, D., Gallagher, M., Schofield, A., Villemure, M., Eidinger, J., Tang, A., (2011). Lifelines Performance and management following the 22 February 2011 Christchurch Earthquake, New Zealand: Highlights of Resilience. Bulletin of the New Zealand Society for Earthquake Engineering. 44 (4), pp.402-417
[79] http://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf
[80] http://cera.govt.nz/sites/default/files/common/recovery-strategy-for-greater-christchurch.pdf
[81] http://strongerchristchurch.govt.nz
[82] http://resources.ccc.govt.nz/files/canterburyearthquake/scirt-infrastructure-rebuild-plan_web.pdf
[83] https://www.otakaroltd.co.nz/anchor-projects/

and more enjoyable to move around. Current initiatives include South Frame and the Te Papa Ōtākaro/ Avon River Precinct. The East Frame will be a new residential area built around a large park to attract people to live in the central city. *"Accessible City projects"* are also planned to improve the travel network in the central city.
In line with the City Resilience Framework[84], the Resilient Greater Christchurch Plan aims to make strategic investments to improve the city's infrastructure resilience and to endure multiple shocks and stresses.

Governance for Resilience

Greater Christchurch is home to 40% of the South Island's population, and is a strategic regional centre and primary economic hub of the South Island. The earthquakes showed gaps and uncertainty in governance arrangements for long-term recovery and resilience in Christchurch City. The role of central government in recovery through CERA has been a big issue, along with turnover in leadership positions. Rigid governance processes made engagement difficult and people were often not up to date with decisions made. It is important to re-build the trust between communities and decision-makers and change the way governance engages with people by ensuring that governance is transparent and participatory.

The Resilient Greater Christchurch Plan[85] which outlines the new resilience strategy for Christchurch was developed as a collaborative sub-regional governance group that included the local Councils (Christchurch City Council, Waimakariri District Council and Selwyn District Council), local Māori leadership (Ngāi Tahu), health board and government agencies. Participative leadership and governance was a focal point for developing the resilience strategy for Christchurch.

The resilience strategy is led by two guiding principles that reflect the type of governance required for a resilient Christchurch: (1) A meaningful Treaty partnership with Ngāi Tahu, and (2) Consistency and collaboration across all tiers of government. Developing a meaningful Treaty partnership with Ngāi Tahu involves developing and enhancing existing relationships with local Papatipu Rūnanga[86] through regular formal engagement. The generation of bi-cultural governance arrangements is important for the resilience of Christchurch. Since the earthquakes Te Rūnanga o Ngāi Tahu was recognized as a statutory partner alongside local and central government agencies and were invited to participate in all decisions relating to the recovery of Greater Christchurch.

Consistency and collaboration across all tiers of government aims to develop a common base of evidence and understanding, and effective and positive relationships between agencies to find solutions to suit specific local conditions. Collaboration also results in better management of resources, avoiding duplication, delivering cost-effective solutions, and making use of regulation to drive change or compliance. The Greater Christchurch Urban Development Strategy partnership is an example of collaborative multi-agency governance[87]. The Canterbury Natural Hazard Risk Reduction Group, formed in 2016 is another example of collaboration across Councils and Civil Defence Emergency Management. The aim of the group is to develop and implement a regional approach to managing natural hazard risk across the Canterbury region.

Regenerate Christchurch[88], established to lead Christchurch from recovery to regeneration has adopted a governance structure consistent with the Resilient Greater Christchurch Plan's guiding principles. It is overseen by an appointed board with a lifespan of five years, after which it will become a City Council entity. Regenerate Christchurch will develop visions, strategies and regeneration plans for Christchurch through engagement with communities, stakeholders and decision-makers. It will also provide advice to the Minister and the Christchurch City Council.

Recommendations for developing a governance system that can contribute to Christchurch's resilience include transparency with the community and maintenance of public confidence amongst decision making bodies, a fair and efficient system for settling insurance claims and paying close attention to the community social and psychological impacts of new policies being introduced.

[84] https://assets.rockefellerfoundation.org/app/uploads/20140410162455/City-Resilience-Framework-2015.pdf
[85] http://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf
[86] Constituent areas of Ngāi Tahu
[87] http://greaterchristchurch.org.nz/people-and-partners/partnership-overview/
[88] http://www.regeneratechristchurch.nz

Economics of Resilience

Greater Christchurch is the primary economic hub of the South Island with 40% of the South Island's population[89]. In 2016 regional statistics, manufacturing, construction and owner-occupied property operations were the highest contributors to Canterbury's GDP[90]. Engineering, technology and research-based industries have also grown in the past few decades from the establishment of tertiary education providers such as the University of Canterbury, Lincoln University and the Ara Institute of Canterbury.

The earthquakes have generated change in demographics and economics in Christchurch. Many businesses have had to relocate and/or shut down. The industry profiles in Christchurch have altered, with construction now being the top industry contributing to 9% of Canterbury's GDP[88,91] as a result of the rebuild. The rebuild has also attracted many newcomers and migrants into the skilled labour workforce.

The resilience challenges and opportunities for Christchurch include: securing the future of Eastern Christchurch; innovation of businesses; and improving the urban form. The eastern suburbs of Christchurch were severely damaged by the earthquakes and need to be supported to recover, rebuild and attract residents and businesses. Working with the lower socio-economic communities in these areas is important to rebuild economic vitality. Businesses need to be innovative to stay competitive with global markets. As is common in all cities, it is crucial that the right environment is provided to ensure that workers and businesses are able to rapidly adapt and keep up to date with new processes and technologies. Greater Christchurch is well placed to provide necessary education and training with three university campuses and a polytechnic, seven Crown Research Institutes, two Centres of Research Excellence and high tech manufacturing businesses. Attention to the urban form through the rebuilding process is important to maintain the desirability of Canterbury as a place to attract economic investment.

The Canterbury Regional Economic Development Strategy[92] has the vision of creating "a region making the most of its natural advantages to build a strong innovative economy with resilient, connected communities and a better quality of life for all". A resilient economy for Christchurch is dependent on the ability to export primary sector products, resources and tourism. The Resilient Greater Christchurch Plan outlines the following actions to support economic resilience in Christchurch:

- Build strong national and international connections as foundations to attract people, develop markets and stimulate collaboration through initiatives that market Greater Christchurch to overseas investors, visitors and workers. Current initiatives include: Ministry of Awesome, Canterbury International Education Leadership Accord, Antarctic Support Programme and Sister Cities.
- Future proof our physical infrastructure to safeguard our economic performance and overseas trading connections through investment in the growth of Lyttelton Port and maximising the numbers of passengers through Christchurch International airport to build connections to international markets. The roll out of fibre broadband and ongoing dialogue around a South Island international data cable link will safeguard our connections to businesses around the world. Current initiatives include: Lyttelton Port Recovery Plan and the Christchurch Airport Open Sky Policy.
- Invest in attracting and retaining workers from overseas to supplement our ageing workforce and stimulate new business ideas through retaining the estimated 25,000 workers who came to Christchurch for the rebuild and harnessing their skills in other industries. Retaining young people and attracting others from overseas through university and tertiary education institutes is also planned. Current initiatives include Starts with a Smile.
- Support an environment that enables innovation and creativity as means to diversify the economy and add value to production through developing innovative and creative networks, simplifying processes that stand in the way of commercial development of opportunities, and support for research activities that can improve productivity. The SMART City concept attempts to improve innovation by embedding technology and enabling opportunities for commercial and public sector organisations to collaborate.

[89] http://greaterchristchurch.org.nz/assets/Documents/greaterchristchurch/Resilient/Resilient-Greater-Christchurch-Plan.pdf
[90] http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/RegionalGDP_HOTPYeMar16.aspx
[91] http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-greater-chch.aspx
[92] http://canterburymayors.azurewebsites.net/wp-content/uploads/2016/09/CREDS-economic-indicators_Jun-16.pdf

Current initiatives include: Business Friendly Councils, EPIC and the Innovation Precinct, Powerhouse, FoodSouth, GreenHouse, Creative Industries Support Fund and AgResearch.

The importance of critical infrastructure performance in disaster resilience is well understood in Christchurch and have been incorporated as much as possible within the necessary financial constraints. Lessons learned by individual businesses and the sharing of these lessons through organisations such as Resilient Organisations[93] and projects such as the Resilient Business New Zealand Initiative[94] help to build businesses that are prepared and able to quickly adapt and work with communities in future disruptions.

Future

Development of the Resilience Strategy for Christchurch has been a collaborative effort including key people and expert knowledge to understand the key issues facing Greater Christchurch and determine a road map to building resilience to overcome these issues in the future. The Strategy is just the start of Christchurch's journey towards better resilience.

An Implementation Plan is being developed to put the Strategy in action, identifying detailed projects and relevant actors. Some projects will be driven by Christchurch's appointed Chief Resilience Officer (CRO). The Greater Christchurch Urban Development Strategy Partnership was created to oversee implementation of the wider plan and monitor progress in the future.

[93] http://www.resorgs.org.nz
[94] http://resilientnewzealand.co.nz/business-resilience/

Hamilton

Current Resilience Strategy

There is no current resilience strategy for the city as a whole. Individual Council units, such as City Waters, have their own resilience strategies in place as an adaption/mitigation strategy however there are no documents on "resilience strategy" through Council's data repository. Many of these resilience strategies are under the Activity Management Plans (AMP), developed in 2015, which provide resilience measures and the rationale behind these decisions. The four critical infrastructures have been examined below.

The three water networks (Water Supply, Wastewater, and Stormwater) have similar resilient strategies which include but are not limited to increasing their capacities, improving their asset plans (City View) and subsequent infrastructure mapping, and insurance of assets. In addition, each unit has individual strategies.

The water supply network has plans in place to not only strengthen reservoir infrastructure to increase the resilience in a seismic event but also to increase capacity of supply in response to growth. Additionally, the new low river contingency system (2016) allows water to be taken from the Waikato if needed under a lower river level. These measures not only increase the resilience of the water treatment plant but also increase the city's accessibility to safe drinking water (with the plant being one of the five critical infrastructure units).

The wastewater network has a strategy to improve resilience to inhibitor/ toxic/ dangerous substances which can pose risks to Hamilton
s ecosystems. Furthermore, the development of new plans to manage unplanned events increases the overall resilience. In a power outage event, there are power supply reinforcements and emergency generators for sites.

Major flooding is a significant risk to the stormwater activity. The mapping of these events is currently being modelled. This knowledge will enable Council to understand where capacity is not available and flooding may occur. Emergency plans and back-up processes are available to minimise the potential effects in a flooding event. In addition, there are erosion protection schemes.

As of 2015 the transport network has some gaps in their current resilience strategies however future plans are in place for increasing resilience of key roading and bridges. River bank stability, erosion, and the potential of river degradation to impact bridge strength (this has an initial risk rating of low however) are some of the highest risks to the transport network- specifically bridges. The Business Continuity Plan (BCP) states that if damage was to be sustained then the assessments and detours will be completed and implemented by Council resources.

Hamilton City Council (HCC) and Waikato Regional Council (WRC) are, however, aiding MCDEM along with other Council bodies, with developing National Disaster Resilience Strategy which will be completed late 2017. Additionally, work is currently being done in regards to a Hamilton City Natural Hazard Risk Analysis which could aid a resilience strategy.

While there is no overall resilience strategy, however, there is a sustainability principles report[95]. This report has eleven principles which look into how to increase the sustainability of Hamilton. Part of this includes the supporting of resilience to climate change, specifically working with central government on reducing greenhouse gas emissions. Furthermore, the keeping of these strategies, with a resilience perspective, in a single document would be of the utmost use in the creation of a resilient strategy plan.

The Hamilton City Council Risk Unit has identified some gaps in the current framework. This is currently being addressed after the Kaikoura earthquake sequence showed some flaws in the communication network. Additionally, in other areas of risk resilience Hamilton City Council has blind spots which this report is aiding to identify and understand.

Instead of using the Rockefeller Resilience Rating, Hamilton City Council has opted to use the UNISDR Local Governments Self-Assessment Tool; this tool is one aspect of the 'Making Cities Resilient' campaign run by the

[95]http://www.hamilton.govt.nz/AgendasAndMinutes/20150819%20Community%20Forum%20Subcommittee%20Agenda%2019%20August%202015.pdf

United Nations Office for Disaster Risk Reduction. This assessment is based on the Sendai Framework[96]'s Ten Essentials for making cities resilient and also ties in with the national Hyogo Framework for Action (HFA)[97] which is aimed at the national level. These ten essentials focus on organisation and coordination, budgets, preparedness and risk assessments, risk reduction for infrastructure, safety of schools and health facilities, risk compliant building regulations and land planning, education, ecosystems and their protection, emergency management capacities, and the needs of the affected population. Using this framework to get a preliminary rating, Hamilton City has scored 2.8 (out of 5) this can be defined as the city is between "achievements have been made but are incomplete, and while improvements are planned, the commitment and capacities are limited" and "there is some institutional commitment and capacities to achieving Disaster Risk Recovery, but progress is not comprehensive or substantial."

Resilience Measurement

Previous to this benchmarking exercise there had not been a city-wide measurement of the resilience of Hamilton. There had been very little work in the field of resilience measurement at an organisational level (at least from a HCC perspective). However, there are plans and strategies in place for specific events and how to increase resilience as the infrastructure, governance, and culture chapters will show. This is also evident in the 'current resilience strategy' chapter as the critical infrastructure networks have plans in place that they have not yet tested. Furthermore, this benchmarking exercise has shown that as there are some gaps and strategies through siloed Council units a holistic approach must be taken in the future to provide a full maturity report.

There are knowledge gaps around how to best measure resilience, there are several available systems such as the Rockefeller or UNISDR- Local Government Assessment Tool. These tools look at different aspects of resilience and it can be difficult to know which system is best and for what purpose. This stems from the lack of access to online relatively easy to use tools. Many of these tools such as the Rockefeller rating require a sign up process and acceptance which may not be feasible for certain cities, especially those on a smaller scale.

One of the key challenges is the costs that a simulation of resilience could cost the city, this is both in terms of monetary and social (decreased water pressure in a water supply resilience test for example). Another hindrance to the measurement process is the lack of access to the online tools as mentioned above.

Additionally, this type of assessment requires many personnel with many backgrounds and skills. The key challenge with this is that many people already have many projects currently and a measurement tool for resilience can seem like a waste of time that could be used for a seemingly more important task. This links back to the lack of access to tools as the lack of specific questions leads to more time needed to analyse indicators which some staff do not have the time for.

The key recommendation arising from this report process is the appointment of a working group to focus on the maturity of Hamilton as a legitimate task consisting of representative from all appropriate units. This would allow a full resilience maturity report to be written and using the gaps analysis could aid the strategists in creating a sustainable Hamilton plan; the UN-Habitat states that the key to sustainable development in cities is the ability for cities to withstand and recover quickly from acute shocks and stresses. This would aid Hamilton in many fields.

Shocks, Stresses and Strains

Hamilton's estimated population is ~161,200 making it the fourth largest urban centre in New Zealand. This population is in an area of 98km2 with a relative population density of 1465.45/km2. This is the highest urban centre population density in New Zealand as the Hamilton City territorial area is highly urban with little rural zones.

Shocks

Water Services:

[96] http://www.unisdr.org/we/coordinate/sendai-framework
[97] https://www.unisdr.org/we/coordinate/hfa

Hamilton's raw water supply is derived solely from the Waikato River. This reliance on one water source decreases resilience. The biggest risk to Hamilton is the disruption of water supply (however arising). However, current climate change predictions are that while river levels may decrease in the summer. This is mitigated by the new low river contingency deployable pump system. This is an instance where the interconnections between territories is important because many areas and people rely on water from the Waikato river thus in a water shortage scenario Hamilton, as it is further downstream than places such as Taupo, could feel the impacts. Contemporarily the water is treated at one plant that provides potable water to eight different reservoirs located around the city. If needed the water treatment plant can treat up to 106Ml/ day (although resource consent from the Waikato Regional Council mandates how much can actually be taken). In regards to the safety of this water, Hamilton water supply has been given an AA standard by Drinking Water New Zealand which means that the source and plant and the distribution grades are "completely satisfactory [with] extremely low level of risk" (para. 8)[98]. Hamilton City has had this grade since the 1960's and this trend is expected to continue.

Electricity and Gas:

As discussed above, the mighty Waikato River is imperative to both Hamilton's resilience building and survival. Most of Hamilton's energy is supplied by eight hydroelectric dams, nine power stations, and geothermal sources. Another type of renewable energy that Hamilton utilises is landfill gas and bio-gas (produced from animal manures and sewage treatment plants). The methane gas that is produced naturally at landfill sites is burned which provides energy and reduces the effect of greenhouse emissions by converting the methane into carbon dioxide (which is less detrimental than methane in greenhouse emission science). Hamilton is the only New Zealand site where natural gas is blended with bio-gas and used to power generators. This use of localised energy supply has the potential to increase resilience as there is less need to rely on other cities and power thus there is less risk in shock/stress events affecting other areas and the flow on impacts.

Stresses

Hamilton has a higher unemployment rate at 9.5% than the New Zealand average of 7.1%[99]. This trend has been observed for at least the last ten years. This can have an impact on social cohesion because those without jobs are less likely to be a part of community participation, can lead to social tensions and unrest, and can negatively affect the way that societies manage collective decision making[100] (World Bank, 2012).

Population growth is seen as a potential stress for cities if adequate facilities and infrastructure are not taken into account. Many urban areas across the world and nationally are expected to continue increasing population (positive population growth). This is also the case with Hamilton. This is a factor that can increase the stress of shocks and other stresses and unless mitigated effectively can become a strain on society. An increased population does not necessarily decrease resilience however, it can increase risk if the city does not adapt. This is due to the increased need for food, water, power, and further demands on housing, jobs, transport, leading to an increase in population density. If mitigated properly then this is nothing more than a statistic rather than a potential issue.

Additionally, better communication with other cities will be needed to increase resilience as the pressures from other city populations (specifically Auckland) could see a rise in the rate of migration into Hamilton (whether to stay or simply bypass). This influx of people (particularly following a shock event) could increase risk and decrease the resilience of Hamilton and its people, if not mitigated.

Climate change is a stress to cities as the increasing temperature rates has a variety of effects on the future climate and weather. Without proper research and examination of the potential effects for individual cities and regions there is an increased risk and subsequent decreased resilience as future plans, strategies, and infrastructure could be compromised. The increased risks of climate change are currently being studied by HCC and its relation to natural hazards such as drought, flooding events, and high winds. This research and subsequent education will lead to increased resilience as people will know more about the potential future effects that will impact them and the city's infrastructure.

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[98] The Institute of Environmental Science and Research. (2008). Public Health Grading of Supplies. Retrieved from http://www.drinkingwater.esr.cri.nz/general/grading.asp

[99] Statistics New Zealand. (2013). 2013 Census QuickStats Hamilton City- Work. Retrieved from http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-a-place.aspx?request_value=13702&tabname=Work

[100] World Bank (2012) World Development Report 2013: Jobs. Washington DC. World Bank. DOI:3-9575-2.

Hazard Knowledge and Awareness

The current status of the Hamilton Basin hazardscape is being mapped through the riskscape software produced by NIWA. Additionally, previous maps have been produced in regards to flooding, storm waters, and liquefaction. Furthermore, Waikato University has recently found one major fault line (Kukutaruhe) through the centre of Hamilton. There are also an estimated potential two other fault lines that run through Hamilton, north and south of the Kukutaruhe Fault line. This has the potential to increase seismic risks to the city; and the identification of this fault, with subsequent education, can increase urban resilience as this information aids city planners, and infrastructure units. This is also the case with other potential hazards in the Hamilton basin which include but are not limited to, flooding (high intensity rainfall and river), drought, high winds and tornadoes, severe storm systems, and volcanic ash deposits. All of these hazards have the potential to increase risk to the people and the city of Hamilton and thus knowledge and education around them is key.

There are gaps in the hazard knowledge of Hamilton. Some of these include the true knowledge of the faults. Currently, from what was found, there is little information on the effects these fault lines could have on the city. Currently, there are very few maps of contemporary hazards for the city thus localised issues and risks are not being mitigated (note that research is being done in this field this summer 2016/17).

One of the largest challenges in the identification and assessment of hazards is the funds available. Funding allocation is key to the resources and staffing of a unit which looks into hazard mapping and the potential risks which leads to increasing resilience. HCC staff already have limited additional capacity, thus cannot commit their full schedules and resources into the evaluation of hazards, therefore this work has taken longer than in other cities who have streamlined this work. One way to alleviate this is through increased funding going into these departments.

Additionally, the seemingly lack of potentially huge disaster zones in Hamilton means that there has been little perceived need for this type of study. This is the root of the problems. At a national level, Hamilton is the fourth biggest city, behind Auckland, Wellington, and Christchurch, yet the three other cities have hazard study programmes due to their proximity to disaster potential zones (whether earthquake, volcanic, or coastal climate). This has a flow-on effect in which there are no huge central government pushes for this research in Hamilton. While Hamilton City Council is in close proximity to Waikato University it should strengthen its relationship in order to build resilience capability through sharing of resources and knowledge. These ties would also alleviate stresses put on Council staff to study the hazards of the Hamilton Basin. Also, these ties and the increased funding means that the investigation of the Hamilton hazardscape will be more in-depth, leading to higher quality results and in turn leading to an increased understanding of Hamilton, its future risks, and overall increasing the cities resilience capability.

Another suggestion is to appoint a Chief Resilience Officer (CRO) who can use an inter-unit approach to resilience for Hamilton. This officer would use the information from the aforementioned suggestion, and aid the strategy and planning department in increasing resilience through proper planning and education of the public. Ideally this CRO would have inter-city connections in order for a holistic and interconnected approach to the evaluation of hazards; this is increasingly important for New Zealand as there is increased risk that geohazards may affect multiple cities or that disaster events in one city may impact another. Thus this investigative, practical research role will be extremely important in the future as population growth and climate change stress will only exacerbate current issues and this role will aid in mitigation and adaptation.

More education to the public surrounding hazards and their effects would increase resilience through the spread of information to more communities.

Community Resilience

There are currently limited formal efforts to build resiliency at a community level in Hamilton. Most efforts have involved providing information to residents about being prepared for a Civil Defence emergency. Hamilton City Council has produced a Community Response Plan - a resource to advise residents on what is needed to be prepared for an emergency. This has been distributed to a number of residents and community facilities throughout the city. Council's Older Person's Plan includes an action to provide information to older people on being prepared for an emergency. There may be actions taking place to build resiliency at a local level occurring, but no stocktake has been undertaken to determine if this is the case. On-going activities like the annual

Neighbours Day projects contribute to encouraging social connections among neighbours in the city which becomes a valuable resource when emergencies occur and people offer support to each other. Efforts to build community resilience have focused on encouraging households to engage in local Social Media groups. Council has an official Facebook page, and Civil Defence has partnered with the Neighbourly platform.

A significant gap in the community may be a lack of understanding of what resilience is and why it is important on a personal and local level. Many residents may be relying on others to meet their needs during an emergency or sudden shock. There is also likely to be an individual funding gap. Many people may want to increase resiliency and be better prepared to meet emergencies if they occur, but do not have the resources to allow them to do it. There may also be a lack of information. Council's resources are a critical resource, but unlikely to be viewed by those who are isolated or in hard to reach locations. Those who are living alone or otherwise not interacting with community agencies may not be aware of this.

Hamilton has a diverse population which is comparatively young compared to most other cities in New Zealand. However, like other cities in New Zealand, the population is ageing. Hamilton is somewhat unique in having growth in both older and younger populations. Hamilton has high Maori and migrant populations. Like other cities in New Zealand, around one quarter of the population have a disability. Building resilience in a city with such high diversity is challenging – different messaging is needed to ensure all groups are reached and engaged. Targeting through social media will be a necessary tool for young people, but older people are less likely to respond to this. Other communities will need a more direct approach. Those with more complex needs, or are living alone need to be considered, as their resilience tools will need to be stronger than others.

There may also be a need to shift perceptions in the community that Hamilton is a relatively "safe" area in terms of natural hazards. There is a perception that Hamilton is not prone to the same level of risk as other New Zealand cities, due to its inland location and (incorrect) perception that it is not near a fault line. This low risk perception has also made it harder to convince companies to invest more resources in staff training and capacity building for emergency preparedness. Working with local communities and potentially the media to shift this perception may be beneficial. Funding to enable and empower individuals and communities to build their own resilience will be an on-going challenge.

Hamilton City Council's Community Development team operate on the principle of working with communities to build capacity and strong relationships across the city. These relationships could be leveraged for increasing resiliency at a community level. A multi-pronged approach that acknowledges the diversity of Hamilton's community would be an essential element of long term success. There is a reasonably high level of community connectedness and a network of community facilities and houses throughout the city that could be used as centres for building resilience at a community level, through partnership with Council and other agencies.

Those most likely to be affected on a personal level in an emergency or sudden shock are also the ones most likely to lack resiliency to deal with it. Putting resources into preparing the most vulnerable and isolated in the city will ease the burden on all at the time of an emergency. CDEM could be a useful point of focus for such an approach.

Programmes to encourage residents to become active members of community groups will need to be promoted across Hamilton. Promotion of volunteering spirit and support to organisations that manage volunteer opportunities can help strengthen resilience in the community. Working with the health providers including mental health rehabilitation is another suggestion/recommendation.

Infrastructure Resilience

For Hamilton's critical assets there are back-up generators on site or mobile, duplicate assets where appropriate, for example, major pump stations. The majority of the water network is asbestos, concrete and the wastewater network has a significant amount of earthen ware. Over time these pipes are being replaced with plastic which will increase the overall resilience of the city. Due to the reticulation network having a ring feed system this increases the resilience of the city as individual pipes become less important as others can support areas where need be. Future plans suggest building a second Water Treatment Plant, ideally using another water source to increase the resilience of Hamilton. There are also emergency plans in place for the infrastructure units. While, the waste water system is vulnerable to flooding in high intensity rainfall events the aforementioned emergency plans help to mitigate potential consequences.

The city can measure its resilience through tools which include but are not limited to infrastructural inspections, leak detection, CCTV, SCADA. Council also has policies in place where they focus on ensuring that greater risk buildings and structures are not only identified but also brought up to level of strength (defined by the Building Act 2004). Also, mapping of the infrastructure means that in an event the location of key assets are known and the environment they are in can be used as a preliminary evaluation.

In regards to the transport network, detailed seismic assessments are being done on bridges to check stability. These reports will aid in building urban resilience. Seismic assessments are being carried out for the above ground assets, but currently there is nothing in place to determine the integrity of underground assets. The condition is known, but can only assume seismic strength. Whilst work can be done (and has been) to strengthen reservoirs, in a seismic event if the pipes fail water will be unable to flow in or out.

Hamilton's geography means that the city is split in two by the Waikato River, and thus is reliant on the traffic bridges to convey not only people but also water and wastewater from one side to another; this means that the roading and bridge networks are integral to the operations of the city. Both the water and wastewater treatment plant are on the western side. In a major event, the eastern side may not have enough water or wastewater storage to continue to supply of service for more than 24 hours. This decreases the resilience of Hamilton as most of its population resides on the eastern side. An additional gap in the framework is the lack of knowledge in siloed units of their roles in a shock event. This stems from a knowledge gap in regards to emergency management perspectives.

The challenge of most importance to the infrastructure and transport network teams when building resilience is adequate funding. There is currently no funding for resilience building; all current increases of resilience have been done under a 'business as usual' system in which specific structures are brought up to current standard as they are replaced or upgraded. It is important to understand what the level of service will be in an event such as an earthquake. For example, what standard should the reservoirs be built to whether that is IL 3 or IL 4? Seismic strength brings up questions of uncertainty such as for the piped network, are the national standards for pipe materials, laying and bedding sufficient service intact though a major event such as an earthquake?

A suggestion to combat the lack of emergency management knowledge by individual silos is to involve other units when doing disaster scenarios, thus including more people and getting a wider more holistic perspective. This will increase the resilience of the city as more people will have knowledge of emergency management with a specific focus on their business as usual roles.

Governance for Resilience

Governance for Hamilton City is driven by elected members. In the past, the governing body of the Council has been an aid to resilience building through the signing of the Local Government Leaders Climate Change Declaration. This declaration aims to give support to the central government to develop and implement an ambitious transition plan toward a low carbon and resilient New Zealand. In particular, it notes that sound planning, and a good understanding of hazards is needed to build resilience. Although the focus of this declaration is on climate change and sustainability, the basic principles are modular and can be applied to urban resilience. The recent local body elections saw a significant number of newly appointed elected members, including a new Mayor. The elected members have yet to express their views with regards to resilience, however the newly elected Mayor has shown commitment to investment and growth of city and this may extend to resilience.

The last Council adopted eleven Sustainability Principles in July 2016 as an overarching guide to the city, which includes five of the actions from the Local Government Leaders Climate Change Declaration:

- Council works with central government to deliver on national greenhouse gas emission reduction targets and supports resilience to climate change in our communities
- Council promotes walking, cycling, public transport and other low carbon transport options
- Council works to improve the resource efficiency and health of homes, businesses and infrastructure in our city
- Council supports the use of renewable energy and uptake of electric vehicles

Council ensures that it understands, prepares for and responds to the impacts of climate change These principles are in the process of being embedded in business as usual operations of the Council and will support development of resilience in the city, particularly with regard to climate change. Council units will be required to consider these principles in their decision making and this will extend to the elected members as well.

The silo effect of Council units can mean there is decreased resilience as changes made to sites have the effect of increasing resilience in one area while potentially making another more vulnerable. However, increasingly there is a more unified holistic approach from Council units which overall increases the resilience of HCC and thus the city.

Another key gap in the current governance system is the lack of understanding of resilience. There seems to be very few people who can define and know of aspects of resilience, even though their internal policies may show that they have taken this into consideration. Because of this the governance structure has, in the past, combined sustainability and resilience together and these terms have been used interchangeably.

Short term political cycles are one of the key constraints in developing a cohesive and consistent approach to resilience. There may be political will to undertake resilience work in one Council term but each term requires the topic to be revisited to garner governance support. Or this situation may be in reverse. Additionally, commitments to workshop resilience (such as through CDEM exercises with Councillors) are still yet to be initiated- in part due to changes in governing officials.

One of the key challenges for developing a resilience strategy is the polarising nature of the topic of resilience. Some of the background discussion to resilience falls into the category of belief. As such, it can be challenging to get Councillors on board with the idea of creating a resilience strategy, particularly when associated with understanding the consequences of climate change for the city and the need to adapt infrastructure to accommodate these changes. This is also true of key staff within Hamilton City Council. Many people have pre-conceived ideas and beliefs about this area and this can lead to resistance to accepting that there is any need to plan for dealing with future challenges and changes. This is most evident in the management of anthropogenic climate change (which is linked to resilience as it is one of the slower stresses that affect all aspects of urban systems). Funding and staffing are also key challenges with most projects.

One of the key suggestions that this report has shown is the need for resilience to be included under its own strategy, which the governing body (including key staff) need to implement. This would cover funding and staffing which are some of the key challenges of many projects. Additionally, the increase in awareness of resilience at the governance level would greatly enhance the Council's ability to build and increase resilience as it would legitimise the concept and allow more work to be done in that field.

Economics of Resilience

There is no evidence of adequate consideration given to the economic impacts of disasters in Hamilton. In the UNISDR local governments' self-assessment, Hamilton scored 2.8 (out of 5). This can be defined as placing the city between "achievements have been made but are incomplete, and while improvements are planned, the commitment and capacities are limited" and "there is some institutional commitment and capacities to achieving Disaster Risk Recovery, but progress is not comprehensive or substantial". This assessment shows a substantial capital investment is required for further improvement of the city's resilience. The necessary investments are always going to be constrained due to factors such as lack of capital and skilled labourers. Therefore, it is necessary to clearly understand the least-cost options to be invested with. This would involve a comprehensive cost-benefit assessment of the tools and perhaps investment optimization models capable of optimizing the investment subject to various constraints. However, there is no readily available framework or optimization tools capable of proper economic assessments.

Another gap in the current economic frameworks is their inability to account for and assess the value of cultural and social capital in sustaining resilience. Bordieu (1986)[101] argued that our focus on economic capital has been due largely to the clear immediacy and transparency of economic exchanges, and that consequently this has meant that other forms of accumulated values such as cultural and social capital have tended to be neglected. Bordieu defined social capital as resources that can be mobilised via social connections and mutual obligations, and cultural

[101] Bourdieu, P. (1986): The forms of capital. In J. E. Richardsun (Ed.) Handbook of Theory of Research for the Sociology of Education. Greenwood Press. pp. 46-58.

capital as resources in the form of knowledge, skills, dispositions, and possession of culturally significant objects. Central to Bordieu theory is the notion that capital is transferrable amongst all three forms via 'symbolic capital' (status, prestige and reputation).

Generating economic frameworks to assess the least-cost options to sustain resilience is not an academically difficult task. However, it does need some urgency and investment which is lacking under the current generally safe Hamilton environment. There is no attempt to accommodate other forms of capital in the currently available economic optimisation models. One of the main reasons for this is that other forms of capitals are hard to express in mathematical forms.

It would be advisable to invest some resources to develop the economic framework, allowing us to complete a proper cost-benefit analysis of investments to improve the various aspects of resilient components that have been discussed in the other chapters. It also requires some change in thinking of economic optimisation models to accommodate social and cultural capital components. It should not be a mathematical process necessarily, but some kind of complementary framework to work in collaboration with economic optimization models. Further assessment of Bordieu's concepts of capital and their application to sustain resilience would be useful. Some scholars have already paid attention to these concepts, and the conceptual framework by Burton and Paragahawewa (2011)[102] on this subject could provide useful insights in this regard.

Future

After looking at the gaps and suggestions of the report chapters the following directions are areas that need to be developed in order to increase Hamilton's ability to cope with and grow from acute shocks and stresses. The following ideas range in costs and benefits from relatively cheap and simple tasks to more expensive greater undertakings:

- After this national report more work is already being started in resilience studies for Hamilton City Council and as more people become aware of the benefits etc. This trend is likely to continue. The legitimisation of resilience as a key approach here at Council will see more work being done in the field.
- Looking at understanding the resilience of the city in more depth – in particular what risks are most pressing, what sectors or people are most vulnerable (White & O'Hare, 2014)[103].
- Development of Resilience Strategies which take a holistic, multi-disciplinary approach to the city (and the sub-region) would flow on from the previous bullet point. It is important to add the sub-region into this approach as some risks will stem from within the region and some from without. These strategies could be embedded in the organisation so that all areas of Council consider them and decisions are made with them in mind. From a Council perspective, collaboration with units such as Civil Defence, Infrastructure, Growth, Community, Risk, and Communications would be integral to its operation.
- In order for the strategies to be embedded more education is needed for both staff and community on resilience and ways to build it. This goes hand-in-hand with increased knowledge of emergency response in disaster events. Using the close ties we have with Civil Defence, scenario testing and desktop exercises could be done at the organisational and practical level. When looking at a cost-benefit analysis this certainly pays off in the long run.
- Another direction is building on existing ties with other national and regional organisations such as NZTA, CDEM, Waikato Regional Council, the local district Councils, WEL Networks, and Tangata Whenua and to continue the positive relationship HCC has cultivated in the region. This will aid future resilience through greater communication in all stages of an event (pre, during, and post). Not only will it increase the resilience of the city but also the region which is fundamental.
- Community projects funding criteria could be re-assess to facilitate the programs that would be helpful to enhance the community connectedness and thus the social capital in the city.

[102] Burton R.J.F., and Paragahawewa, U.H. (2011) Creating culturally sustainable agri-environmental schemes. Journal of Rural Studies 27, 95-104.

[103] White, I. and O'Hare, P. (2014) From rhetoric to reality: which resilience; why resilience; and whose resilience in spatial planning?, Environment and Planning C, 32 (5): 934-950.

- Facilitate research on efficient use of available and upcoming technologies that are capable of enhancing the resilient of city e.g. better use of various communication technologies.
- Explore the possibility of pre-financing suitable programs in the city that would helpful to mitigate potential risks to the city due to any unforeseen shocks. This could be done by weighing a cost of recovering from a shock to a cost of measures to avoid any risk of a shock.
- Once resilience has been recognised, as a key approach able to manage complex uncertainties, here at Council, people whose tasks revolve around resilience building (such as a Chief Resilience Officer like Wellington and Christchurch have) would be instrumental to increasing the city's resilience. Part of this work would be the greater study of hazards (natural, man-made, and stresses) that the city faces and the potential effects and ways to mitigate potential damages. While some work has been done, a comprehensive hazard approach needs to be undertaken in order for the city to be proactive (not reactive) to disaster events.

These direction points have been created as future solutions to the gaps that the National Science Challenge Report has shown. They are a guide only.

Tauranga

Current Resilience Strategy

The Draft Bay of Plenty Civil Defence Emergency Management Group Plan 2017 by the Bay of Plenty Civil Defence and Emergency Management (CDEM) Group will soon be replacing the current Group Plan 2012-2017[104]. The Group Plan is the strategic plan for delivery of coordinated emergency management for the Bay of Plenty region. The vision for the new Group Plan is "A safe, strong Bay of Plenty together". The mission statement for the Group is "Enabling our community to manage risks, cope with and bounce back from emergencies". The Bay of Plenty's vision reflects that of the National CDEM Strategy: A Resilient New Zealand[105], which is currently under review.

The Group Plan focuses on building community resilience to hazards under five goals and respective objectives based on the 4Rs[106]:

- Goal 1 Reduction - Reducing risks from hazards to acceptable levels
- Goal 2 Readiness - Increasing community awareness, understanding, preparedness and participation in CDEM
- Goal 3 Response - Ensuring an effective response capability
- Goal 4 Recovery - Ensuring an effective recovery capability
- Goal 5 Monitoring and Evaluation - Robust monitoring and evaluation

Goal 1 focuses on increasing knowledge about the risks facing the Bay of Plenty, ensuring information about hazards and risks is easily available and understandable, assisting in determining levels of acceptable levels of risk to influence policies, and ensuring that risks are proactively and responsible managed.

Goal 2 works towards improving individual, family, community and business preparedness, improving community participation and planning in Civil Defence emergency management, and encouraging community participation in hazard and risk management decisions.

Goal 3 looks at ensuring response capability is planned, regularly monitored and continuously developed, and ensuring that overall coordination during an emergency is timely, responsive to needs and efficient.

Goal 4 builds on Goal 3 in the recovery phase ensuring that communities are able to recover as quickly as possible.

Finally, Goal 5 aims to implement a robust process of monitoring and evaluation to have correct structures in place to deliver CDEM effectively across the region and ensure that work programmes are on track.

The Group Plan has a strong focus on enabling communities and community participation. A new Group Plan is currently being developed based on the Ministry of Civil Defence's capability assessment conducted in 2015[107].

[104] https://www.boprc.govt.nz/media/456976/2013-04-civil-defence-publication-bay-of-plenty-civil-defence-emergency-management-group-plan-2012-2017-v2-pdf.pdf
[105] http://www.civildefence.govt.nz/cdem-sector/cdem-framework/national-civil-defence-emergency-management-strategy/
[106] http://www.civildefence.govt.nz/cdem-sector/cdem-framework/the-4rs/
[107] http://www.civildefence.govt.nz/cdem-sector/monitoring-and-evaluation/cdem-capability-assessment-tool-/

The Tauranga City Council (TCC) is also in the process of developing a city-level Resilience Strategy based on the Bay of Plenty CDEM Group Plan, National CDEM Strategy, the National Resilience Framework (figure 2)[108] and the MCDEM National Disaster Resilience Strategy[109].

Resilience Measurement

Resilience measurement is conducted using a few different tools:

- The MCDEM capability assessment[110] - conducted against the 4Rs
- The Resilient Organisations Benchmark Resilience Tool - run through all authorities[111]
- Lifelines vulnerability assessments - conducted for different infrastructure networks[112]

The Bay of Plenty Lifelines Group[113] conducts studies to assess the resilience of infrastructure. The Vulnerability Study 2014[114] is ongoing with the objective of producing a workable tool to understand and reduce the vulnerability of Lifelines Group assets during natural events. The Lifelines Group is also conducting the Resilient Organisations Benchmarking Project 2017[115] to benchmark the resilience of lifelines assets.

TCC sends out research questions to the community on an annual basis on levels of preparedness in the community (e.g. how many households have emergency kits). The Civil Defence group also works closely with communities to build community relationships and enhance preparedness and hazards knowledge, but do not as yet adopt a measure to assess levels of resilience.

The Resilient Organisations Benchmarking Project undertaken in 2014[116] showed that the Bay of Plenty Lifelines Group organisations scored higher on average than other organisations in the Resilient Organisations database. The greatest resilience strengths within the lifelines organisations were effective partnerships, decision making and good planning strategies. TCC had high scores for having a resilient culture, good leadership, effective partnerships and good planning strategies which can be leveraged to promote resilience in the organisation and its activities.

Both Civil Defence and TCC interviewees stated that it is firstly important to establish what resilience means for Tauranga and the Bay of Plenty in order to develop a comprehensive tool to measure it. Understanding the attributes that make communities and assets vulnerable or resilient is needed. The Resilience Strategy[117] being developed for Tauranga will be considering this.

Shocks, Stresses and Strains

The potential shocks, stresses and strains facing the Bay of Plenty region including Tauranga are presented in the risk profile in the Bay of Plenty Civil Defence Emergency Management Group Plan[118].

The Bay of Plenty region is the second fastest growing region after Auckland with a projected population increase of 30% between 2001 and 2026. Tauranga city's population is projected to increase by 60% in this time period. The region has an ageing population with those older than 65 making up a higher proportion than the national

[108] Horrocks, J. (2014) Concept of National Resilience: DRAFT. Acting Manager Analysis & Planning, Principal Advisor Emergency Management, Ministry of Civil Defence & Emergency Management. Personal Communication May 8, 2015.
[109] http://www.civildefence.govt.nz/cdem-sector/national-disaster-resilience-strategy-development/
[110] http://www.civildefence.govt.nz/cdem-sector/monitoring-and-evaluation/cdem-capability-assessment-tool-/
[111] http://www.resorgs.org.nz/Resources/benchmark-resilience-tool.html
[112] For example, GHD (2010) Tauranga City Council: City Transportation Vulnerability Assessment, GHD.
[113] http://www.boplifelines.co.nz
[114] http://www.boplifelines.co.nz/projects/vulnerability-study/
[115] http://www.boplifelines.co.nz/projects/boplg-organisational-resilience-(2nd)-benchmark-project-2017/
[116] http://www.resorgs.org.nz/images/stories/pdfs/bay_of_plenty_resilience_benchmark_report.pdf
[117] See section 7.1
[118] https://www.boprc.govt.nz/media/456976/2013-04-civil-defence-publication-bay-of-plenty-civil-defence-emergency-management-group-plan-2012-2017-v2-pdf.pdf

average. There are isolated communities in the region such as the population on Motiti island which are highly reliant on limited transport linkages.

The concentration of economic activities such as agriculture and forestry in certain areas increases vulnerability to weather related events and disease. The large population of small and medium sized businesses has been considered to have little resilience to disruptions. There is also a low level of business continuity planning. The presence of large-scale industrial sites and the Port of Tauranga creates the potential for significant hazardous chemical emergencies to occur.

The natural environment in Bay of Plenty presents potential shocks such as volcanic activity, earthquakes, storms, tsunamis and flooding.

Hazard Knowledge and Awareness

The Bay of Plenty CDEM Group Plan[119] includes a comprehensive register of the hazards facing the Bay of Plenty region[120]. The Bay of Plenty has seismic faults and volcanoes in its surrounds that present threats from local volcanic eruptions, earthquakes and flooding (including coastal hazards). Other risks include agricultural emergencies, industrial processes, urban fires, public health crises, infrastructure failure and hostile acts.

Comprehensive risk assessments and analyses have been conducted and all hazards have been identified in priority order:

- Higher priority hazards - flooding (Rangitaiki river-Whaka and Opotiki), coastal storm, animal disease pandemic, volcanic eruption-local, human disease pandemic, biological pests and new organisms, wildfire/rural fire, tsunami-local, major air accident-Rotorua, earthquake MM6, earthquake North Island Shear Belt MM8, tsunami-distal.
- Moderate priority hazards - coastal erosion, heavy rainfall, electrical failure, civil unrest/terrorism.
- Lower priority hazards - hazardous substance release, telecommunications failure, geothermal, volcanic eruption distal-ashfall, oil tanker fire at berth, marine accident-cruise liner.

An important role of CDEM is to inform and educate communities on hazards and risk levels. Residents have a good understanding and are awareness of hazards such as storm surge, coastal erosion and flooding. For example, CDEM conducted flood scenarios and rain storm modelling and educated communities about the modelling process, possible outcomes and how they affect their property titles. Many property files now have had risk notations added with the acknowledgement from the residents.

The hazards and their risks are addressed in the Group Plan with objectives and proposed actions under the 4Rs (Reduction, Readiness, Response and Recovery). Chapter 8 of the TCC City Plan Section 32 Report[121] deals with managing developments in Tauranga in response to natural hazards. The SmartGrowth Strategy[122] addresses growth projections for land development and urban growth whilst making sure that communities are safe from natural hazards, with a long-term approach to build out of hazard areas

Natural hazards planning strategies for growth are to defend, adapt or retreat. With flooding being a frequent issue in Tauranga, TCC has started a retreat programme where the Council is buying properties that get flooded to open an overland flood path. There is also a policy statement in place giving residents the opportunity to apply for funding to divert flood flows away from their property. The retreat programme aims to purchase the most at-risk and worst flood-affected properties gradually over time.

TCC is also running a 10-year natural hazards planning programme in collaboration with CDEM and Western Bay of Plenty District Council conducting research to create an integrated policy approach to deal with hazards related to the sea, harbour and river.

[119] https://www.boprc.govt.nz/media/456976/2013-04-civil-defence-publication-bay-of-plenty-civil-defence-emergency-management-group-plan-2012-2017-v2-pdf.pdf
[120] See http://bopcivildefence.govt.nz/hazards/natural-hazards/ for more details on hazards
[121] https://www.tauranga.govt.nz/documents-reports/Councils-regulatory-documents/tauranga-city-plan/city-plan/city-plan-chapter-8.aspx
[122] http://www.smartgrowthbop.org.nz/strategy/2013-strategy/

The level of hazards knowledge and awareness is considered very good in Tauranga. The focus now is to understand and learn to deal with the effects of climate change and sea level rise, such as rising ground water levels, flooding, breaking down of road corridors and erosion of cliff top houses.

Community Resilience

A core function of the Bay of Plenty CDEM group is to work closely with communities to build community resilience through providing education and awareness on disaster risks and disaster preparedness. CDEM has been working in collaboration with communities to develop community response plans and build social cohesion and community relationships by holding events that bring the community together. CDEM's focus is to make sure that the people in the community know each other and support each other.

TCC's community development team[123] was established in October 2014 to "encourage and support strong, innovative and vibrant communities". The team's philosophy is to build local capacity and empower the community, enabling people to do things for themselves, and therefore building community resilience. Undertakings for community development and resilience include:

- The Community Development Match Fund - $100,000 provided annually for community groups applying to fund their own community projects (social, environmental, cultural etc.)
- Managing relationships with Council's key community partners such as the Foodbank, Citizens Advice Bureau, Neighbourhood Support, Arts and Culture groups – assistance with funding, build capacity to do their own strategic planning and funding proposals, training and education etc.
- Identifying and supporting vulnerable communities – homeless (increasing in Tauranga), elderly, disabled (29% of community has some form of disability), migrant community etc.
- Advisory forums – Positive Ageing[124], Disability Advisory Group[125] etc.

The Council facilitates connecting community groups and people with key organisations, iwi, Ministry of Health and other relevant organisations. TCC joined the "Neighbourly" website to engage with the community and provide up-to-date information.

The Council constantly monitors and measures key challenges faced by local communities. Resilience issues that have come up during consultations with the community include:

- Food resilience – a multi-stakeholder group is being set up to understand this issue
- Hazards – community groups formed to understand the community's role in mitigation etc. For example, the Tauranga carbon reduction group
- Neighbourhood support – identified as a key strength for disaster recovery and resilience. The importance of neighbourhood support groups having close relationships with police and other key organisations was highlighted

Current gaps and challenges that need to be addressed include: more clarity from the Council perspective around what the greatest risks are to the community as a whole, having a clear coordinated approach to deal with the risks, identifying key stakeholders and ensuring wide community engagement in the process. Communities have a good understanding of hazards and a good level preparedness due to CDEM engagement. However, it was understood that capability around business continuity is still under-developed. The Council has recognised the need to have a better understanding around how to ensure that key functional teams can provide services back

[123] https://www.tauranga.govt.nz/our-communities/community-development.aspx
[124] https://www.tauranga.govt.nz/our-communities/positive-ageing.aspx
[125] https://www.tauranga.govt.nz/our-communities/disability-advisory-group.aspx

into the community after a disaster event as part of resilience building and strengthen relationships with other organisations that work in the community.

Infrastructure Resilience

Tauranga City Council's Infrastructure Strategy[126] presents the strategy adopted to manage the city's assets over the next 30 years. The Strategy focuses on:

- Providing the infrastructure required for resilience and growth in a manner that aligns with TCC's Financial Strategy[127]
- Ensuring the ability to maintain current levels of service through growth and other pressures
- Maintaining assets in a prudent and sustainable manner

The Strategy specifies the natural hazards that assets could be exposed to including climate change, and states that TCC addresses climate change in the development of its infrastructure through:

- Development of stormwater infrastructure within greenfield areas – designed using rainfall data which has been adjusted for climate change as a requirement of Tauranga's Infrastructure Development Code[128]
- Storm Surge and Coastal Erosion – provision ensured through planning requirements when infrastructure is considered for installation within these at-risk areas
- Existing Brownfields areas – TCC has no set policy position on considering the effects of climate change on existing infrastructure within Tauranga, however during the first three years of the 2015-25 Long Term Plan[129] the Council is undertaking research to better understand the risks of climate change

The Infrastructure Strategy also addresses the need to be responsive to changes such as legislative, regulatory or funding changes; fluctuations in the world's economy, responding to natural or unexpected events; changes in political climate; changes in organisation structure; and changes in technology impacting on infrastructure. TCC has prepared comprehensive Asset Management Plans for each asset type which comprise of day to day operations, monitoring, planning and consideration of risk, criticality and resilience to natural hazards and climate change.

TCC has identified the city's critical assets, criteria for critical assets, vulnerable areas and key hazards. Risk scores have been developed based on this information. There is a movement now towards the need to develop resilience scores and conduct more in-depth analyses of vulnerable/critical assets using bow-tie analysis.

Gap Analyses are conducted every 3-6 years based on ISO 55000 Standards for Asset Management[130] and the International Infrastructure Measurement Manual (IIMM)[131]. ISO 55000 refers mainly to risk, while the IIMM mentions the need to have a resilience strategy and programme in place, including defined levels of service for resilience. The ISO 55000 and IIMM assessments[132] determined that the best performing assets in Tauranga were transportation, followed by the three waters (water, wastewater and stormwater) and parks, while the largest gaps were in property and resource recovery and waste.

[126] http://econtent.tauranga.govt.nz/data/documents/lead/long_term_plan/2015/infrastructure_strategy.pdf
[127] Financial Strategy presented in the Tauranga City Council Ten Year Plan 2012-2022: https://www.tauranga.govt.nz/documents-reports/Councils-lead-documents/long-term-plans/ten-year-plan-2012-2022.aspx
[128] https://www.tauranga.govt.nz/documents-reports/Councils-regulatory-documents/infrastructure-development-code.aspx
[129] https://www.tauranga.govt.nz/documents-reports/Councils-lead-documents/long-term-plans/long-term-plan-2015-2025.aspx
[130] http://www.assetmanagementstandards.com
[131] http://www.nams.org.nz/pages/273/international-infrastructure-management-manual-2011-edition.htm
[132] From: Tauranga City Council (2016) Asset Management Gap Analysis June 2016, Tauranga City Council

The Bay of Plenty Lifelines Group[133] conducted the Resilient Organisations Benchmarking Project in 2014 to assess the resilience of lifelines organisations[134]. The assessment showed that the Bay of Plenty Lifelines Group organisations displayed good resilience on average with the greatest resilience strengths being effective partnerships, decision making and good planning strategies. However, many organisations did not appear to stress-test their plans. Breaking down the silo mentality within and between organisations was identified as a suggestion for the future.

In speaking to the TCC asset management planning team, a knowledge gap was identified in understanding appropriate infrastructure levels of service following an event. Better knowledge of how assets operate in failure circumstances, how far they can (be allowed to) fail etc. will assist in infrastructure resilience planning in the future.

Governance for Resilience

The city operates under three governance structures:

- The local Council governance structure[135]
- Civil Defence group Joint Committee[136]
- The Bay of Plenty Coordinating Executive Group[137]

These groups work together closely to discuss and address issues affecting Tauranga and the Bay of Plenty region. However, the role of governance in terms of disaster recovery and resilience is not fully defined. The TCC interviewees suggested that a useful exercise would be to consider different disaster/disruption scenarios locally and regionally and assess what governance structures need to be in place to drive response and recovery in the short, medium and long-term. Testing is needed to determine who needs to lead different aspects of recovery such as economic recovery and regeneration, and social recovery.

A gap that was identified in discussions was that the CDEM Group Plan[138], although it has comprehensive plans for dealing with natural hazards, doesn't clearly present resilience strategies to respond to stresses and strains. The Council and the region also do not currently have a clear strategy on climate change as a whole.

In going forward, it is necessary to define what "resilience" means for Tauranga City and the region, and gain clarity around roles and responsibilities of the different authorities. TCC'S aim is to create a single resilience strategy for the city. Resilience workshops will begin to be held from April 2017 to start the conversation.

Economics of Resilience

"Bay of Connections: Bay of Plenty Regional Strategy - An Economic Growth Strategy for a Sustainable Future"[139] is the long-term plan and guiding document setting the economic development priorities for the Bay of Plenty region including Tauranga city. The Strategy's vision is to make the Bay of Plenty the most dynamic and progressive region to achieve economic prosperity, a sustainable environment and improved well-being for all people. The Strategy's mission is "to deliver a progressive Regional Economic Development Strategy that inspires new and existing initiatives, builds on collective regional strengths, and through partnership and collaboration preserves and enhances the natural and unique Bay of Plenty environment". The ten-year high level outcomes for the region are:

1. Per capita GDP in the region has grown faster than the national average

[133] http://www.boplifelines.co.nz
[134]http://www.resorgs.org.nz/images/stories/pdfs/bay_of_plenty_resilience_benchmark_report.pdf
[135] http://econtent.tauranga.govt.nz/data/Council/files/committee_manual.pdf
[136] https://www.boprc.govt.nz/Council/committees-and-meetings/civil-defence-emergency-management-group-joint-committee/
[137] http://bopcivildefence.govt.nz/about-us/structure/bay-of-plenty-cdemg-co-ordinating-executive-group/
[138] See section 7.2
[139] https://www.boprc.govt.nz/knowledge-centre/strategies/regional-economic-development-strategy/

2. Average household income has increased faster than the national average
3. There has been a major reduction of households in the bottom quartile of national income
4. Stakeholders and agencies collaborate in effective partnerships
5. Sustainable business practices are increasing
6. There has been significant progress in advancing all key areas of focus

The highest contributor to GDP in the Bay of plenty is the agriculture sector, followed by forestry, fishing, mining, utilities, manufacturing and construction. The economic strengths in the region include its proximity and accessibility to Auckland, satisfactory hard and soft infrastructure, having the largest export sea port in New Zealand with capacity for expansion, being the country's main timber growing and processing area and having strong brand recognition in fruit growing. The region's weaknesses are its declining population, significant ageing population, low workforce participation, high reliance on narrow sector base, lower range of career opportunities outside the main centres and poor access to an international airport. Therefore, the economic development strategy has chosen four themes and 13 focus areas to develop economic sustainability and prosperity for the future:

1. More globally competitive firms in the Bay of Plenty
2. Focus areas:
    - Forestry – align with Rotorua and Bay of Plenty natural materials innovation
    - Food and Cultivation Processing – alignment across the region and innovation
    - Niche Manufacturing – become the centre of excellence for metallurgy.

3. World class infrastructure and skills to catalyse economic development
4. Focus areas:
    - Transport and Logistics – establish appropriate infrastructure to support economic development (roading, broadband, industrial land, energy, Port of Tauranga and Rotorua International Airport)
    - Broadband and Communications – support regional broadband projects to meet the needs of businesses, research institutions, education providers and others.
    - Tertiary Education and Research – develop regional partnerships with tertiary and research institutions to accelerate innovation and entrepreneurship
    - Labour and Skills – attract and develop the required skill resource to meet industry needs
    - Energy – alignment between sub-regions and sustainable energy options for the future

5. Environmentally sustainable
6. Focus areas:
    - Tourism – develop an integrated strategy building on the brand developed by Rotorua International Airport
    - Maori Economic Development and Land Use – maximise economic growth and development for Maori and efficient land utilisation and energy development

7. Innovative and productive industry sectors
8. Focus areas:
    - Marine – develop the Harbour Central Marine Precinct
    - Information and Communication Technology – link ICT businesses throughout the region and stimulate business growth

- Aquaculture – establish a significant aquaculture industry in the Eastern Bay of Plenty

Discussions with TCC highlighted that the economic effects of a disaster need better understanding. For example, if the Tauranga port was impacted from an earthquake disaster there needs to be analyses conducted to understand what the impact on the city and region would be. Better knowledge on how disasters impact economic activities can lead to robust discussions with decision-makers on how to address the related issues. The kiwifruit bacterial disease outbreak Psa[140] in 2010 provided a good example of an unexpected shock to the region's economy which required speedy, collaborative work from Bay of Plenty Regional, Tauranga City and Western Bay of Plenty District Councils.

Going forward there is a need to understand the diversity of the region's economy, its reliance/over-reliance on particular sectors and the short, medium and long-term impacts[141] of a disaster on the economy and the community.

Future

TCC is taking steps towards improving the understanding of resilience in Tauranga and developing a city-level resilience strategy to address challenges and improve the resilience of the city.

[140] https://www.boprc.govt.nz/environment/pest-management/case-study-Councils-work-together-to-help-fight-psa-outbreak/

[141] Impacts can be both positive and negative. For example, disaster rebuilding has a positive impact on the construction industry

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Current Resilience Strategy

The Hawke's Bay Civil Defence Emergency Management Group[142] (CDEM) has a strong resilience focus with its vision being "a resilient Hawke's Bay Community". Resilience is embedded regionally through the Hawke's Bay CDEM Group Plan 2014-2019[143]. The Group Plan is the resilience strategy for the Hawke's Bay region including Napier city. The aim of the plan is to build resilience in the community, with resilience defined as "how we withstand, adapt and bounce back in response to a disaster". The plan states "a resilient community is one which expects and is well prepared for an adverse event; they can cope well with the disruption and recover quickly. Everyone has a role to play in creating a resilient community".

The Group Plan is structured around the 4Rs[144] to achieve the following outcomes:

- Reduction:

  -Everyone understands the risks they face and accepts responsibility for reducing risks and being prepared.

  -Sound integrated planning, which has resulted in risks being reduced to acceptable levels.

- Readiness:

  -A strong community spirit, which helps people to pull together to ensure their safety.

  -Businesses and response organisations with well-rehearsed business continuity plans that safeguard both people and business income.

  -Community and response organisations with the capability to deal with unexpected events.

  -Community recognises the critical role Civil Defence Emergency Management plays in ensuring their safety and prosperity.

- Response:

  -People know what to do and to help each other in the event of an emergency.

  -A rapid, well-coordinated and effective response to an emergency.

- Recovery:

  -A responsive, well-coordinated and efficient recovery from an emergency.

The Group Plan focuses on participatory resilience planning and the creation of resilient communities. The Civil Defence Group initiates at least two community resilience-building projects a year. The projects aim to understand what resilience means for the community and implement exercises to engage the community, provide education and connect communities. For example, a pilot project called Tangitū Bay Watch[145] was initiated for the community to come together to create and promote a community resilience plan. CDEM will revisit this project every two years to identify key people and provide assistance. Other initiatives include Exercise Te Matau-a-

[142] http://hbemergency.govt.nz
[143] http://www.hbemergency.govt.nz/assets/Documents/Operative-HBCDEM-Group-Plan-as-at-20-June-2014.pdf
[144] http://www.civildefence.govt.nz/cdem-sector/cdem-framework/the-4rs/
[145] https://www.facebook.com/pg/TangituBayWatch/about/?ref=page_internal

Māui[146] to practice the CDEM Group's integrated response to a significant earthquake event and What's the Plan Stan[147] which is a national resource promoting emergency preparedness in primary and intermediate schools.

The Civil Defence group have also begun developing a Community Resilience Strategy[148] presenting the need for a coordinate regional approach to develop community resilience building projects. The Community Resilience Strategy outlines methods to build community resilience, guiding principles, stakeholders and their responsibilities, and tools for measuring resilience, community engagement and a community resilience plan checklist.

The Clifton to Tangoio Coastal Hazards Strategy 2120[149] is a resilience strategy that is being developed for the long-term management of the coast between Clifton and Tangoio in the Hawke's Bay region. The vision for this strategy is that "coastal communities, businesses and critical infrastructure from Tangoio to Clifton are resilient to the effects of coastal hazards" from 2015 to 2120. The strategy is still being developed collaboratively by Napier City Council, Hastings District Council, Hawke's Bay Regional Council and groups representing local iwi through a joint committee.

Napier City Council participants stated the Council has close relationships with various partners who have decision-making powers to execute a fast response in the event of an emergency. There is no specific Council-led resilience strategy or plan, therefore the city relies on key people coming together for decision-making, which was identified as an area for improvement.

Resilience Measurement

The interviewees stated overall city resilience is not yet specifically measured. Civil Defence utilises measures to evaluate household preparedness including communication and evacuation strategies. "Resilient areas" based on household preparedness are mapped out using GIS along with ebbs and flows of residents' interest in Civil Defence preparedness messaging. Civil Defence also analyses the effects of Civil Defence campaigns such as "Get Ready Get Thru"[150] through community surveys. The Civil Defence Group's Community Resilience Strategy, currently being developed,[151] provides a basic tool to measure community resilience through rating indicators under social capital, managing risk, household plan and resources.

The Council conducts economic regular vibrancy measures and surveys to collect data on retail businesses, business occupancy and other statistics related to the city's economy. The Council interviewees stated adopting a city resilience measurement such as the Rockefeller City Resilience Framework[152] would be useful.

Shocks, Stresses and Strains

The main shocks identified for Napier are its natural hazards, of which the top hazard is earthquakes, particularly having experienced the 1931 Napier Earthquake which still remains New Zealand's deadliest disaster. Other hazards posing risks for Napier include tsunami, volcanic ash fall, human pandemic and flood/storm events. The Hawke's Bay CDEM Group Plan[153] provides the risk profile for the Hawke's Bay region including Napier which addresses its shocks, stresses and strains.

The Group Plan presents the following risk implications for the region from its natural environment and hazards:

- Its high number of natural hazards.

[146] http://hbemergency.govt.nz/assets/Documents/Exercise-Te-Matau-a-Maui-Final-Report-11-February-2016.pdf
[147] http://hbemergency.govt.nz/education/whats-the-plan-stan
[148] Strategy not yet available online
[149] http://www.hbcoast.co.nz/strategy-development/
[150] http://www.civildefence.govt.nz/cdem-sector/public-education/research-and-evaluation/get-ready-get-thru-campaign-evaluation/
[151] Strategy not yet available online
[152] https://www.rockefellerfoundation.org/report/city-resilience-framework/
[153] http://www.hbemergency.govt.nz/assets/Documents/Operative-HBCDEM-Group-Plan-as-at-20-June-2014.pdf

- Majority of people in the region living on flood plains. Napier is situated below sea-level which makes managing stormwater challenging.
- Risks of landslides to transportation links and property.
- Impacts of climate change and increasing coastal hazards.
- Significant areas of development located on potentially liquefiable soils.

Risk implications from the region's social environment include:

- The high number of young and elderly populations, and below-average family incomes which indicate large sections of the community may have difficulty providing for their own safety.
- The ageing population in Napier and the Hawke's Bay region will require specialised evacuation and welfare services.
- Population changes such as population growth, or alternatively population loss if people leave for better economic opportunities.
- Variable levels of community and organisations preparedness to disasters.
- High number of tourists, who are unfamiliar with the local natural hazard environment and preparedness protocols.

Risk implications from the region's built environment include:

- Isolated coastal communities in the region with single road access.
- Infrastructure networks such as roads, bridges and wharves which are vulnerable to natural hazards.
- Major transportation hubs such as the port and airport are located close to each other, therefore increases the likelihood of being affected by the same event.
- Supply of electricity and gas to the region is limited by the capacity of single main transmission routes.

Hazard Knowledge and Awareness

The hazards knowledge in Napier is considered quite good with a lot of research undertaken in the last two decades. The Hawke's Bay CDEM Group Plan[154] lists all the natural, technological and biological hazards identified for the region along with a risk analysis and strategy to respond to these risks under the 4Rs framework[155]. Hazards based on devastation (not regularity) have been listed as following:

1. Earthquake
2. Tsunami
3. Volcanic ash
4. Human pandemic
5. Flooding and stormwater

Interviewees from the Hawke's Bay Civil Defence group stated the region's Councils have funded further research on the region's top hazards with a 10 Year Hawke's Bay Hazards Research Plan[156] which is reviewed every five

[154] http://www.hbemergency.govt.nz/assets/Documents/Operative-HBCDEM-Group-Plan-as-at-20-June-2014.pdf
[155] http://www.civildefence.govt.nz/cdem-sector/cdem-framework/the-4rs/
[156] http://www.cdemhawke'sbay.govt.nz/assets/Documents/10-Year-HB-Hazard-Research-Plan-CR-2015-098.pdf

years. A comprehensive hazards research database with hazards maps are publically available on the Hawke's Bay Civil Defence website's Hawke's Bay Hazard Information Portal[157]. The Hazard Information Portal allows residents to identify hazards affecting their individual properties, as well as view detailed hazard maps for single hazards. Currently maps are available for:

- Tsunami evacuation zones
- Tsunami inundation extents
- Active and inactive faults
- Earthquake liquefaction (currently under review)
- Earthquake amplification
- Quaternary geology
- Coastal hazards
- Boat safe distances
- Flooding
- Detention dams and detention dam hazard zones
- Wairoa river bank stability

The Clifton to Tangoio Coastal Hazards Strategy 2120[158] will identify coastal risks and the long-term management of the coast between Clifton and Tangoio in the Hawke's Bay region once completed. The Napier District Plan was amended to introduce a River Hazard Area overlay with associated policy and rules allowing the public to clearly see which areas of land have a high likelihood of flooding during extreme weather[159]. The Heretaunga Plains Urban Development Strategy (HPUDS[2010])[160] is a collaborative approach by Napier City Council, Hastings District Council and Hawke's Bay Regional Council to manage urban growth from 2015-2045 taking into account climate change, peak energy, transport efficiency objectives, natural environmental standards, and demographic and employment projections. "Facing the Risks"[161] reports on the findings of the Hawke's Bay Engineering Lifelines Project 1998-2001 which defines the risks posed to key engineering lifelines from all known hazards.

Civil Defence and the Councils undertake a lot of work to improve hazards knowledge and awareness by informing communities and businesses of risks, holding workshops with Council planners and consultancies, and advocating smart development and changes in District Plans through strategies such as HPUDS. The future challenges at the moment include getting communities to put into practice mitigation strategies, exploring tsunami evacuation strategies, and developing stronger connections between Civil Defence and policy makers.

Community Resilience

The Hawke's Bay Civil Defence Group Plan[162] has a strong focus on building community resilience and promotes resilience building throughout the Reduction, Readiness, Response and Recovery phases. The Civil Defence group have also been working on developing a Community Resilience Strategy which was finalized in April[163], presenting a coordinated regional approach to develop community resilience-building projects. The methods identified to achieve this include:

- Community engagement – Coordinated development of Community Resilience Plans with communities; and provide tools for organisations and businesses to create Business Resilience Plans

[157] http://www.cdemhawke'sbay.govt.nz/hazards/portal
[158] http://www.hbcoast.co.nz/strategy-development/
[159] http://www.napier.govt.nz/assets/Document-Library/District-Plan/plan-change-10-section-32.pdf
[160] http://www.hpuds.co.nz
[161] http://www.hbemergency.govt.nz/about-us/lifeline-utilities/facing-the-risks
[162] http://www.hbemergency.govt.nz/assets/Documents/Operative-HBCDEM-Group-Plan-as-at-20-June-2014.pdf
[163] Strategy not yet available online

- Public education – Coordinated and effective preparedness, hazard and response messages to the public; and increased uptake of Hawke's Bay CDEM education to children and young people by education providers
- Connecting communities – Coordinated programme to run or support community events and initiatives; and increase in networks with others and supporting networks between others

The strategy identifies a set of guiding principles for resilience-building activities, stakeholders and their responsibilities, and provides a set of tools including a resilience measure, community engagement checklist, and community resilience plan checklist. The Tangitū Baywatch project[164] is a pilot study conducted to get the community involved in resilient community planning. Similar projects will be carried out across Napier.

The Napier City Council does not have a specific community resilience strategy. Instead, the Council's Community Development Team is responsible for supporting community resilience and has an in-house Civil Defence group member assisting with community resilience-building projects. The Council and Civil Defence group participants collectively stated the Canterbury Earthquakes highlighted the importance of developing strong neighbourhoods for building community resilience. Currently, the connectedness of neighbourhoods in Napier is considered good, with even low socio-economic suburbs like Maraenui having a strong sense of community. The Council provides a lot of support for neighbourhood support groups. Napier has been identified as having the largest number of neighbourhood support groups per population. The Civil Defence group also works closely with the neighbourhood support coordinators. The Council regularly assists community groups by working alongside new or struggling groups and encourages the development of community leaders through supporting targeted workshops and training. Civil Defence recruits and trains volunteers from the community for welfare purposes in response. The volunteer's skills are; providing psychosocial first aid, establishment of satellite communications, use of VHF radios, completing outreach, and running Civil Defence Centres. In addition, the volunteers are public ambassadors for Civil Defence through project mentioned later in the chapter, Resilient Street (a pilot only at present) and Safe as Houses project.

The Safe as Houses Project[165] is a collaborative project run by the Council, fire services, police, Accident Compensation Corporation (ACC), District Health Board (DHB) and Civil Defence which surveys and advises households on disaster preparedness and general safety, and contributes to resilience-building by getting neighbours to meet each other, have open discussions around safety, and promote public awareness by Civil Defence group and police. Civil Defence is piloting a spin-off project called "Resilient Homes" utilising the same process to survey households on disaster resilience and preparedness. The Council also runs the World Health Organisation's Safe Communities Programme and was accredited as an International Safe Community in September 2010[166]. The Safe Communities Programme brings together over 40 community organisations and contributes to resilience by connecting communities with key organisations.

The Council members interviewed stated they have a good awareness of vulnerable communities and their needs, and the current challenge is to assist these vulnerable communities to prepare for and respond in the event of a disaster. The Council assists homes by providing starter kits and educating families on having a supply of personal hygiene items, torches, water etc. for emergencies. People with a disability are currently identified as particularly vulnerable due to being disconnected from the rest of the community due to lack of information and communications with these groups. The Council is working on a Disability Strategy to address this gap. A new vulnerable community identified is residents of Council-run community housing. The Council is starting to work with these communities and is planning to use a village-by-village approach to develop community resilience plans for each community. Another barrier to community resilience is geographical issues in the region due to its topography which can cause difficulties in getting resources from one area to another.

The tight-knit community in Napier is an asset for community resilience. The current gaps and challenges identified that need addressing in the future to improve community resilience include:

- Getting Civil Defence messaging and disaster warnings to the deaf community

[164] Introduced in section 8.1
[165] Page 7, http://www.napier.govt.nz/assets/Document-Library/Reports/Safer-Napier-Annual-reports/safer-napier-annual-report-2013.pdf
[166] http://www.napier.govt.nz/assets/Document-Library/Reports/Safer-Napier-Annual-reports/safer-napier-annual-report-2013.pdf

- Getting people to engage in resilience-building work. E.g. some businesses do not participate
- Breaking the city down into sizeable areas Civil Defence can work closely with
- Identifying people with leadership/mana to lead the community resilience strategy at the grass-roots level
- Having accessible community events in suburbs
- Identifying community assets in the suburbs

Infrastructure Resilience

Infrastructure Resilience is a key component of the Infrastructure Strategy in Napier City Council's Long Term Plan 2015-2025[167]. The Long Term Plan proposes resilience building through:

- Active participation in Civil Defence planning and activities, at both regional and local levels
- Regular investigation of options for alternative service provision and system redundancy
- Identification of critical assets and ensure mitigation methods are developed
- Obtaining insurance where it is deemed to be the most cost-effective approach

The key infrastructure assets and networks in Napier include transport, three waters[168], energy and communication networks, and the Hawke's Bay sea and air ports (HB Airport and Napier Port). Each network has critical assets that would affect services in the event of an emergency.

The Council participants stated roads in the transport network within Napier have some resilience due to redundancy with alternative routes available if certain sections are out. However, there are only two arterial routes which result in huge volumes of traffic. Bridges are a critical transport asset that would affect the overall transportation networks if they were to fail. Napier is geographically isolated and connects to the rest of the North Island by road through State Highways 2 and 5 (SH2 and SH5)[169]. If either of these highways were not accessible, the alternative route would take approximately 3 hours longer, which would affect freight and transport logistics delaying goods and services coming into and travelling out of Napier. The water networks are also designed with redundancy, but rely on single point water sources such as reservoirs and pumps to function[170]. As the majority of Napier is situated on low lying land only several metres above sea level, and on reclaimed land, pumping stations are a critical asset to the stormwater and wastewater networks, with 75% of the stormwater being pumped. The severe weather event in August last year[171] challenged the stormwater and wastewater networks in Napier due to loss of power, and resulted in road closures. The Napier Port and Hawke's Bay Airport are also critical assets for the city, and situated fairly close to each other face thus increasing the risk of by the same hazard affecting them both simultaneously.

The Hawke's Bay Lifelines Group conducted a comprehensive risk assessment of key utilities from 1998-2002 called "Facing the Risks"[172] to understand and reduce the time taken to restore services after a major disaster. The project identified the key risks facing the region and performed risk scenarios to understand the impacts on infrastructure assets and networks. Risk assessments were performed to identify critical infrastructure and points of failure.

With the re-alignment of the Napier City Council last year[173], new infrastructure teams have been established leading to new studies in this space. Council and Civil Defence group participants shared that the Lifelines Utilities group started a project in 2016 to identify vulnerabilities of different assets and their interdependencies to determine priorities, perform mapping, develop fuel plans etc. There has been work done recently on identifying critical assets in the three waters networks to evaluate proactive operation, maintenance and renewals.

[167] http://www.napier.govt.nz/assets/Document-Library/Plans/Annual-Plans-and-Ten-Year-Plans/napier-city-Council-long-term-plan-2015-25.pdf
[168] Water, wastewater and stormwater
[169] http://www.journeys.nzta.govt.nz/hawke's-bay/traffic-dashboard/tauranga-to-napier-via-sh-1
[170] http://www.napier.govt.nz/services/water/about-water/
[171] http://www.nzherald.co.nz/hawke's-bay-today/news/article.cfm?c_id=1503462&objectid=11688495
[172] http://www.hbemergency.govt.nz/about-us/lifeline-utilities/facing-the-risks
[173] http://www.nzherald.co.nz/hawke's-bay-today/news/article.cfm?c_id=1503462&objectid=11595891

There is also a programme of work looking at identifying and strengthening earthquake-prone buildings, prioritised based on the evaluation of key routes leading to important facilities such as hospitals, schools and community facilities.

Infrastructure asset management undertaken to date has aligned with the International Infrastructure Management Manual (IIMM)[174] , however has been largely to an operational level. The Council advised that they are now going forward in reference to ISO 55000 Standards for Asset Management[175] and will take a more strategic approach to integrated Asset Management. The Council participants stated that there is a good understanding of risks affecting the city and its infrastructure, but the current risk management processes are largely informal. Council is looking to better formalise risk management processes in-line with Napier City Council's Corporate Risk Management Framework.

The current gaps in building infrastructure resilience in Napier include:

- Needing better information and data that is accurate data of a good quality
- Having the right information at the right time
- Having the right tools and right staff
- Needing updated processes

The current challenges for working towards better infrastructure resilience include time, people (technical staff, labour, qualified supervisors), funding, and constraints in information sharing between agencies due to commercial sensitivities. At present, day to day operations take priority in terms of funding and resources, although there is a strong willingness to understand and develop better infrastructure resilience.

Suggestions for the future include understanding infrastructure network pinch points, conducting more research on current weaknesses and areas for improvement and developing plans to address gaps, and considering the bigger picture and incorporating learnings from other cities into Napier. The engineering industry's workforce in Napier is ageing, therefore there needs to be programmes to attract more engineers into Napier and the industry in general. Addressing the issue of how to resource and fund resilience-building is also important going forward.

Governance for Resilience

Napier City Council runs a "double debate system", where all items considered by Council are first presented at a standing committee made up of Councillors and elected members. The double debate system allows Council to debate matters on two separate occasions. There are also joint committees with other Councils in the region[176], including a regional Civil Defence emergency management joint committee,[177] chaired by the Mayor of the Napier City Council and a Coastal Hazards Strategy Joint Committee[178]. These joint committees allow Napier City Council to engage with other Councils to address resilience challenges affecting the region in a formal and accountable way.

At the Chief Executive-level a collective called Hawke's Bay Local Authority Shared Services (HB LASS)[179] was established by the five Hawke's Bay Councils to advance shared services in the region to improve levels of service, reduce costs, improve efficiency and increase value through innovation. The HB LASS work together on initiatives including Civil Defence, Business Hawke's Bay and Regional Community Outcomes. The Council participants stated the HB LASS promotes resilience by bringing together the strengths of the different Councils and coming up with common platforms to address regional issues.

The Council participants informed there are also governance related meetings held regularly throughout the year to exchange information and develop solutions to address regional problems. An example is the LIFT Hawke's

[174] http://www.nams.org.nz/pages/273/international-infrastructure-management-manual-2011-edition.htm
[175] http://www.assetmanagementstandards.com
[176] http://www.napier.govt.nz/our-Council/Council-committees/about-committees/
[177] http://www.hbrc.govt.nz/our-Council/Council-committees/civil-defence/
[178] http://www.hbcoast.co.nz/about-us/committee/
[179] http://www.hblass.nz

Bay groups where Councils in the region, government organisations and Iwi meet quarterly to discuss issues ranging from economic development, to social issues and crime.

The Napier City Council's Long Term Plan 2015-2025[180] sets out infrastructure resilience as a key component of the infrastructure strategy. The Long Term Plan also includes the development of community resilience plans in high-risk areas as a service performance measure in the Social and Cultural Group. The Matariki - Hawke's Bay Economic Development Strategy[181] is a key document for the region setting out the strategy to work together as a region promoting sustainable development to increase household incomes and raise Hawke's Bay economic performance. The Heretaunga Plains Urban Development Strategy[182] also uses collaborative approaches across the region to promote sustainability and resilience.

The interviews conducted with the Council and Civil Defence group highlighted currently the governance systems in Napier and the region support resilience, although resilience as an explicit concept may not be mentioned. The Council was recently restructured[183] and there is a lot of work underway to update its processes. Suggestions for the future include:

- Development of a resilience strategy
- Holding multi-stakeholder workshops to understand and plan for resilience-building in Napier
- Creating a joint committee focused on resilience since it is a cross-cutting issue
- Having better relationships with universities and bringing international learning around resilience to Council

Economics of Resilience

The Hawke's Bay region has an integrated economy. For example, businesses in Napier and Hastings have customers in both cities. People living in Napier sometimes work in Hastings, and vice versa, therefore economic resilience requires a regional focus. Currently, Hawke's Bay's top industry is manufacturing, followed by agriculture, rental, hiring and real estate services, and health care and social assistance[184]. A Napier City Council participant stated in Napier, the economy consists of 20% agriculture, 20% manufacturing and a large percentage of services.

The Matariki – Hawke's Bay Regional Economic Development Strategy and Action Plan 2016[185] sets the economic vision for the Hawke's Bay region: "Every household and every whanau is actively engaged in, contributing to and benefiting from, a thriving Hawke's Bay economy". The Napier City Council participants described the core objectives of the Matariki strategy as:

- Increasing jobs – Currently there aren't enough full-time and year-round jobs available in the region. Most key industries in the region such as agriculture and tourism are seasonal.
- Lifting incomes – Hawke's Bay as an ageing population and a large Maori population. The focus lies in increasing job opportunities for lower decile communities and provision of better salaries.
- Raise Hawke's Bay economic performance into the top quarter of New Zealand regions – This is to be achieved through better resilience to shocks, stresses and strains, and diversification of the economy.

The Matariki strategy aims to help businesses grow, attract new businesses into the region, promote great new ideas, develop entrepreneurship and youth entrepreneurs, support start-up businesses, attract skilled migrants, provide career management skills, as well as plan major public projects (such as roads) to benefit the whole region.

[180] http://www.napier.govt.nz/assets/Document-Library/Plans/Annual-Plans-and-Ten-Year-Plans/napier-city-Council-long-term-plan-2015-25.pdf
[181] http://www.hbreds.nz
[182] http://www.hpuds.co.nz
[183] http://www.nzherald.co.nz/hawke's-bay-today/news/article.cfm?c_id=1503462&objectid=11595891
[184]http://www.stats.govt.nz/browse_for_stats/industry_sectors/imports_and_exports/hawke's-bay-snapshot/hb-social-economic-infographic.aspx
[185] http://www.hbreds.nz

An economic development strategy for Napier City Council is under development at the moment which looks at economic resilience. The Hawke's Bay Local Authority Shared Services (HB LASS)[186] has a region-wide collaborative initiative called Business Hawke's Bay which looks at regional economic issues. A Social Inclusion Strategy is also being developed aligning with the Matariki strategy to govern Inter-sectoral and LIFT Hawke's Bay group activities[187,188]. Disaster recovery is considered through the Civil Defence emergency management joint committee[189] and the HB LASS group for Civil Defence[190]. A Council participant stated although the term "resilience" is not explicitly used, the concept is embedded into the economic development planning and activities in the region.

The Hawke's Bay Business Hub[191] located in Ahuriri is supported by all the Councils in the region and provides a collaborative space to support businesses through providing business advisory services, business mentoring and business management and technology advice. The Business Hub supports businesses in preparing to withstand economic shocks and business continuity planning which contributes to economic resilience. The Council participant stated there are six co-business workspaces being established for start-up companies to locate themselves.

The Council participant said that there are good sources of data and information on economic activities available to the Council. Local consultants do regular benchmarking work, economic impact assessments and state of economy reports on a quarterly basis[192]. All the Councils in the region have a partnership with Infometrics[193]. The Council also has a close relationship with MBIE and Statistics New Zealand and have good data on industry mix, changing employment data etc. providing a good evidence base for economic strategy development.

The Council and Civil Defence participants stated the challenges, which need to be addressed for improved economic resilience, include:

- Local, regional and national impacts of disasters – Disasters can have knock-on effects which need to be understood. For example, the Kaikoura earthquakes impacted the figs export industry in Hawke's Bay due to increased transport time and cost because of the longer alternative route for delivery.
- Impacts of a disaster on tourism – How to respond to a disaster were to occur while a large number of tourists were in town (cruise ship etc.)
- Disruptions through technology changes and the introduction of artificial intelligence replacing human employees in industries.
- Economic vulnerabilities due to reliance on the port, airport and roads connecting the region with the rest of the country.
- Encourage immigration of a large number of skilled young people from outside of the region to the region.
- Prevent the migration of skilled young people out of the region.
- Learning to work with and support start-ups, high growth companies and encouraging service sectors in technology, software and design.
- Creation of industries with international links.
- Increasing industry diversity.
- Understanding the businesses of the future.

[186] http://www.hblass.nz
[187] Page 2, http://www.napier.govt.nz/assets/Document-Library/Policies/Triennial-Agreement-for-Hawke's-Bay-region-2016-19.pdf
[188] The LIFT groups are collaborations by different agencies to identify and respond to prioritised regional problems. See section 8.7.
[189] http://www.hbrc.govt.nz/our-Council/Council-committees/civil-defence/
[190] See footnote 44
[191] http://www.hbbusinesshub.co.nz/our-services/whos-who-1
[192] http://www.businesshawke'sbay.co.nz/why_hawke's_bay/economic-monitor/index.htm
[193] http://www.infometrics.co.nz

The Civil Defence and Council participants concluded in the future, economic resilience in Napier and the Hawke's Bay region could improve through addressing the above challenges and attracting more events into Hawke's Bay, including events in the non-tourist season and focusing on the strengths of the region as a food and wine region in the future.

Future

Napier and the Hawke's Bay region have a good awareness of the importance of preparing for and building resilience to disaster events. There is a willingness to head towards greater consideration for resilience. With the recent re-structure of the Napier City Council, new processes are being put in place to improve the efficiency and effectiveness of the way the Council functions to address issues affecting the city.

Dunedin

Current Resilience Strategy

Resilience is incorporated in a number of strategies and plans developed by the City Council. These include the Integrated Transport Strategy[194], Financial Strategy[195], Infrastructure Strategy[196], Social Wellbeing Strategy[197], Economic Development Strategy[198] and the Civil Defence Emergency Management Plan[199].

Others include the Energy Plan[200], which includes a food resilience strategy[201], Spatial Strategy for Retailing in Dunedin[202], The Dunedin Digital Strategy[203] and Social Housing Strategy[204].

Some work would be required to consolidate the resilience aspects of these various documents into one document outlining the resilience approach for the city.

Resilience Measurement

The only measures reported on by Civil Defence Emergency Management relate to undertaking the necessary planning meetings (defined number), training activities and community education programmes (undefined).

Historically there was a residents' opinion survey question asking residents if they were prepared for disasters, but there no definition around what that entailed. Currently the only similar measure is the Quality of Live surveys[205] undertaken on behalf of the Ministry of Civil Defence and Emergency Management by Colmar Brunton.

Shocks, Stresses and Strains

The Civil Defence Emergency Management Plan[206] include floods, earthquakes, severe weather, tsunami, storm surge, rural fire, pandemics, infrastructure failures and industrial or transportation accidents as hazards communities are vulnerable to. It is widely recognised that current climate change patterns are likely to result in more frequent severe weather events. There aren't any significant stresses and strains identified. Dunedin has a population of approximately 120,250, with a small but steady upward trend. There is a greater than national percentage of the population in the 15-25 year group. The main employment in the city is based on tertiary education and the health sector. There is often a significant number of tourists at any given time, with cruise ship visits resulting in up to 5000 visitors coming in at once. Most commercial building stock is old and generally have not been upgraded for seismic resistance.

Longer term issues such as sea level rise are not identified in the Civil Defence Emergency Management Plan, but are addressed in detail in documents in the Dunedin City Council's website.

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[194] http://www.dunedin.govt.nz/your-council/strategic-framework/transport-strategy-2013
[195] http://www.dunedin.govt.nz/your-council/long-term-plan-2015-2016/section-1-major-issues-and-strategies/financial-strategy
[196] http://www.dunedin.govt.nz/your-council/long-term-plan-2015-2016/section-1-major-issues-and-strategies/infrastructure-strategy
[197] http://www.dunedin.govt.nz/your-council/strategic-framework/social-wellbeing
[198] http://www.dunedin.govt.nz/your-council/council-documents/policies/economic-development-strategy
[199] http://www.dunedin.govt.nz/your-council/council-documents/policies/civil-defence-emergency-management-plan
[200] http://www.dunedin.govt.nz/your-council/council-documents/energy-plan
[201] http://www.dunedin.govt.nz/your-council/council-documents/energy-plan/food-resilience
[202] http://dcc.squiz.co.nz/__data/assets/pdf_file/0003/225705/Spatial-Strategy-for-Retailing-in-Dunedin-2009.pdf
[203] http://www.dunedin.govt.nz/services/business-support/dunedin-digital-strategy
[204] http://www.dunedin.govt.nz/your-council/council-documents/policies/social-housing-strategy
[205] http://www.dunedin.govt.nz/your-council/latest-news/september-2016/dunedin-tops-quality-of-life-survey-measure
[206] http://www.dunedin.govt.nz/your-council/council-documents/policies/civil-defence-emergency-management-plan

Hazard Knowledge and Awareness

The level of hazards knowledge in Dunedin is considered good. The Otago Regional Council (ORC) Natural Hazards Database[207] contains a lot of information that is publically available. ORC, in support of the Second Generation District Plan[208] (2GP), have prepared a number of natural hazard reports in regarding to flooding, alluvial fans, land instability and coastal hazards (including sea level rise). Other agencies such as GNS Science and the Fire Service also hold a raft of information.

The current knowledge gaps are in "known unknown" hazards and risks such as seismic activity, liquefaction, groundwater issues in South Dunedin etc. The challenges for identifying and assessing hazards include prioritization, collaboration with other parties, community acceptance, timing and associated costs.

In the future it is hoped that hazard knowledge can be improved with better collaboration with ORC and other relevant organisations, 2GP updates in the future with new information via plan changes and continued land information memorandum (LIM) process and information improvement.

Community Resilience

Some areas and neighbourhoods are more prepared than others when it comes to the current status of community resilience; particularly those with community boards or active, well connected and well-resourced place-based groups. This is partly because these groups also speak on behalf of their community, so it's easier to understand what awareness and action there is. In the Greater South Dunedin area there is a high level of awareness of flood risk and less understanding of earthquake risk. However, it was noted that there is a misconception that infrastructure will 'solve' the flood risk. There is a mixed level of understanding of climate change, its impacts, and the human response to this. In certain communities, some schools are leading work to increase understanding of environmental change.

Dunedin City Council (DCC) has identified greater South Dunedin as a vulnerable community with its low lying coastal areas in terms of flooding. South Dunedin is comprised of hilly suburbs such as Corstorphine/Calton Hill, Brockville, Halfway Bush and Pine Hill with little social and service infrastructure. This makes these areas vulnerable to economic impacts in the event of a disaster. All Dunedin communities would be affected by an earthquake event, with coastal communities most impacted by a significant earthquake due to the potential for tsunami.

Dunedin has a Social Wellbeing Strategy[209] with priorities for promoting resilience. Emergency Management Otago[210] is about to begin community response planning which includes resilience work. DCC's community development team has been supporting work in the South Dunedin community to do develop community resilience plans over the past year. Good Food Dunedin[211] is connecting a number of food resilience initiatives. Community-driven housing related initiatives include Climate Safe Housing[212], Cosy Homes[213] and Curtain Bank[214], along with other local energy-related projects.

Bringing together groups to work on resilience issues across the city is a challenge. There is lack of agreement on handling issues like flooding for developing community resilience. A sense of neighbourhood connection is a contributor to resilience and is uneven around the city, although work continues to progress development of place-based initiatives. There is, in general, a competition for resources to support community development work. In the future, it is recommended that a Climate Change group for the city involving both city and regional Councils, GNS, Emergency Management Otago, the University of Otago and other experts is established to work towards a better resilience culture.

[207] http://www.orc.govt.nz/Information-and-Services/Natural-Hazards/hazards/
[208] https://2gp.dunedin.govt.nz/2gp/info_naturalhazards.html
[209] http://www.dunedin.govt.nz/your-council/strategic-framework/social-wellbeing
[210] http://www.otagocdem.govt.nz
[211] https://www.dunedinnz.com/live-and-work/good-food-dunedin
[212] http://climatesafehouse.nz/safe-as-houses/
[213] http://www.dunedin.govt.nz/your-council/council-documents/energy-plan/cosy-homes
[214] http://dunedincurtainbank.org.nz

Infrastructure Resilience

One of the Dunedin City Council's main functions is to provide infrastructure, and critical network infrastructure in particular, including roading and footpaths, water supply, wastewater and stormwater. The latter three include an asset base with a gross replacement cost of $1.6 billion, while the roading and footpath asset base represents a further $1.3 billion[215].

Climate change has been flagged as a critical consideration in the Council's long term planning. The Council uses guidance from the New Zealand Government, based upon the best available climate science, to underpin planning. Looking forward, Dunedin is expected to experience greater seasonality with the climate becoming drier for extended periods, with increased mean temperatures and daily temperature extremes. Increased peak demand due to drier periods and decreased average river 'low-flows' could create a drought situation. However, rainfall events are likely to become heavier but less frequent, which results in an increased annual catchment yield. Sea level is predicted to rise with increased occurrence of associated storm surges. Dunedin may be at particular risk to the effects of sea level rise as it has significant areas of low-lying land, some of which is reclaimed. The Otago region is also prone to seismic activity.

Events in Christchurch and elsewhere have provided the infrastructure engineering community with significant learning opportunities. The Council has taken the time to incorporate industry learning into the way it manages infrastructure. The 3 Waters networks are made up of significant portions of earthquake vulnerable materials such as earthenware pipes and typically the most vulnerable materials were installed early in the 20th century. The Council works with other authorities and lifeline utilities throughout the Otago region in order to implement the activities outlined in the Otago Lifelines Project Report[216]. This report addresses the criticality of network components, known risks from environmental effects, interdependencies between lifeline utilities in responding to a major event and proposed initiatives to improve network resilience.

Some infrastructure responses to these challenges which the Council adopts or recommends include:

- Infrastructure built to a resilient standard
- Vulnerable materials are addressed at the time of renewal except where an asset has a high level of criticality, in which case the asset will be assessed to determine its level of resilience and where necessary renewal may be prioritised
- Avoid re-zoning land for urban development reliant on reticulated infrastructure in areas that are at risk from liquefaction, lateral spread or other seismic effects that may put people, property or infrastructure at risk
- Reduce single point dependencies for highly critical infrastructure
- Increase the flexibility and resilience of affected infrastructure to reduce the risk of prolonged service interruption
- Undertake active planning for potential events due to climate change scenarios

Governance for Resilience

As per the CDEM Act 2002, the Otago CDEM Group provides governance over the 4 "R's" of emergency management. In practice the governance encompasses little more than receiving reports for the CDEM Group office.

Economics of Resilience

As a city, Dunedin has four significant advantages:

[215] As at 2015

[216] http://www.orc.govt.nz/PageFiles/1404/November%202014/03%20Agenda%20Otago%20CDEM%20Group%20meeting%2014%20November%202014.pdf (Pages 9-67)

1. A strong knowledge base (University of Otago, dentistry, medical, research) Otago Polytechnic (health services, design, IT, engineering, business improvement)
2. A growing pool of creative and high-tech enterprises and talent (NHNZ, health technologies) and a growing business service community
3. High quality amenities (heritage, large areas of green space, world class venues such as Moana Pool, Forsyth Barr stadium)
4. Cohesive community and whanau and a great lifestyle (relaxed ease and openness of doing business)

Dunedin's Economic Development Strategy[217] partners (Otago University, Otago Polytechnic, Otago Southland Employers Association, Otago Chamber of Commerce, Ngai Tahu and the Dunedin City Council) identified the economic challenges for the city and have developed a collective strategy to mitigate these over a 10-year timeframe. Dunedin residents want greater economic opportunities. This requires developing, attracting and retaining more people and businesses to work, live, invest, visit and play in Dunedin. Five strategic themes are being worked on in the Economic Development Strategy. These are: business vitality, alliances for innovation, a hub for skills and talent, linkages beyond the borders and a compelling destination.

Dunedin is still too often regarded as a place to visit rather than a permanent destination, and not on the radar of international investors, businesses and migrants. In order to develop economic resilience, Dunedin needs to improve international connections and build up high value and tradeable sectors of the economy. The city needs to have a unified stance and a passion for doing things differently, and not just business as usual. The city needs to pool its resources, work in partnership and be bold in its outlook and delivery.

Future

With the re-structuring of Otago Civil Defence to form of Emergency Management Otago in November 2016, there has been a drive toward a consistent approach to building community resilience in Otago. The development of a new website, with a simple 1,2,3 approach to emergency preparedness is one activity. The development of Community Response Plans and the planning workshops/discussions leading to the development of the plans create a wider awareness in the community of the hazards faced and how the community itself can respond.

[217] https://www.dunedin.govt.nz/__data/assets/pdf_file/0008/262997/Dunedins-Economic-Development-Strategy-2013-2023.pdf

National Resilience and the NSC Resilience Challenge

National Resilience Strategy

The Ministry of Civil Defence and Emergency Management (MCDEM) are developing a new National Disaster Resilience Strategy replacing the National CDEM Strategy[218]. The Resilience Strategy is being developed in collaboration with local and central government and key partners and stakeholders. With New Zealand committing to the international Sendai Framework for Disaster Risk Reduction[219] in March 2015, the new strategy presents the opportunity to consider how the Sendai Framework priorities and international best-practices can be put into practice in New Zealand.

Development of the Strategy is a six-phase process. The first phases included holding multi-stakeholder workshops across the country to receive feedback on what the strategy needs to include and what it should represent. MCDEM is currently at stage 3 of development where an external Project Reference Group will be set up to begin initiating a kāhu/hui to develop a Māori resilience framework. Findings from phases 1 and 2 have confirmed that the Strategy needs to:

- Have a broader focus on resilience (rather than CDEM)
- Focus on reduction of risk and increased resilience as a two-pronged strategy to build overall national resilience
- Promote all-of-society ownership of disaster resilience
- Use the Sendai Framework as a strong reference point
- Have specific actions rather than broad objectives

This information has led to four priorities as cross-cutting issues that needs to be addressed in developing the Strategy:

- Improve the understanding of risk to enable better risk-informed decision-making
- Reduce existing risk and minimize the creation of new risk
- Strengthen resilience, both planned and adaptive
- Build a culture of resilience

The Resilience Challenge

The Rural Programme

The Rural Co-Creation Laboratory[220] will broker innovative solutions for enhancing the resilience of rural New Zealand, recognising its unique contribution to our national identity and its pivotal economic function. A resilient rural backbone will be built via:

- Developing an integrated framework for assessing resilience to natural hazards across rural value chains: from households to regions and small to global-scale agribusinesses;

[218] http://www.civildefence.govt.nz/cdem-sector/cdem-framework/national-civil-defence-emergency-management-strategy/
[219] http://www.unisdr.org/we/coordinate/sendai-framework
[220] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Rural

- Producing tools for resilience-interventions and defining opportunities, through comprehensive scenario activities with key sectors, communities and regions; and
- Building a researcher-stakeholder co-creation team and outreach network as 'honest brokers' for policy and practice leadership via new networks and through chains of land care, disaster management and other farming, tourism and rural community initiatives.

These outcomes will fast-track resilient solutions for multiple hazards into the New Zealand rural context.

Specific Projects within Programme:

1. **Resilience Solutions for Rural New Zealand**: will co-produce and broker innovative solutions for enhancing the resilience of rural New Zealand.
2. **Multi-level Resilience**: will develop and apply an integrated, analytical framework for promoting resilience at multiple scales across rural value chains. It will showcase the economic consequences of resilience initiatives for agri- and tourism businesses under multi, cascading and creeping natural hazard events.
3. **Resilience to Wildfire Challenges**: will co-develop resilience initiatives for wildfire with communities and integrate rural wildfire hazard risk assessment and resilience initiatives within a multi-hazard environment.
4.

The Urban Programme

The Urban Co-Creation Laboratory[221] will integrate, implement and build onto the knowledge and tools created in the Resilience Toolboxes to enable cities in New Zealand to adapt and transform with urban change whilst building their resilience to natural hazards. Resilient cities will be built via:

- Developing a framework for evaluating city resilience to natural hazards in the New Zealand context and building an inter-city expertise collaborative network to advance implementation of resilience tools and measures; and
- Working with the case study of Auckland City to develop an operating Resilient Cities model, focusing particularly on the issues of building resilience to nature's challenges into the rapid growth-plans and growth pains of the city, including major nationally significant investments in transport and housing.

Specific Projects within Programme:

1. **Resilient Cities Network Development:** This project aims to develop a consensus of solutions (resilience tools, measures and indicators) that will create a New Zealand city resilient to natural hazard. An analysis of Auckland's resilience using the United Nations Office for Disaster Risk Reduction Disaster Resilience Scorecard for Cities[222] and New Local Urban Indicators[223] is underway. The project will also establish a network that incudes and links the main cities in New Zealand with the science. Producing this report has been the first step towards this goal.
2. **Resilient Auckland Planning:** This project aims to place the Auckland Council's Strategic Plan under a resilience "lens" to trace future land use under planned scenarios of population and economic growth, including testing longer-term simulated environments in Auckland, and reporting key resilience measures for the different options.
3. **Resilient Auckland Communities:** This project aims to develop resilient Auckland communities, with a focus on Pacific Island and Asian communities and migrant and refugee groups.
4. **Resilient Auckland Businesses:** This project aims to identify vulnerabilities in the business sector, and assist with the development and testing of mechanisms to make Auckland businesses resilient. The

[221] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Urban
[222] http://www.unisdr.org/2014/campaign-cities/Resilience%20Scorecard%20V1.5.pdf
[223]https://www.unisdr.org/campaign/resilientcities/assets/documents/privatepages/02_Local%20Indicators_Handout.pdf

project aims to develop a baseline for Auckland businesses and work with the more vulnerable businesses to assist with improving their resilience.

5. **Resilient Auckland Infrastructure**: This project aims to develop and test resilient indicators for infrastructure networks with an initial focus on transport for the Auckland region, then moving onto other infrastructure types (water, electricity, telecommunications).

The Edge Programme

Communities living on 'The Edge' are located in dynamic physical settings (e.g. coastal margins, flood plains), which are highly vulnerable to natural hazards. The Edge co-creation laboratory[224] will initially be developed in Hawke's Bay, one of New Zealand's "hot spots" of community conflict around coastal hazard management. It will lead to tangible, viable and acceptable solutions to support communities living in highly vulnerable settings.

Specific Projects within Programme:

1. **Building a shared understanding of processes, hazards and community resilience**. The project aims to explore wider community understandings and experiences of hazards in the case study area, including characterisation of the social and economic characteristics, networks and values and attitudes that underpin community attachment and resilience.
2. **Scenario exploration of coastal futures**. The aim is to develop a shared community – scientific – local government understanding and vision for future hazards and identify whether, and to what extent, there will be intensification of risk to the community over time.
3. **Building the resilient vision.** This project explores and develop adaptive technical and planning pathways to build community resilience and inform and advise future decision-making processes.

The Mātauranga Māori Programme

The Mātauranga Māori co-creation laboratory[225] will integrate local/traditional/Iwi knowledge and integrate new Te Reo and Māori values into improved natural hazard resilience strategies for all New Zealand communities. This laboratory will also provide a basis for Māori researchers to explore Mātauranga Māori, Māori innovation and creativity and explore more meaningful ways to communicate resilient solutions to Māori and New Zealand.

Specific Projects within Programme:

1. **Wāhanga Tuatahi (Tikanga Māori):** This project aims to provide underpinning guidance to Mātauranga Māori and develop tikanga to support the strategies and case-study approaches of the RNC. The project will elucidate Mātauranga Māori and develop existing and new Te Reo in relation to natural hazard and resilience to support hazard education, hazard management, emergency response and disaster recovery.
2. **Wāhanga Tuarua (Māori Assets)**: This project aims to identify and strengthen key iwi/hapū assets (farms, forestry, marae, pa) that provide cornerstones of community resilience, through highlighting their role and importance and fostering appropriate adaptive strategies. The role these assets play through the hazard cycle will be promoted, from aspects of critical infrastructure capability, through to roles in supporting social response and recovery.
3. **Wāhanga Tuatoru (Māori cultural landscapes and kaitiakitanga)**: This project will develop frameworks to support iwi to undertake their own natural hazard monitoring and management strategies and revive traditional environmental planning methods for Māori land, natural resources and landscapes of cultural significance.

[224] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Edge
[225] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Matauranga-Maori

The Trajectories Programme

The Trajectories Toolbox[226] is pursuing a series of projects with the aim of developing systematic approaches to resilience assessment and monitoring.

Project one is the resilience assessment decision making tool (also referred to as the Resilience Honeycomb Heuristic – see figure 5). This tool guides people through a systematic decision making process that is designed to help researchers, practitioners, and stakeholders identify the underlying theory, assumptions, information requirements, and limitations of their resilience assessments. This tool has been applied in facilitated workshops, and is currently being modified to facilitate self-assessments.

Project two, the resilience digital information system, is an information utility that aggregates, organises, and facilitates sharing of pertinent data to support a range of evidence-based solutions for resilience in New Zealand. Between March and November 2016, the Trajectories team initiated a stakeholder consultation process as part of the DIVE programme development. The process involved a series of workshops, surveys, interviews, and software prototype design and testing.

Project three is referred to as the Suite of Resilience Indicators. The focus of this project is twofold. First, the Trajectories team is identifying a large number of indicators that can be used to assess resilience of systems. The second element of the indicators project is to develop a prototype place-based resilience index at the sub-national level in New Zealand.

The final project is the Warrant of Fitness (WOF) programme. The WOF will fully launch in 2018 as a way of translating research and assessment into action. The WOF will use a case study to benchmark resilience, understanding the selected resilience interventions being applied, and whether resilience enhancements are being made and to what extent, in the case study system.

Each of these projects is occurring in the unique transdisciplinary, cross-institutional collaboration context of the Resilience to Nature's Challenges (RNC).

[226] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Trajectories

DECISION MAKING ELEMENTS		
☒	Standardized comparison	PURPOSE
☐	Programme evaluation	
☐	Target areas for investment	
☐	National	SCALE
☐	Regional	
☒	Territorial authority	
☒	Meshblock	
☒	Place-based community	FOCUS
☐	Ethnic community	
☐	Infrastructure network	
☐	Rural economy	
☐	Household	
☒	All-hazards	DISRUPTION TYPE
☐	Earthquakes	
☐	Drought	
☐	Flood	
☐	Volcano	
☒	Preparedness/ Pre-disruption	PHASE
☒	Response/ Immediately post-disruption	
☒	Recovery/ Post-disruption	
	Availability	DATA
☒	Collected nationally	
☐	Private data included	
☐	[…]	
	Quality	
☒	Collected regularly	
☐	Peer reviewed	
☐	Sampling error below 10 percent	

Figure 5: Systematically evaluating elements of the resilience assessment using the Honeycomb Heuristic

The Hazard Programme

The Hazard Toolbox Programme[227] will involve closely integrated teams of community members/ representatives, officials, and scientists to generate new hazard knowledge, and a set of fit-for-purpose hazard tools and solutions that meet community and stakeholder aspirations for nationally consistent delivery of risk information that underpin development of resilience solutions across all relevant natural hazard types.

Specifically, this Programme will develop new frameworks and methods to consistently express all parts of the hazard spectrum, from low-magnitude/high-frequency to high-magnitude/low-frequency cases. This will be incorporated with hazard and resilience-relevant knowledge among a wide range of community groups, governance and private agencies and other science stakeholders. This toolbox will further take into account the dynamic shifts that may occur along the hazards impact spectrum, due to factors including: climate change, societal change, and geological activity.

[227] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Hazard

This Programme will provide the RNC with accurate and useable information by developing:

- a better understanding of how co-creation will aid in exchanging hazard and impact knowledge between scientists and end users; and
- a better understanding of the 'what' and 'when' of natural hazards in a variety of contexts, including cumulative, cascading and unexpected hazards.

Specific Projects within Programme:

1. **Co-creation of hazard impact and resilience scenarios:** This project will develop a nationally consistent framework for risk and impact information for New Zealand's natural hazards, using scenario-based approaches.
2. **Hazard spectrum and correlation modelling:** This project aims to statistically quantify multiple different natural hazards in terms of frequency and magnitude, allowing them to be incorporated in probabilistic analysis formulae.

The Culture Programme

The Cultural Toolbox[228] research will investigate three priority research areas focused on understanding, harnessing and building social norms that underpin a resilient culture in New Zealand. Integral to this research will be an outcome-focused plan to clearly define the best tools and strategies to facilitate resilience becoming an integral "part of what we do and who we are". Diverse research methods will include a co-creation approach to build trust and respect-based relationships with key stakeholders/users from the outset. The programme will investigate new and rapidly evolving technologies, and the ways these can be harnessed to develop social norms of resilience across diverse communities and hazard profiles. It will engage with citizens to build their desire for involvement in hazard-related science, and develop a framework for citizen-science initiatives.

This research will develop a means to enhance existing, or develop new social "norms" of resilience to nature's challenges in New Zealand communities. For a step-change in Resilience, its practice and understanding must become embedded in our communities and workplaces. If the need for resilience is a socially embraced concept, resilience norms will drive resilience behaviour and decision-making at all levels in New Zealand.

Specific Projects within Programme:

1. **Developing social norms towards a culture of resilience** will seek to understand existing and prospective social norms around resilience to natural hazards, and how these norms can be enhanced or developed to contribute to a resilient culture. The project will consider norms in the context of location, sudden shocks (e.g. earthquakes, storms, wildfires) and incremental hazards (e.g. sea-level rise).
2. **Emerging Technologies** will investigate social norms in the context of emerging technologies, and look at how people's interaction with information and communication technologies (ICTs) can contribute to a resilient culture.
3. **Connecting Citizens to Science** will investigate citizen science as a tool for increasing opportunities for New Zealanders to become involved in science activities, and improving the strategic framework for citizen science.

The Infrastructure Programme

The Infrastructure Toolbox[229] aims to develop an improved understanding of the resilience of spatially-distributed infrastructure networks to natural hazards through development of new methodologies fitted to NZ-specific infrastructure. The programme will develop an "infrastructure resilience rating" for various systems, that can be used to fine-tune and improve the resilience to natural hazards of the infrastructure serving a community. This

[228] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Culture
[229] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Infrastructure

system will be used to drive public policy in infrastructure investment and provide asset owners with knowledge of externalities when investing in building resilience.

In the face of New Zealand's unique natural hazard environment, and based on engineering science evidence, this toolbox will enable New Zealanders to anticipate critical infrastructure vulnerabilities, and protect and transform the built environment to support thriving communities.

Specific Projects within Programme:

1. **Networks and Components:** This project aims to development risk-based methodologies to quantify the direct damage and resilience of large distributed infrastructure networks to multiple types of natural hazards.
2. **Network Interdependencies:** This project aims to advance risk-based methodologies of infrastructure networks from simply understanding the loss of service due to damage to network components onto understanding the cascading impacts which result from network service disruption, and ultimately impact societal resilience.
3. **Performance Measures and Impacts:** This project aims to develop a 'National report card' framework and an "infrastructure resilience rating" by which distributed infrastructure network resilience can be understood by the general public in order to lead to societally-driven and public policy improvements in resilience.

The Governance Programme

The Governance Toolbox[230] addresses the role played by governance, policies, and institutional relationships that underpin an enduring resilience of communities to natural hazards. Research-based governance initiatives will build inter-generational mechanisms and practices of governance to face disruptive hazard shocks including those that vary with global change and climate change. Outcomes of this Programme will enable:

- Community and organisational adaptability to local and emerging needs (including for an uncertain future with a range in possible hazard and risk).
- Negotiated, actionable response by public and private sector agencies and communities to both predictable and unpredictable futures.
- New institutional frameworks where resilience is a key factor considered in decision-making in a way that incorporates the dynamic and changing nature of multiple hazards and risks as well as social and demographic shifts in New Zealand society.

This Programme will create new knowledge about mechanisms and strategies for resilience governance at district, regional and national levels in NZ, and empower governance actors to work together to anticipate, adapt and function effectively in the face of natural hazard.

Specific Projects within Programme:

1. **Overarching Resilience Governance Concepts:** will develop a conceptual and methodological lens to guide the case study projects carried out within the RNC, facilitating comparisons and ensuring robustness and scholarly stretch.
2. **Case Studies**: The core governance research will be undertaken within the RNC Laboratory case studies – initial focus will be on the Rural and Edge case studies. Each case study will include three stages (tasks):
    - *Lessons.* This task will use multiple methods to identify and map the institutional architecture and drivers behind successful resilience in New Zealand. This will help us understand excellence in native/adaptive practice that can be built upon for wider and deeper impact for resilience decision-making, and identify appropriate governance opportunities in the case study.

[230] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Governance

- *FutureTools.* This task will establish a set of tools that could potentially address the range of resilience and governance issues and desired outcomes identified with stakeholders in case study sites.
- *Creating Future Resilience Pathways.* Within the case studies, this task will develop and integrate a set of methods, tools and practices that can most effectively fit case-study purpose and influence resilience through institutions.

3. **Case Study Comparisons and Triangulation**: This task will bring together findings from the diverse case study projects and build a New Zealand-wide best practice model for resilience governance, setting future goals that address enablers and barriers.

The Economics Programme

The Economics Toolbox programme[231] aims to provide economic decision-support tools that enable New Zealand to more effectively and quickly transition to a nation resilient to natural hazards. These toolsets, which will be operate at multiple scales and for multiple stakeholders will:

- Offer capabilities to simulate economy-wide consequences of infrastructure (horizontal and vertical) failure with and without alternative mitigations/adaptations;
- Extend widely-practiced approaches/conventions to economic decision/policy analysis (benefit-cost analysis) to allow for better appraisal of alternative resilient-building strategies; and
- Identify a set of best-practice risk-sharing and financial interventions to motivate resilience.

The toolbox programme will provide state-of-the-art economic tools to drive resilience by enabling decision-makers to build better business and value cases for, and to assess the potential of, alternative resilience-building initiatives and pathways.

Specific Projects within Programme:

1. **Enabling Pathways to Resilience:** To enable the rapid assessment of economic consequences of resilience-building strategies across time and space, three tools are currently being developed. Measuring the Economic Resilience of Infratructure Tool (MERIT) is being developed under this workstream. MERIT a suite of tools, including demographic, land use, transport, business behaviour, tourism modules interfaced with a dynamic economic module. Under this workstream information with other modelling packages is being dealt with – particularly between MERIT and Riskscape, which is GIS-based tool that calculates expected losses by overlaying a single hazard scenario, assets, and damage functions. MERIT is also being coupled with other models including distributed infrastructure models (electricity, water, and transport networks) and a multi-hazard module to create an integrated 'decision support system' through interoperability. A spatial version of MERIT will be used to assess the interactions between the economy, land use change and transport networks in an integrated manner. Urban hazard preparation and recovery strategies will be assessed to aid decision-making.
2. **Valuing Resilience Initiatives**: Work is underway to extend the widely practiced Cost-Benefit Analysis (CBA) framework to enable analysis of resilience-building strategies and comparison of these to 'status quo' strategies. This extended framework aims to improve on current limitations of the approach identified by the team. This workstream kicks-off in full force in July 2017. Negotiations are currently underway with NZTA to incorporate resilience impacts (such as those calculated by MERIT above) into the Economic Evaluation framework.
3. **Motivating Resilience**: A toolkit of risk-sharing and financial interventions to motivate resilience is currently being developed. This includes work on alternative financial mechanisms to deal with residential insurance retreat due to sea-level rise, distributional impacts of earthquake insurance and how to prevent inequality in insurance-related financial transfers (Owen and Noy, submitted), the impacts of red-zoning, and financial incentives for earthquake strengthening outside main urban centres.
4. **Resilience to Flow-on Impacts of Natural Hazards in Local Economies:** A transferable decision support tool will be developed for identifying both resilience-enhancing characteristics of local

[231] https://resiliencechallenge.nz/Resilience-Home/Science-Programmes/Economics

economies and 'hot spots' (critical industry sectors and inter-regional links) that amplify the flow-on impacts from natural hazards through the economy. The results will provide a greater level of detail to support local government and communities in prioritising strategies which will build resilience across local economies.

Future Direction

The seven cities that were featured in this report all have a good understanding of the challenges they will be facing in the future, and are working towards adopting better resilience practices.

Auckland is dedicated to improving its resilience and become the world's most livable city. The Auckland Plan and the Auckland Civil Defence and Emergency Management five-year strategy, "Resilient Auckland" are providing a clear strategic direction to work towards these goals. Auckland is also conducting resilience assessments using UNISDR tools to understand its current state of resilience to identify areas for improvement.

In Wellington, a lot of planning and implementation of projects are underway addressing the 30 focus areas identified in the Wellington Resilience Strategy to achieve its goals of connectedness, better decision-making and healthy, robust homes and built environment.

Christchurch is also planning and implementing projects under the 11 programmes identified in the Resilient Greater Christchurch Plan. Christchurch's resilience goals are to connect people and communities, enhance community participation, prosper as a city, and better understand the risks and challenges it faces.

Hamilton City Council undertook their contribution to this report as an opportunity to self-evaluate their resilience processes and identify gaps and challenges. Their findings have led them to understand the importance of formalizing resilience-building and the city is beginning to have discussions on how these can be incorporated into Council operations.

Tauranga had started having formal resilience discussions at the time of this exercise. The Tauranga City Council has recognized that resilience goes beyond civil defence and are working towards developing a resilience strategy at the city level.

Currently, Napier has also been following a resilience-building model led by civil defence. With the recent re-structuring of Napier City Council, the city is working towards more efficient and effective processes that contribute to the city's resilience as a whole.

Otago civil defence underwent a recent re-structuring to form Emergency Management Otago, which is taking steps to develop a consistent approach to resilience-building in Dunedin and the Otago region as a whole.

Conclusions

With the national movement towards a resilient New Zealand led by the Ministry of Civil Defence and Emergency Management, understanding where our cities lie in their resilience journeys at present is important. This report creates an understanding the current state of resilience, and resilience gaps and challenges in our seven biggest cities.

This has been a positive experience for us at the RNC as well as the cities that took part in this exercise. The report shows the resilience strengths of the different cities, and identifies areas that can be improved. The RNC, working collaboratively with the major New Zealand cities will provide further research and innovative solutions to improve national resilience.

This report promotes learning, knowledge-sharing and collaboration between cities as we work together to make New Zealand more resilient. The findings also inform the RNC to identify how the RNC toolboxes can assist in developing tools that can benefit our cities.

The next step in the Resilience Cities Network Development Project is to develop a collaborative resilience network between cities, starting with the cities that were addressed in this report. The resilience network aims to connect key people, projects, knowledge and experiences on a regular basis to facilitate open communication and a culture of collaboration to work towards common resilience goals.

This report can be used to evaluate the resilience progress of New Zealand cities as they mature and develop their resilience practices. It is recommended that this resilience report is updated in three years' time to assess the continuing evolution of resilience in our major cities.

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