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Adapting infrastructure to climate change

James Hughes

Exceptional thinking together

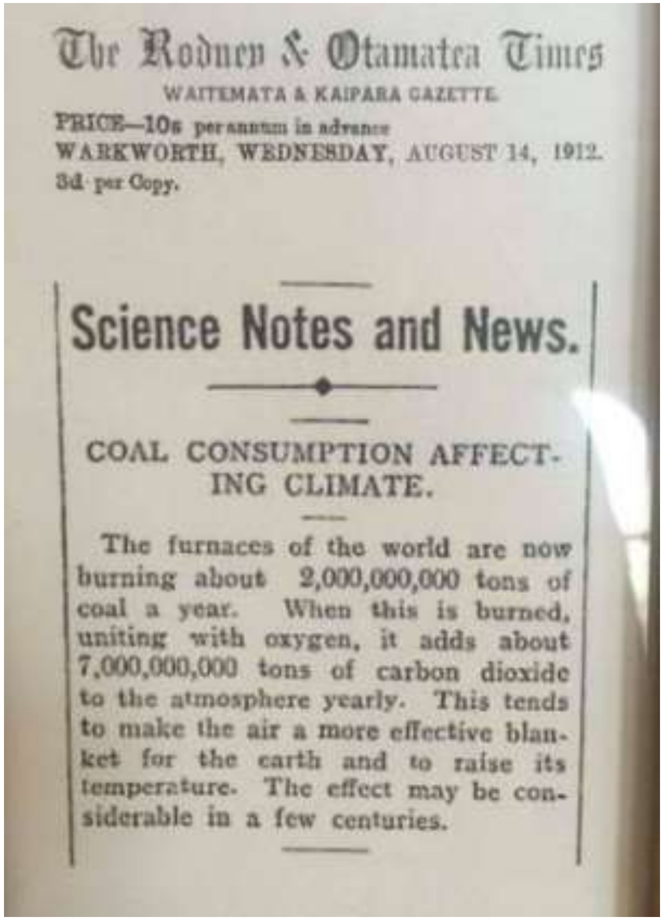
www.tonkintaylor.co.nz

Agenda

- Background
- Emerging policy and a focus on climate risk in NZ
- Approaches to assessing and managing climate risk
- Sector examples

Background

Data



The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE

PRICE—10s per annum in advance

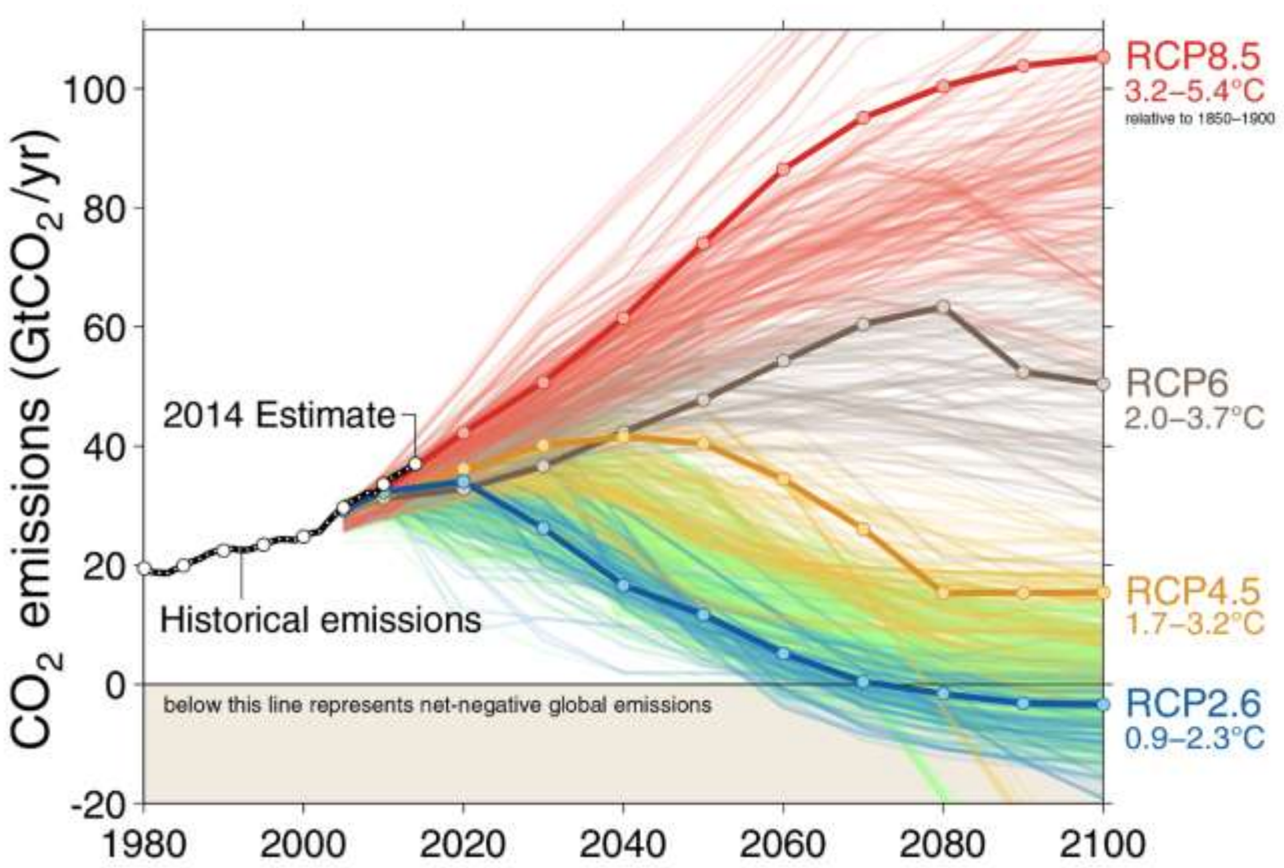
WARKWORTH, WEDNESDAY, AUGUST 14, 1912.

3d per Copy.

Science Notes and News.

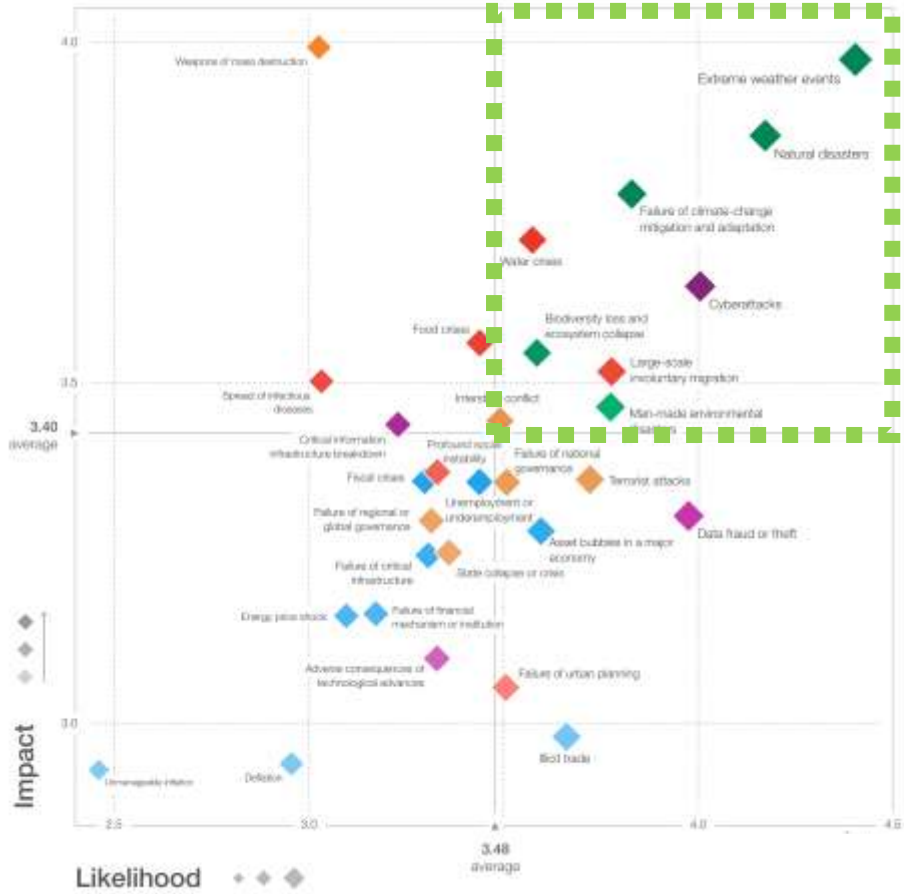
COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.



Source: Fuss et al, 2014

So what does this mean?



World Economic Forum: ***Global Risks Report 2018***

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Top 5 Global Risks in Terms of Likelihood

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1st	Asset price collapse	Asset price collapse	Asset price collapse	Storms and cyclones	Severe income disparity	Severe income disparity	Income disparity	Interstate conflict with regional consequences	Large-scale involuntary migration	Extreme weather events	Extreme weather events
2nd	Middle East instability	Slowing Chinese economy (<6%)	Slowing Chinese economy (<6%)	Flooding	Chronic fiscal imbalances	Chronic fiscal imbalances	Extreme weather events	Extreme weather events	Extreme weather events	Large-scale involuntary migration	Natural disasters
3rd	Failed and failing states	Chronic disease	Chronic disease	Corruption	Rising greenhouse gas emissions	Rising greenhouse gas emissions	Unemployment and underemployment	Failure of national governance	Failure of climate-change mitigation and adaptation	Major natural disasters	Cyberattacks
4th	Oil and gas price spike	Global governance gaps	Fiscal crises	Biodiversity loss	Cyber attacks	Water supply crises	Climate change	State collapse or crisis	Interstate conflict with regional consequences	Large-scale terrorist attacks	Data fraud or theft
5th	Chronic disease, developed world	Retrenchment from globalization (emerging)	Global governance gaps	Climate change	Water supply crises	Mismanagement of population ageing	Cyber attacks	High structural unemployment or underemployment	Major natural catastrophes	Massive incident of data fraud/theft	Failure of climate-change mitigation and adaptation

Top 5 Global Risks in Terms of Impact

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1st	Asset price collapse	Asset price collapse	Asset price collapse	Fiscal crises	Major systemic financial failure	Major systemic financial failure	Fiscal crises	Water crises	Failure of climate-change mitigation and adaptation	Weapons of mass destruction	Weapons of mass destruction
2nd	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Climate change	Water supply crises	Water supply crises	Climate change	Rapid and massive spread of infectious diseases	Weapons of mass destruction	Extreme weather events	Extreme weather events
3rd	Slowing Chinese economy (<6%)	Oil and gas price spike	Oil price spikes	Geopolitical conflict	Food shortage crises	Chronic fiscal imbalances	Water crises	Weapons of mass destruction	Water crises	Water crises	Natural disasters
4th	Oil and gas price spike	Chronic disease	Chronic disease	Asset price collapse	Chronic fiscal imbalances	Diffusion of weapons of mass destruction	Unemployment and underemployment	Interstate conflict with regional consequences	Large-scale involuntary migration	Major natural disasters	Failure of climate-change mitigation and adaptation
5th	Pandemics	Fiscal crises	Fiscal crises	Extreme energy price volatility	Extreme volatility in energy and agriculture prices	Failure of climate-change mitigation and adaptation	Critical information infrastructure breakdown	Failure of climate-change mitigation and adaptation	Severe energy price shock	Failure of climate-change mitigation and adaptation	Water crises

Economic | Environmental | Geopolitical | Societal | Technological

Is unprecedented the new normal?

- The past is not a good indicator of the future
- Direct / indirect / residual risks

- ICNZ: $234M in insured losses (2017);
- ICNZ: $72M in May event, $174M to date (2018)
- What about uninsured?

The Washington Post
Democracy Dies in Darkness

Wonkblog | Analysis

Houston is experiencing its third '500-year' flood in 3 years. How is that possible?

By Christopher Ingraham
August 29, 2017 at 7:30 AM

This drone video taken Aug. 27 shows the historic flooding in Houston caused by Hurricane Harvey. (ahmed.gul/Instagram)

Hurricane Harvey has brought "500-year"


MICHAEL HISTORY
OCT. 7-12, 2018
DEPRESSION
T.S.
HURRICANE
CAT. 3+
OCT. 11: WEAKENS TO TROPICAL STORM
OCT. 12: BECOMES POST-TROPICAL
OCT. 10: LANDFALL NEAR MEXICO BEACH, FL AS 155 MPH CATEGORY 4
OCT. 10: INTENSIFIES TO CATEGORY 4
OCT. 9: STRENGTHENS TO CATEGORY 3
OCT. 7: BECOMES TROPICAL STORM MICHAEL
OCT. 8: BECOMES A HURRICANE
The Weather Channel
OCT. 7: T.D. 14 FORMS


U.S. HURRICANE LANDFALLS
2017-2018
MICHAEL (CAT. 4)
MEXICO BEACH, FL
919 MB - 155 MPH
FLORENCE (CAT. 1)
WRIGHTSVILLE BEACH, NC
35.93" Rain
HARVEY (CAT. 4)
ROCKPORT, TX
937 mb - 60.58" Rain
IRMA (CAT. 4)
SOUTH FLORIDA
931 mb - 7+ ft Surge
MARIA (CAT. 4)
PUERTO RICO
920 mb - 155 mph

Philip Klotzbach
@philklotzbach

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Table of 10 strongest continental US landfalling #hurricanes on record as ranked by minimum sea level pressure at landfall. #Michael ranks 3rd with a landfall pressure of 919 hPa.

Strongest Continental United States Landfalling Hurricanes (Ranked by Pressure)

Rank	Year	Month	Day	Storm Name	Landfall Wind (kts)	Landfall Pressure (mb)
1	1935	9	3	Labor Day	160	892
2	1969	8	18	Camille	150	900
3	**2018**	**10**	**10**	**Michael**	**135**	**919**
4	2005	8	29	Katrina	110	920
5	1992	8	24	Andrew	145	922
6	1886	8	20	Indianola	130	925
7	1919	9	10	Florida Keys	130	927
8	1928	9	17	Lake Okeechobee	125	929
T-9	1926	9	18	Great Miami	125	930
T-9	1960	9	10	Donna	125	930

T represents tie with other years
Continental US landfalling hurricane data goes back to 1851

Hurricane Michael's slightly lower pressure than Katrina does not necessarily mean that it will be as dangerous or more so than the storm that flooded New Orleans. Katrina killed more than 1,000 people due to infrastructure failures and mismanagement of emergency resources, not because of where it sat on the record charts, according to various news outlets. But more powerful hurricanes can be apt to trigger those sort of failures. Hurricane Maria killed nearly 3,000 Americans in Puerto Rico in 2017 due to infrastructure failures after a landfall pressure of 914 mb. (Maria's Puerto Rican landfall doesn't count toward the continental U.S. pressure record because Puerto Rico, an island and U.S. territory, is not part of the physical, continental U.S.)

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Infrastructure impacts

Homeland Security

National Protection and Programs Directorate
National Risk Management Center

INFRASTRUCTURE IMPACT SUMMARY

October 10, 2018, 1400 EDT

HURRICANE MICHAEL – INFRASTRUCTURE IMPACT SUMMARY – UPDATE 1

ASSESSMENT

The Department of Homeland Security (DHS)/National Protection and Programs Directorate (NPPD)/National Risk Management Center (NRMC) assesses medium-to-high regional impacts to infrastructure in Florida, Alabama, Georgia, and South Carolina as a result of heavy rainfall, wind damage, flooding, and storm surge from Hurricane Michael. No national impacts are anticipated.

Communications, power, fuel, water, food, agriculture, ports, road, rail, air, hospitals, dialysis, nursing homes, emergency services, dams, hazardous waste, wastewater.

INFRASTRUCTURE	LOCAL / REGIONAL IMPACT LEVEL	NATIONAL LEVEL IMPACT	IMPACT: ● LOW ● MEDIUM ● HIGH
Communications	● (red)	● (green)	**Communications:** High winds and flooding could cause communications outages resulting from potential disruptions of electric power service and infrastructure damage (e.g., towers, antennae and service facilities). Backup batteries and backup generator power could be insufficient if power outage recovery times exceed fuel availability and resupply capability. Providers may mitigate outages with deployable, mobile communications systems.
Energy	● (red)	● (green)	**Electric Power:** Customers are very likely to experience electric service disruptions from storm impacts to infrastructure assets. High winds could cause damage to overhead transmission and distribution assets, while flooding and storm surge may impact low-lying assets. Utilities have been preparing accordingly and restoration efforts will begin once conditions are deemed safe based on occupational safety criteria. Utilities have engaged mutual assistance networks if resources are needed for restoration efforts. Nuclear generation will be shut down in accordance with Nuclear Regulatory Commission requirements (2 hours before impacts from hurricane-force winds) at the Joseph M Farley nuclear plant in Columbia, AL. **Fuel:** Fuel disruptions are expected to be local, with minimal regional and national impacts. Local retail fuel station shortages may occur due to high demand in impacted areas. Post-storm supply and re-supply efforts could be constrained due to a variety of issues including electric power and communication disruptions and transportation delays due to roadway obstructions. **Offshore Energy:** Energy companies have removed personnel from 75 (+62 from October 9, 2018) oil platforms in anticipation of Hurricane Michael, with approximately 40 percent of daily crude from offshore Gulf of Mexico wells temporarily shut down. The evacuations are expected to be short-term and have little to no impact on fuel production regionally or nationally.
Food, Water, Shelter	● (yellow)	● (green)	**Water:** Electric power outages and flooding may interfere with drinking water treatment and delivery. Drinking water may be unavailable to some locations if pumping and lift stations lack backup generation or run out of fuel. If drinking water systems are unable to maintain sufficient pressure in the water distribution system, boil water notices will be issued to ensure safety. Systems nearest the coast are at risk of saltwater intrusion due to storm surge. Water and wastewater mains along barrier islands, shorelines, and bridge crossings are at increased risk from flooding and possible sinkhole formation. **Food and Agriculture:** Hurricane-force winds and local flooding will damage crops and impact livestock. Georgia is the largest producer of peanuts and second largest producer of cotton in the United States. The cotton and peanut crops could suffer damage due to high winds and flooding. Local impacts to food production, processing, and storage facilities from electric power outages, wind, and flood damage are expected.

smoothvega
@smoothvega
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This makes me sick #Houston

10:51 AM - 28 Aug 2017

8,675 Retweets **14,860** Likes

- Areas of hardship within NZ will be more greatly affected during and after a shock event.
- In a major event, how will society respond? How can we learn from this?

Examples at home

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364 river control, flood protection, and land drainage schemes
protect some 1.5 million hectares of land
collective replacement value of $2.3 billion

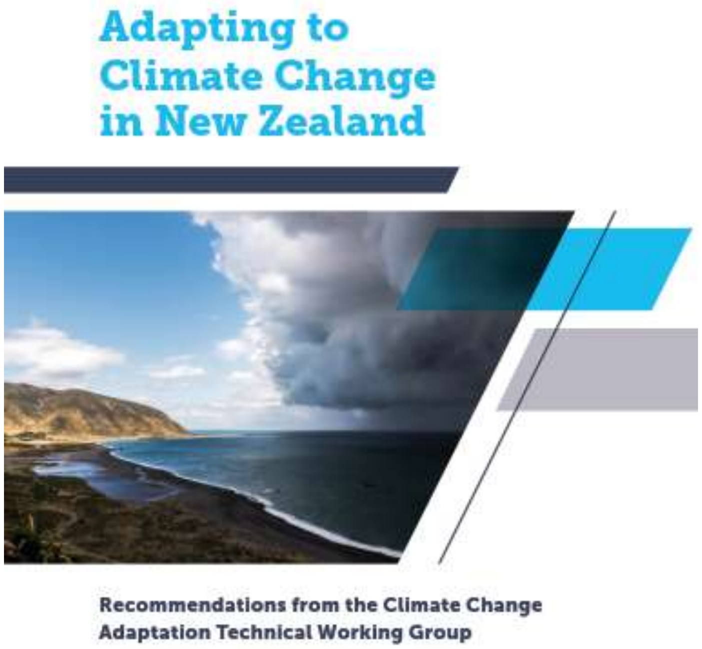
Increased focus on climate risk, resilience and adaptation in NZ

Many things happening

- Climate Commission
- MfE – Working Group, stocktake and options report (2017/18)
- Nat CC risk assessment, as well as local CCRA (eg Auckland)
- LGNZ Sea Level Rise Exposure Survey
- CDEM National Resilience Strategy
- Local Government Risk Agency, 60:40 Review
- MfE Coastal Guidance and DAPP approaches
- National Science Challenges – Deep South, Resilience to Natures Challenges
- NSC: Impacts of CC on wastewater and stormwater, upcoming Drought research
- Sea Rise Project (NIWA)
- LINZ / EQC / CDEM etc – Resilience data project
- Resilience frameworks such as UNISDR '10 Essentials of Resilience'
- Other: Metadata stds, Lifelines Vulnerability Studies, Infrastructure risk assessments, Loss modelling for insurance etc.

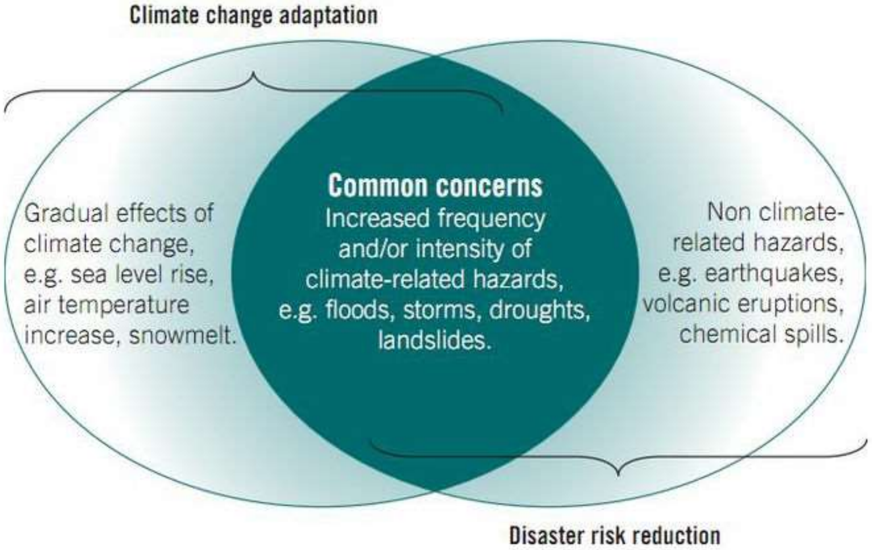
CCATWG Recommendations

- Action 1: Develop and regularly update a national adaptation action plan
- Action 4: Develop a national *methodology* and regularly undertake a national climate risk assessment
- Action 7: Review existing legislation and policy to integrate and align climate change adaptation considerations: (eg. LGA, RMA S106, NZCPS, Building Code, NPS')
- Action 12-14: Build capability and capacity in climate change adaptation across sectors – including for risk management



A focus on improving:

- Understanding of exposure and risk
- Working across disciplines – CCA, DRR, AM, Insurance, Policy etc
- Consistency of approaches - eg risk and vulnerability (eg via the NCCRA)
- Consistency of terminology and data



Toward Resilience: A Guide to Disaster Risk Reduction and Climate Change Adaptation (http://www.ecbproject.org/resources/library/341-toward-resilience-a-guide-to-disaster-risk-reduction-and-climate-change-adaptation)

Approaches to assessing and reporting on climate risk

How well do we understand exposure and risk to infrastructure?

Source: Bell et al (2015), including the infographic; Parliamentary Commissioner for the Environment (2015)

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Business drivers to assess and manage risk

- Slightly different drivers in public sector vs business environment:
- **Future regulation** – eg prodcomm, climate commission etc
- **Growing investor pressure** – leading to increasing need for disclosure of climate risks and divestments
- **Competitive advantage** – for companies addressing environmental issues (ESG)

> - Introducing mandatory climate-related financial disclosures is an important action the Government can take to encourage investment that supports the transition to a low-emissions economy. These disclosures help overcome information and inertia barriers inhibiting entities from adequately addressing climate risk and capitalising on low-emissions opportunities. They can help investors to correctly value assets and investment opportunities, and avoid misdirected finance or stranded assets.

Taskforce on Climate-related Financial Disclosure - TCFD

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

About Events Publications TCFD Knowledge Hub TCFD Supporters News

TCFD Supporters as of the One Planet Summit September 2018

513 organizations have expressed their support for the TCFD as of the One Planet Summit held in New York on September 26, 2018. The list below reflects all our current supporters, including companies and other organizations.

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BLACKROCK® About Us Newsroom Insights Investor Relations Responsibility Careers

BlackRock is trusted to manage more money than any other investment firm*. Our business is investing on behalf of our clients – from large institutions to parents and grandparents, teachers, nurses, doctors and people from all walks of life who entrust their savings to us.

Larry Fink, chief executive of the world's largest fund manager, BlackRock, which manages more than US$6 trillion of assets:

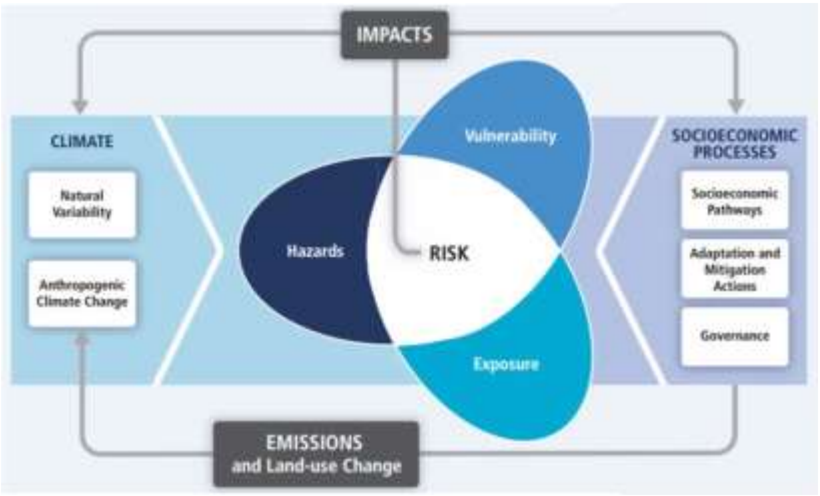
Fink's annual letter to the boards of thousands of companies warned that BlackRock would be exploring climate change in interviews with non-executive directors over the coming year.

He would be looking for "demonstrable fluency" on climate change and, where it was lacking, disinvestment was likely to follow.

Impacts on a range of business activities

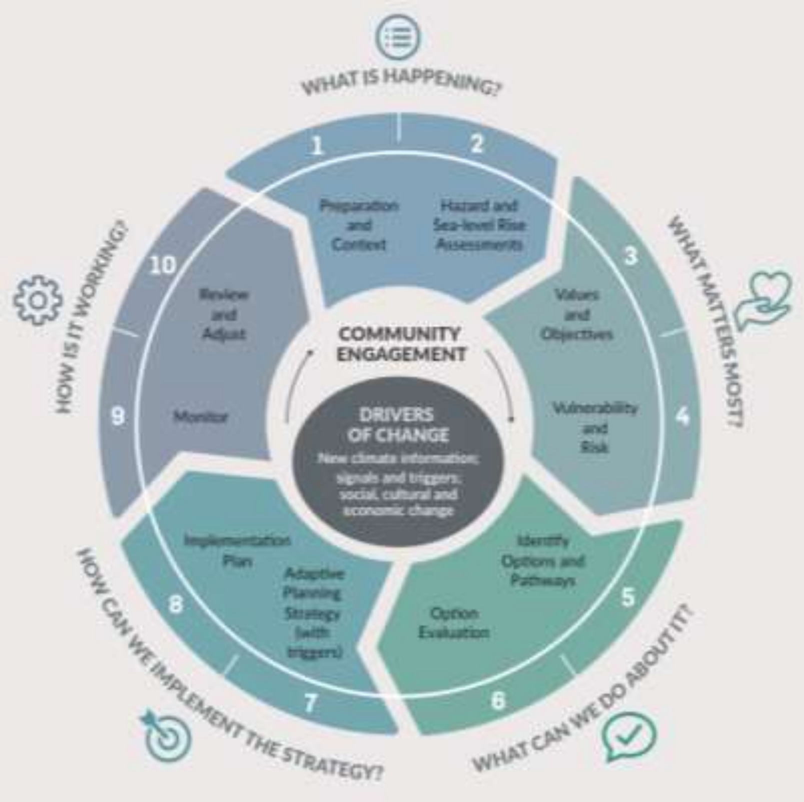
- Physical risks (BAU and during extreme events)

  Eg to infrastructure, operating costs, supply chain risks, business interruption etc
- Impact on insurance
- Impact on markets
- Policy and legal impacts
- Reputational impacts
- Transition risks (eg to low carbon)



A risk and adaptation framework for infrastructure

1: Overall framework



MfE Coastal Guidance, 2017

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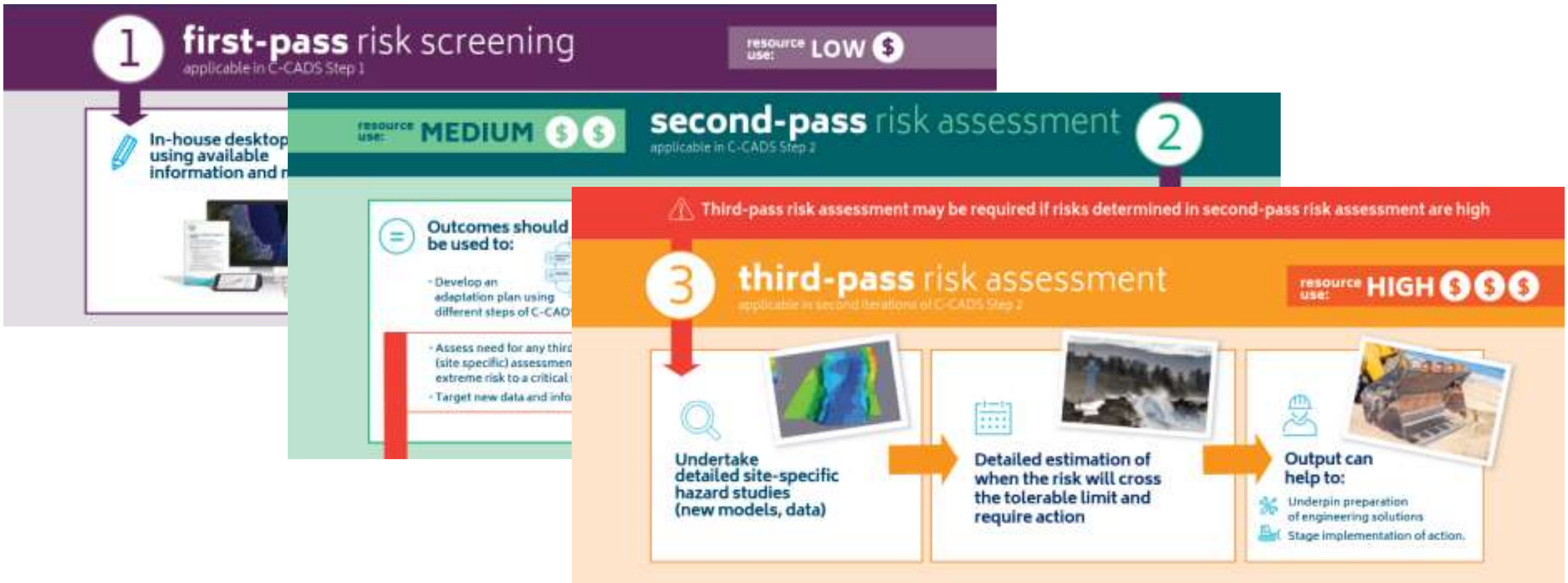
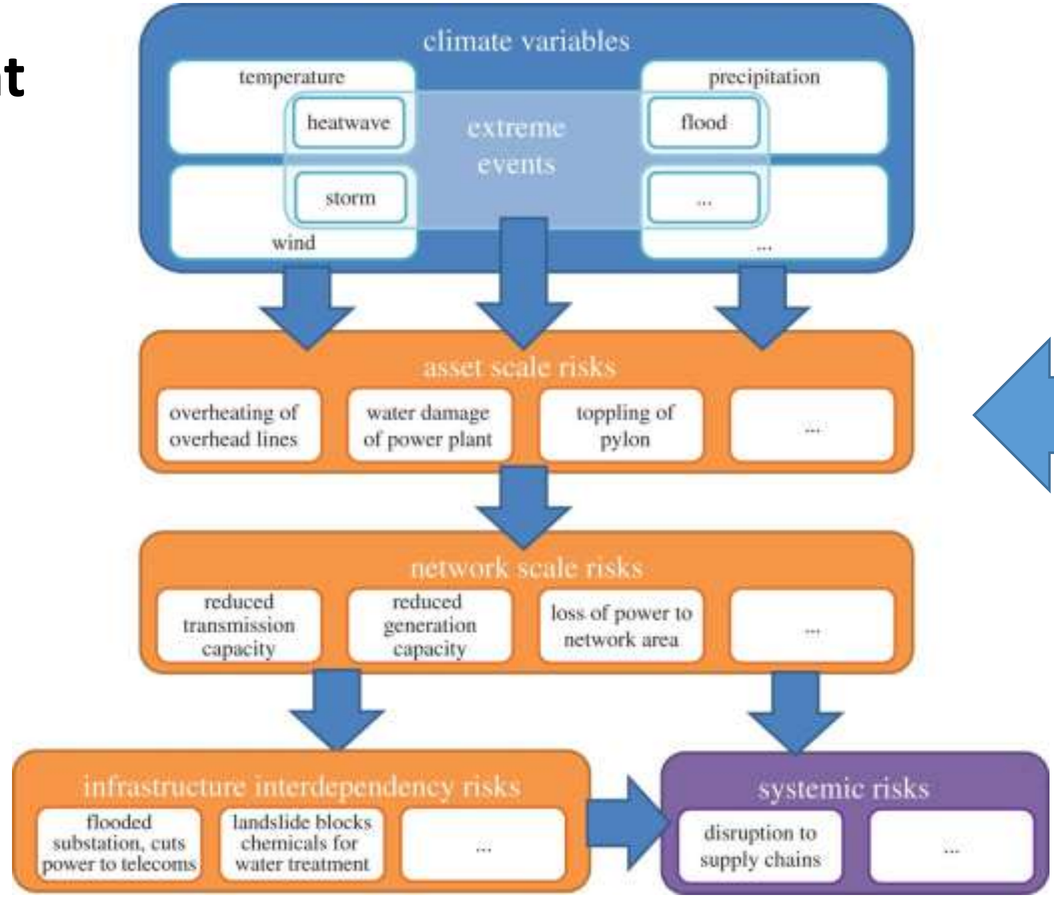
2: Risk assessment process



Source: NCCARF, CoastAdapt

2: Risk assessment process



INPUTS - EG:

- Climate hazard
- Vulnerability of infrastructure
- Consequence of failure (criticality)

Dawson et al, 2018. A systems framework for national assessment of climate risks to infrastructure

2: Risk assessment notes

- Climate risk varies with time
- Approaches (such as AS5334) encourage an assessment across a range of time horizons
- Assumptions required around RCP scenarios
- This assessment will allow:
    - Timing for commencing adaptation planning, decision-making and development of possible adaptation 'pathways',
    - Setting of triggers and thresholds for transition to agreed pathways,
    - Decision-making around opportunistic investment ahead of time (eg when assets are renewed, or when co-beneficial projects are identified).

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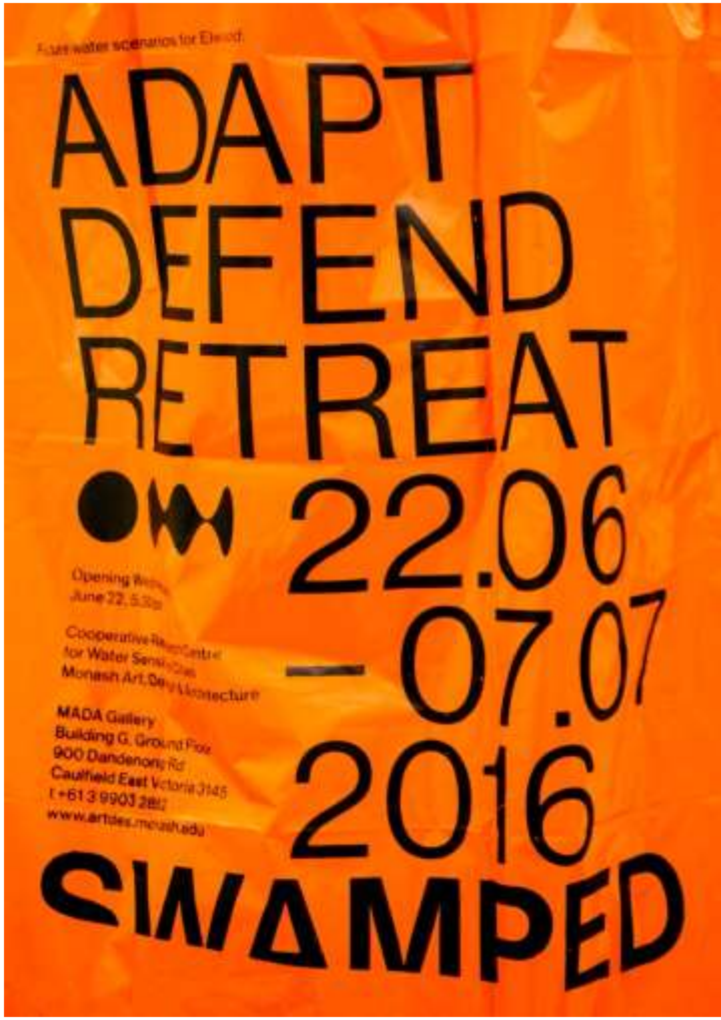
3: Determine options for addressing risk

- *Manage the unavoidable*
- *Avoid the unmanageable*



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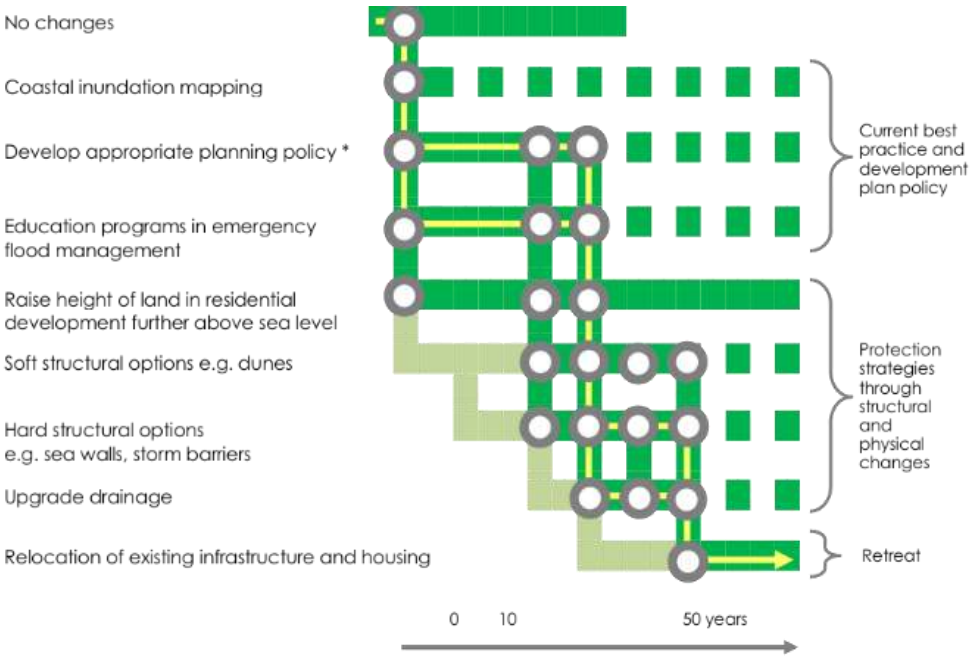
3: Types of actions needed

- **No regrets** – actions that yield benefits even in the absence of climate change.
- **Flexible/Reversible** – actions that can be easily retrofitted or upgraded
- **Safe failure**
- **Safety Margin** – designing infrastructure to cope with the full extent of likely climate impacts.
- **Soft** – financial, institutional or behavioural tools.
- **Reducing decision-making time horizons** – building cheaper, shorter-lived assets.

3: Pathways

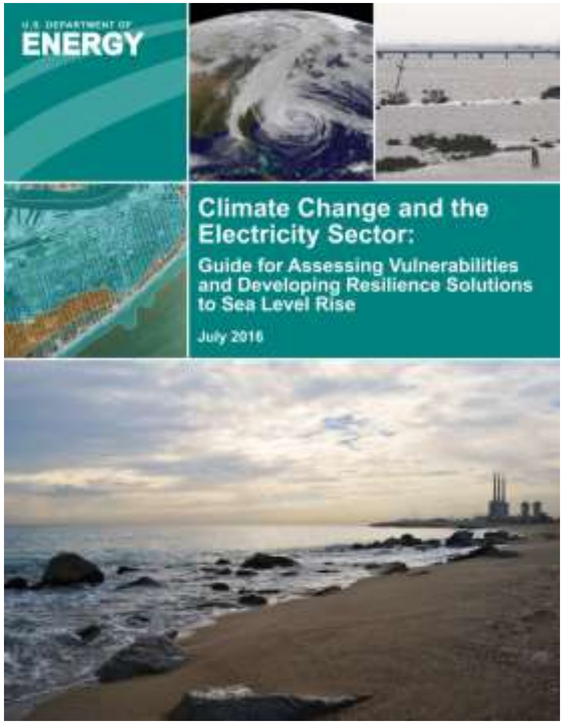


* includes revising mandatory planning provisions in development plans, reviewing the building code and strictly regulating hazard zones

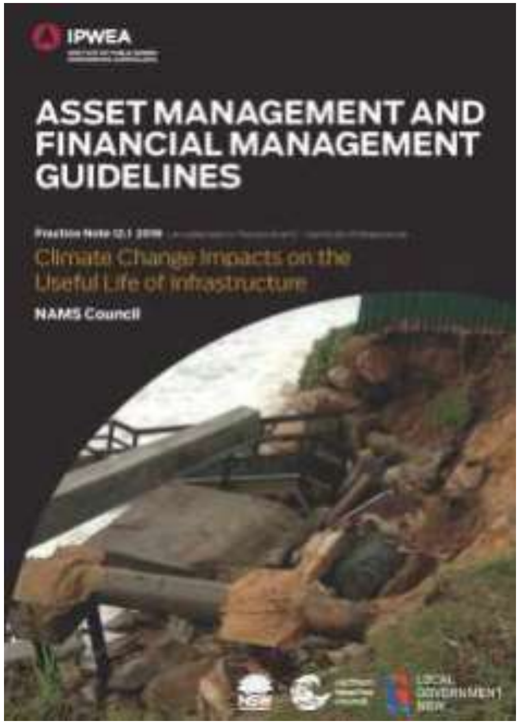
Ref: Eyre Council

Sector examples of approaches to assessing risk and adaptation

Guidance


U.S. DEPARTMENT OF
ENERGY
Climate Change and the Electricity Sector:
Guide for Assessing Vulnerabilities and Developing Resilience Solutions to Sea Level Rise
July 2016


NCCARF
Policy Guidance Brief 7
Climate proofing Australia's infrastructure
Key Points


IPWEA
ASSET MANAGEMENT AND FINANCIAL MANAGEMENT GUIDELINES
Climate Change Impacts on the Useful Life of Infrastructure
NAMS Council

LGNZ Exposure study – interim findings

SLR exposure project

- To quantify local government infrastructure which is ***exposed*** to SLR scenarios.
  - 0.5 m
  - 1.0 m
  - 1.5 m
  - 3.0 m
- Councils with available LiDAR data covered all four scenarios.
- The national 25 m DEM was used to develop 3.0 m SLR scenario only for councils without LiDAR.
- Partially LiDAR covered councils were sent both.
- ***NOTE:*** Exposure does not necessarily imply impact or damage

Wastewater and stormwater sector: impacts & implications

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Wastewater & Stormwater Impacts

WASTEWATER

- Increased I&I and overflows in WW systems
- Assimilation capacity of receiving environments reduced
- Increased strength of influent risking breach of toxicity levels
- Pipes float causing cracking.
- Increased odours at TPs and outfalls
- Performance varies with temperature e.g. oxidation ponds
- Drought and increased instances of very low flows and blockages

STORMWATER

- Increased flash flooding - Roads, Assets, buildings/lifeline
- Slumping and landslides along open storm water systems
- Increased or acute contamination loading- gross pollution, fine pollution, sedimentation
- Reduction in available capacity through less time to drain between events – lower level of service

National Science Challenges

THE DEEP SOUTH

Telco sector

Telco impacts (Garnaut review)

Climatic Variables

- Increase in extreme daily rainfall
- Increase in intensity of extreme wind
- Increase in frequency and intensity of storms
- Increase in solar radiation
- Increase in variation of wet/dry spells
- Decrease in available moisture
- Increase in electrical storms
- Increase in frequency/intensity of bushfire events

Impacts

- Flooding of exchange/roadside manholes and underground pits
- Storm/wind damage to above ground transmission
- Erosion exposing major cables and trunk routes
- Increased saline corrosion of telecommunication broadcasting towers
- Degradation of aerial cabling
- Decline in stability of tower structures and foundations
- Overheating of exchanges and base stations
- Road closures due to flooding inhibiting service and/or restoration efforts
- Exposure of telecommunications infrastructure to bushfire

Implications

IMPLICATIONS CONSIDERED IN DETERMINING MAGNITUDE OF IMPACTS

- Increased capital and operating expenditure to cope with more extreme weather events, infrastructure degradation and fault rates
- Increased capital expenditure due to accelerated obsolescence of materials / structures

ADDITIONAL INDIRECT IMPLICATIONS

- Higher costs for provision of telecommunications services
- Loss of revenue for companies providing telecommunications services— e.g. telephone, radio, television, internet service providers
- Loss of telephone/radio/internet services causing business interruption and loss of productivity of commercial customers
- Domestic and emergency services communications may be compromised due to service disruptions
- Disruption of communications for public services (e.g. train services)

Garnaut climate change review 2008: Impacts of climate change on Australis's telecommunications network.

Power sector

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Figure ES.1 Emerging Practices in the Power Sector, by Risk Management Pillar

Hazard	Impacts
Meteorological	
Cold spells	Potential ice buildup in cooling water systems, including blockages of cooling systems. Temporary reduction in power output or temporary shutdown.
Heatwaves and Extreme Air Temperature	Reduced thermal efficiency and water shortage. Reduced thermal-generation efficiency through reduced available thermal differential between the input and output temperatures, which decreases the power output of any thermal power plant (ESMAP 2011). A large volume of water is typically used in a steam-based power station. It is often taken from a reservoir or river and discharged back, although at a higher temperature than at the water intake point. Air and water temperature increase during heatwaves can result in operational constraints or impacts downstream due to regulated limits on the water temperature in the natural environment. During the 2003 European heatwave, electricity demand soared as the temperature rose and the heatwave lasted. Drought and extreme heat created additional stresses on energy generation and transmission. Reduced river flows and higher water temperatures reduced the cooling efficiency of thermal power plants (conventional and nuclear) and up to six power plants were shut down completely (Létard et al. 2004). During the event, 17 French nuclear reactors had to limit or stop output, resulting in a shortfall of about 8 gigawatts (GW) of nuclear power (Forster and Lilliestam 2010). Since the 1980s, Germany had to reduce nuclear power generation during at least nine summers (Müller, Greis, and Rothstein 2007). Reduced water availability also tends to occur during heatwaves (with increasing water conflict between sectors). Thawing permafrost in northern climates can cause fuel transport challenges, such as damage to pipelines and roads.
Tropical Cyclones and Storms	Widespread destruction, including structural and flood damage to built assets. Tropical cyclones and storms have the potential to damage thermal power generation facilities through structural damage. While thermal power plants are designed to withstand extreme wind loads (and are cyclone rated in cyclone-prone areas), they can incur damage during the most extreme events. Tropical cyclones are also associated with heavy rainfall downpour, which can easily lead to localized or widespread flooding of coal stockpiles, equipment, and ancillary infrastructure, including road and rail facilities. Tropical cyclones generate high winds; in desert or fine-flying debris environments, they can block and damage intake air filters. Wind-driven rain or salt spray can similarly damage air intakes; if they are destroyed, housed equipment, such as the engine and generator, can also be damaged.
	Tropical cyclones can severely damage offshore gas supply facilities. Snow can also block air intakes and require temporary shutdowns.
Storm Surge and Coastal Inundation	Widespread destruction, including structural and flood damage to built assets. Debris blockages of cooling water intakes can result in temporary disruptions. Flooding of pumps susceptible to water damage can result in lengthy outages requiring replacement pumps. Water damage to electrical equipment in particular, including control rooms, can require major refurbishments. Many components in thermal stations are sensitive to water. Fuel supply lines can be at risk. Many gas and coal supply facilities are located near coastlines. Inundation can damage these facilities (e.g., pipelines, rail and road transport infrastructure, processing plants, and stockpiles) and reduce generation output until supply lines are repaired. Salt contamination can lead to increased corrosion and reduced component life span.
Hydrological	
Plain and Flash Floods	Flood damage to thermal plants. The impacts are similar to storm surges, except for low risk of salt contamination (Urban and Mitchell 2011). Floods can also cause erosion and exposure of pipelines particularly close to rivers, leading to damage. Sink holes can occur, which may damage generation supply facilities.
Climatological	
Droughts	Water-shortage impacts on thermal generation. Most thermal-generation facilities (with the exception of gas turbine stations) rely heavily on fresh water for cooling purposes (Urban and Mitchell 2011). In some cases, seawater can be used for some cooling functions, but there is still a need to access a large volume of fresh water for generation. During drought periods, water resources can become extremely scarce; water restrictions, water licensing, and conflict over water use can further exacerbate water supply disruptions and shortages. Closed loop, non-evaporative cooling systems can overcome this, but they are less efficient during high ambient temperature situations.
Sea Level Rise	Although hazardous, sea level rise can be mitigated due to the longer timeframes involved.

Vector


Vector
WORKING TOGETHER ON RESILIENCE
SEPTEMBER 2018


DISTRIBUTION
• HIGH WINDS
• FLOODING
• SEA LEVEL
• VEGETATION
• VEHICLES
• ANIMALS TOUCHING ELECTRICITY LINES
TRANSMISSION
• HIGH WINDS
• FLOODING
• COOK STRAIT CABLE FAILURE
• SEA LEVEL
GENERATION
• LOW WIND LEVELS
• WATER TEMPERATURE
• DROUGHT
CROSS SUPPLY CHAIN
• EARTHQUAKE
• CYBER-ATTACK
• VOLCANIC ACTIVITY
• FIRE
• EQUIPMENT FAILURE
• LANDSLIDES/EROSION
• AIR TEMPERATURE
• LIGHTNING
• GEOMAGNETIC REVERSAL
• SOLAR FLARES

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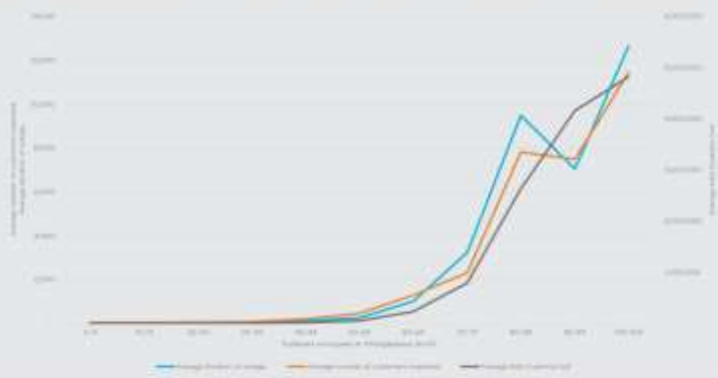
KEY CLIMATE CHANGE RISKS TO VECTOR'S NETWORK

- Vector has undertaken an assessment of the risk of different climate parameters to the Auckland electricity and gas network – The Physical Effects of Climate Change report, completed by EY in November 2017 (Ref. 1).
- An analysis of Vector's outage data revealed climate variables, particularly wind, with historically high impacts.
- The graph below shows that as sustained wind speeds on the Vector network exceeded 70km/h there is a significant increase in the duration of outages (blue line), customer minutes lost (grey line) and number of customers affected (orange line).
- The EY model projects that the number of hours with wind in the 70-80km/h range will increase significantly.
- Taking the 75th percentile output (1 in 4 chance) the projected increase in customer minutes lost is expected to increase by 200% by 2030 and almost 400% by 2050.
- The impacts of climate change are felt across the electricity supply chain, as illustrated below.

Average outage duration, customers impacted and total customers lost based on wind speed (2004-16)



Key climate change risks on whole electricity system

Table 2
Potential climate impacts per asset class

	Generation				T&D	
	Thermal	Hydro	Wind/PV	Biomass	Lines	Stations
Air temperature	●	●		●		
Water temperature	●			●		
Water availability	●	●		●		
Wind speed			●		●	
Sea level	●	●	●	●	●	●
Floods	●	●	●	●	●	●
Heat waves	●		●		●	●
Drought	●	●		●		
Storms					●	●

Source: Adapted from Asian Development Bank (2013).

1 The results of EY's work, including the assumptions and qualifications made in preparing the report, are set out in The Physical Risks from Climate Change – Report of Findings for Vector Limited dated November 2017 ("Report"). The Report has been prepared for Vector. EY disclaims all liability in relation to any other party who seeks to rely upon the Report or any of its contents.

Vector – Shared approach to reducing risk

EDBs typically have the following investment options to improve resilience:

- Establishing microgrids using distributed and renewable generation;
- Undergrounding or relocating exposed parts of the network;
- Using new technology network storage options (becoming increasingly feasible by rapidly falling costs);
- Using new technology options such as aerial bundled conductors and smart poles (enabled by declining costs of sensors and network communication technology);
- Changing the configuration of the network to be more meshed;
- Utilising temporary generation; and
- Increasing vegetation cut zones, removing trees that can fall on lines and limiting third party asset strikes (vegetation management is also under the control of the government, councils, and other infrastructure providers, as well as consumers).

Customers' now have individual options to improve resilience, thanks to new technology and reducing costs, including:

- Mobile on-site generation;
- Permanent on-site generation;
- Renewable generation;
- On-site storage solutions;
- Solar energy and battery solutions;
- Vehicle-to-Home (V2H) solutions that utilises the energy stored in a EV to supply a home during an emergency; and
- Private on-site asset management (e.g. sewerage systems).

Figure A: V2H supply chain

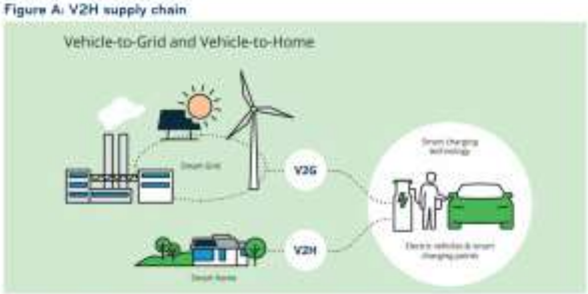
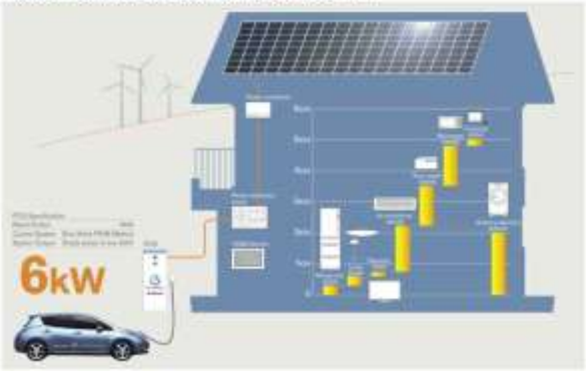


Figure B: Possible load combinations supplied by V2H



Closing comments

Closing comments

- Problems are complex & dynamic – we need **new ways of working together** to manage the significant climate risks we face
- **Expect** more guidance and consistency in approaches at national and regional levels. Including a **joined up approach** to DRR and CCA
- **Consistent and aligned policy** and institutional arrangements
- **Risk assessment** across all sectors: Communities, infrastructure, natural environments, business and industry, health sectors, international dimensions etc
- **Options and pathways** which consider defend-adapt-retreat, policy interventions, hard and soft solutions etc
- Engagement and working together to build a **common vision and long term view**

Tonkin+Taylor

"Human civilization is built on the premise that the level of the sea is stable, as indeed it has been for several thousand years".

NY Times, 2016

THANK YOU

REDUCING RISK
BUILDING RESILIENCE

EQC'S RESILIENCE STRATEGY

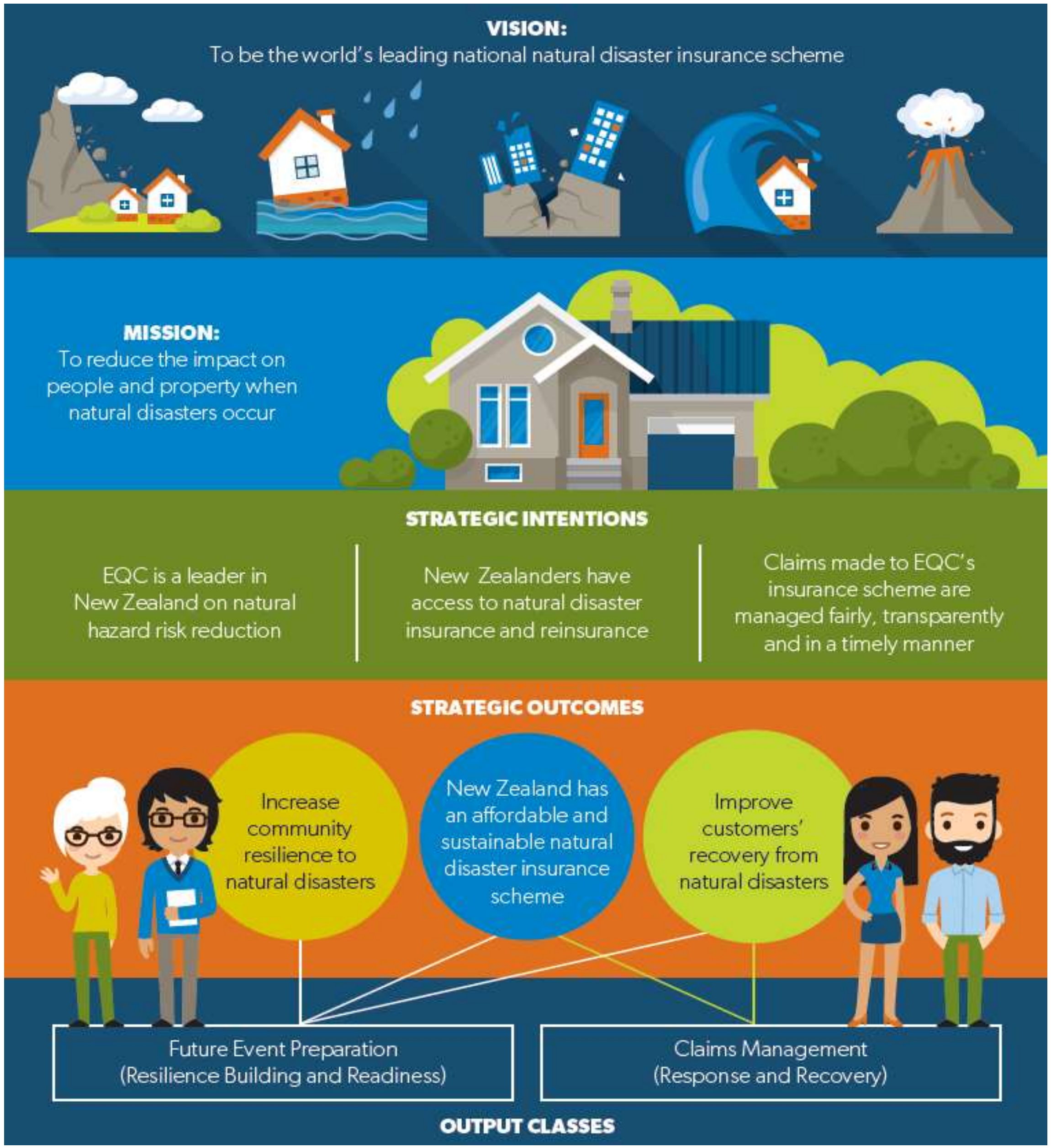
DR RICHARD SMITH – MANAGER RESEARCH STRATEGY AND INVESTMENT

NATIONAL LIFELINE UTILITIES FORUM 2018

OUR MISSION: TO REDUCE THE IMPACT ON PEOPLE AND PROPERTY WHEN NATURAL DISASTERS OCCUR.

EQC
EARTHQUAKE COMMISSION
Kōmihana Rūwhenua

EQC'S STRATEGIC CONTEXT

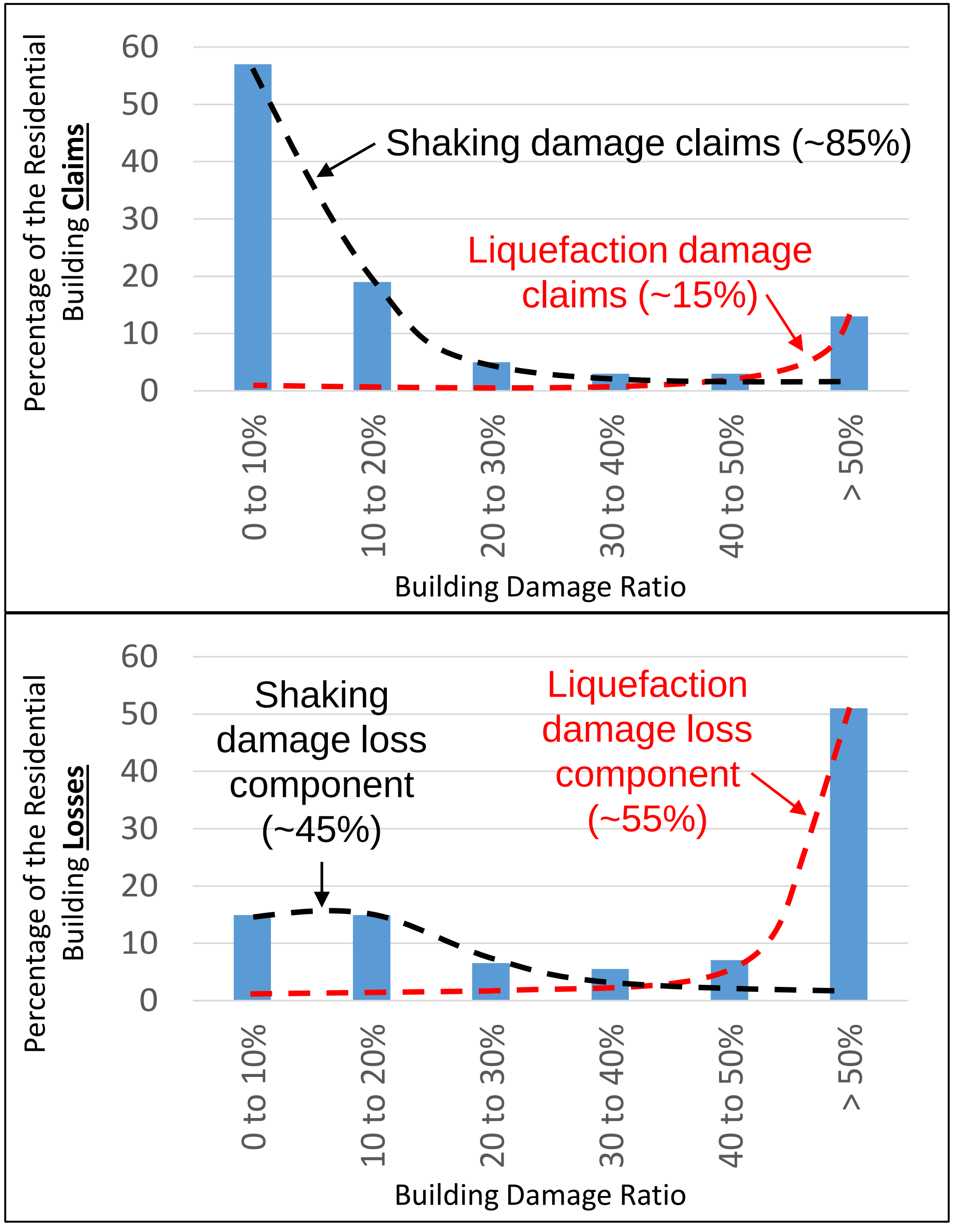


NEW ZEALAND'S NATURAL DISASTER RESILIENCE CHALLENGES

EQC'S RESILIENCE GOAL

Stronger homes, built on better land, served by resilient infrastructure, supported by affordable risk capital.

WHY IS EQC INTERESTED IN BETTER LAND USE PLANNING AND ENGINEERING ?



Large numbers of low value claims due to shaking damage to dwellings, but..

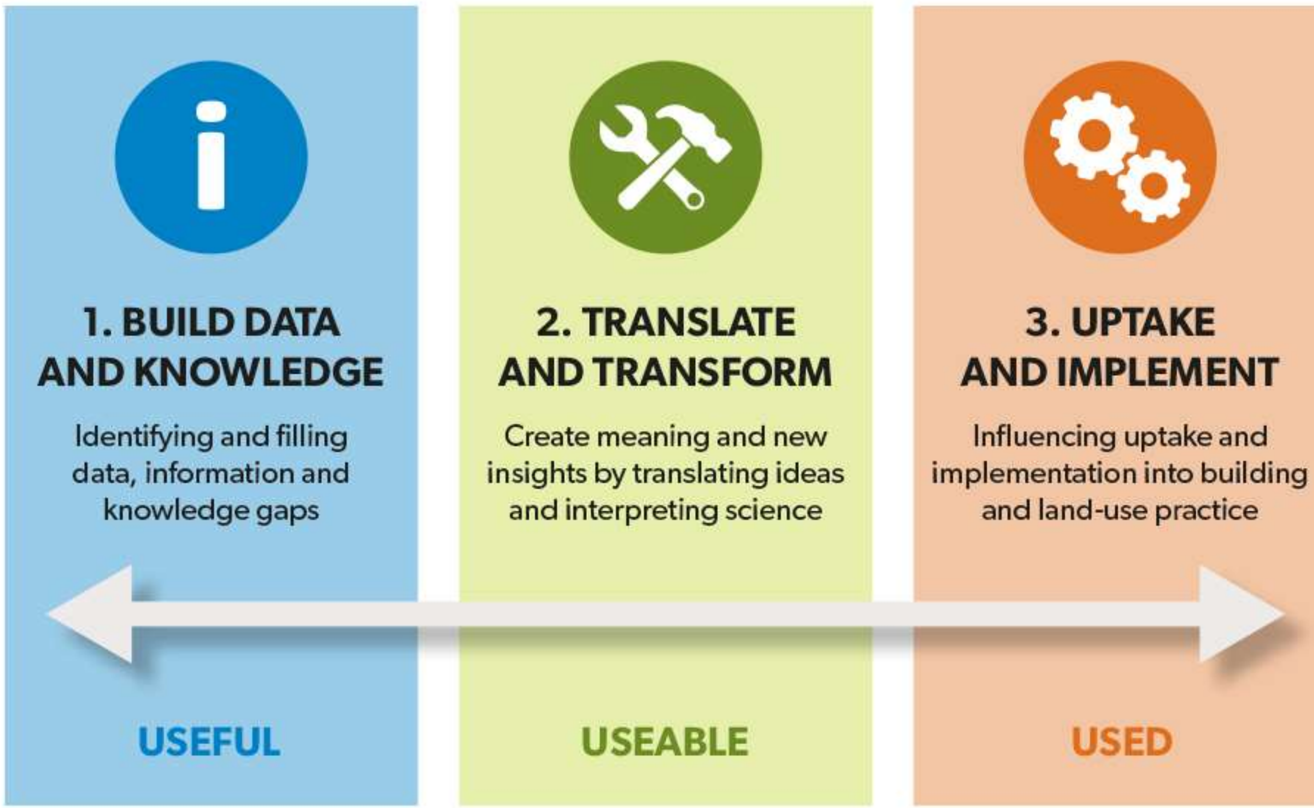
Very high $$$ value of losses due to land damage (55%)

WHAT WILL SUCCESS LOOK LIKE?

Our vision is that natural hazards resilience is an everyday part of all aspects of decision-making for New Zealand homes, towns, and cities.

OUR GUIDING PRINCIPLES

WHAT EQC WILL DO



PARTNERS FOR ACTION

Infrastructure Owners and Operators

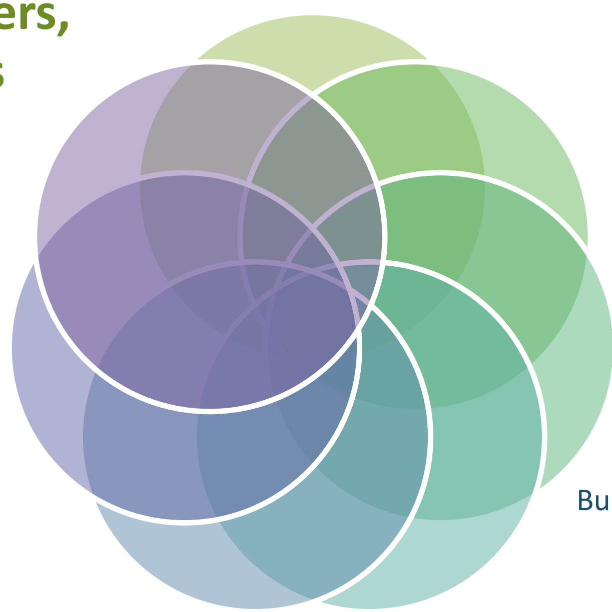
Resilience performance choices

Professionals e.g. Engineers, Architects, Developers

Practice standards and capability
Resilience performance choices

Local Government

Resilience performance choices
Implementation of building and land policy and plans



Insurers/Reinsurers

National and local risk profiles
Risk treatment settings

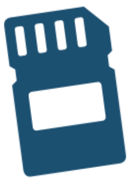
Central Government

Building, infrastructure, and land regulatory policy
Resilience performance choices
Unified leadership across the system

Public/Homeowners

Resilience investment choices

PRIORITIES OVER THE NEXT THREE YEARS



A RENEWED FOCUS ON THE STRATEGIC VALUE OF DATA AND INFORMATION

Initial priorities:

> Geotechnical data in high risk areas

> Improved sharing of hazard information

COORDINATED AND TARGETED SCIENCE INVESTMENT

Initial priorities:

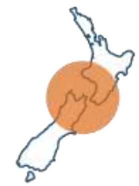
> Research on the effects of risk-based insurance coverage

> Improved volcanic and landslide hazard models

ACCELERATING THE SYNTHESIS AND TRANSLATION OF RESEARCH OUTPUTS

Initial priorities:

> Engineering guidance for seismic improvements of buildings



ENHANCING LOSS MODELLING/ IMPACT ESTIMATION PRODUCTS

Initial priorities:

> Replatforming existing capability and expanding the hazard types that can be modelled

DEVELOPING RECIPROCAL PARTNERSHIPS

Initial priorities:

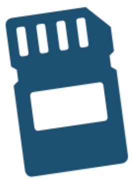
> Local government and key regulators

> Guidance and training for engineers and land use planners

HOW CAN WE WORK TOGETHER?

Infrastructure Owners and Operators

Resilience performance choices



DATA AND INFORMATION

NZ Geotech Database

GeoNet

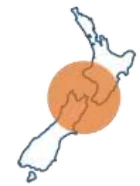
TARGETED SCIENCE INVESTMENT

National Hazard Models

Infrastructure engineering research

TRANSLATION OF RESEARCH OUTPUTS

Engineering practice guidance



ENHANCING LOSS MODELLING/ IMPACT ESTIMATION PRODUCTS

Economic analysis and modelling to inform infrastructure resilience investment

DEVELOPING RECIPROCAL PARTNERSHIPS

Training
Sector education

Resilience investment advocacy

THANK YOU

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