Rising challenge for coastal infrastructure: national guidance and risk-exposure project

Rob Bell and Ryan Paulik

Climate, Freshwater & Ocean Science

Coasts & estuaries:
Changing risk the “new norm”

More frequent consequences

Predict and act limited – past not a useful guide

A paradigm shift is needed

Do we continually react, clean up & stay put?

- What are the limits of this strategy?

Do we anticipate?

- How can we do this?

Do we ‘protect’ our coast?

- What are the limits of this strategy?
  - Escalating costs
  - Loss of amenity & habitat
  - Availability of materials
  - Rise of residual risk (e.g. breaches, edge effects)

Do we adapt?

- Support communities to build back better or somewhere else?

Sea rise (0.2 m >>) = more frequent flooding, erosion

Michael Shepherd-Finch

Michael Allis

Sven Martin

KING TIDES Auckland

Snap the coast See the future

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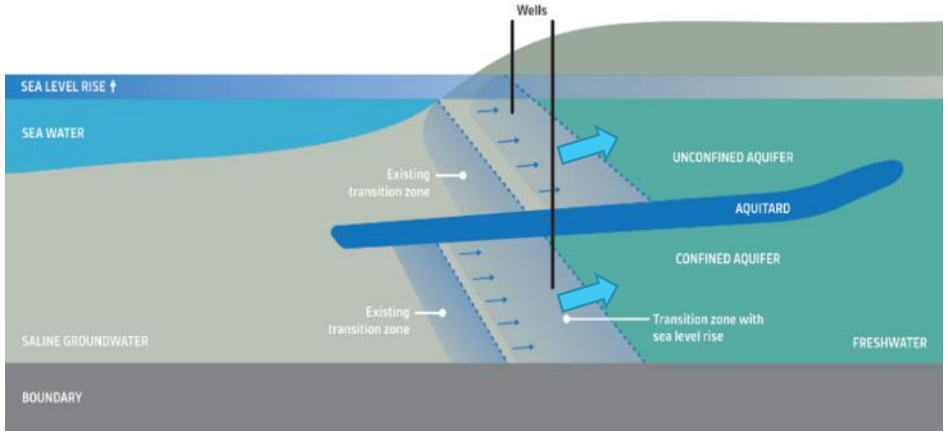
Groundwater, compound hazards & infrastructure



Credit: Chris Loufte

- Rising groundwater levels (tidal)
- Reduced field capacity (soakage)
- Salinization (g/w, lowland river systems, infrastructure)
- Compound hazards becoming more common e.g. rising g/w and pluvial/fluvial flooding combined with SLR and storm-tide/wave events (overtopping)

  ⇒ include in hazard/risk assessments

- Existing stormwater networks “under pressure” – often gravity systems
- Decrease in level of service (networks and secondary flowpaths)
- Road and building foundation instabilities
- Coastal erosion of roads and services
- Resolving flooding impact priorities: getting wet vs damage

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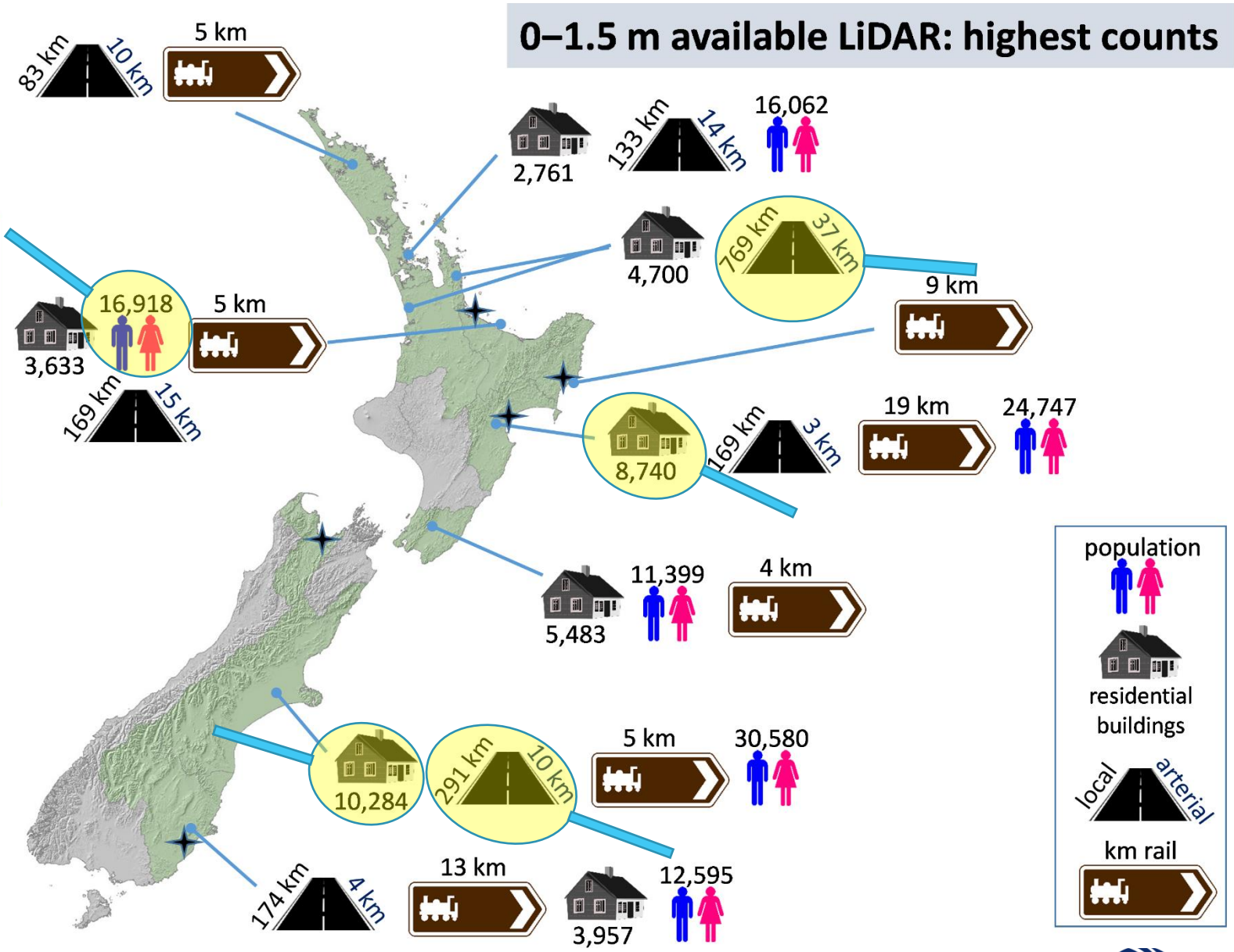
Replacement cost of all buildings
$19B (2011)

Total No. of residential buildings
43,680
Total No. all buildings
68,170
Total resident population
133,265 (Census 2013)

National Infrastructure
- **382** critical-facility buildings
- **5** airports
- **1,547** jetties & wharves
- **2,121 km** of roads (1,930 km local roads)
- **46 km** railway



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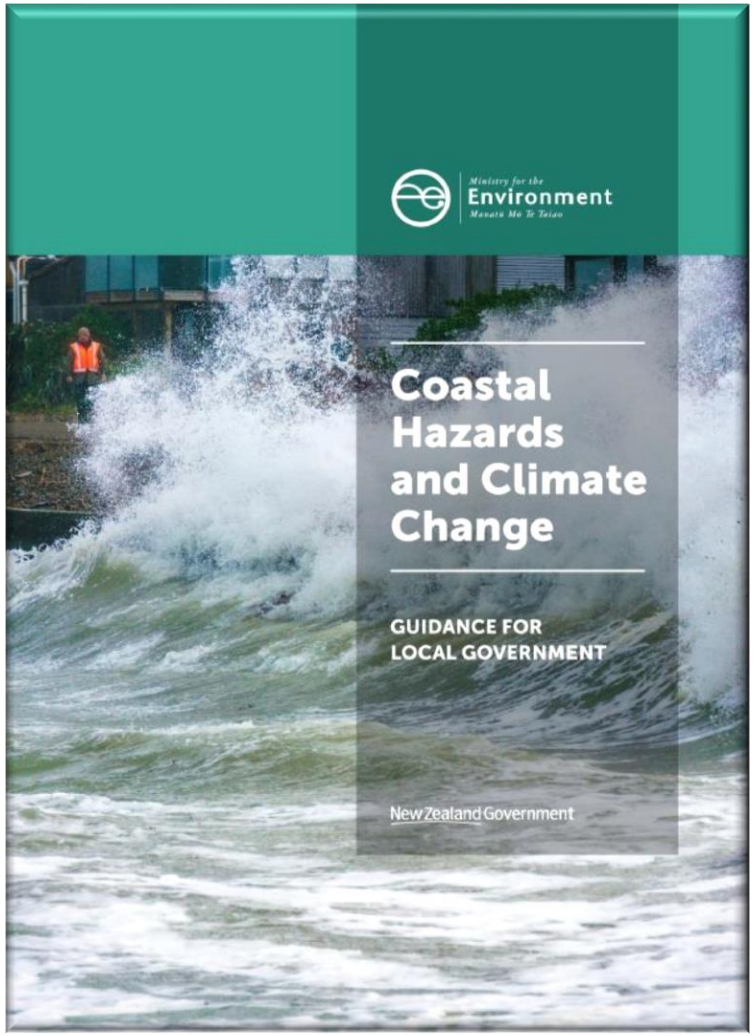
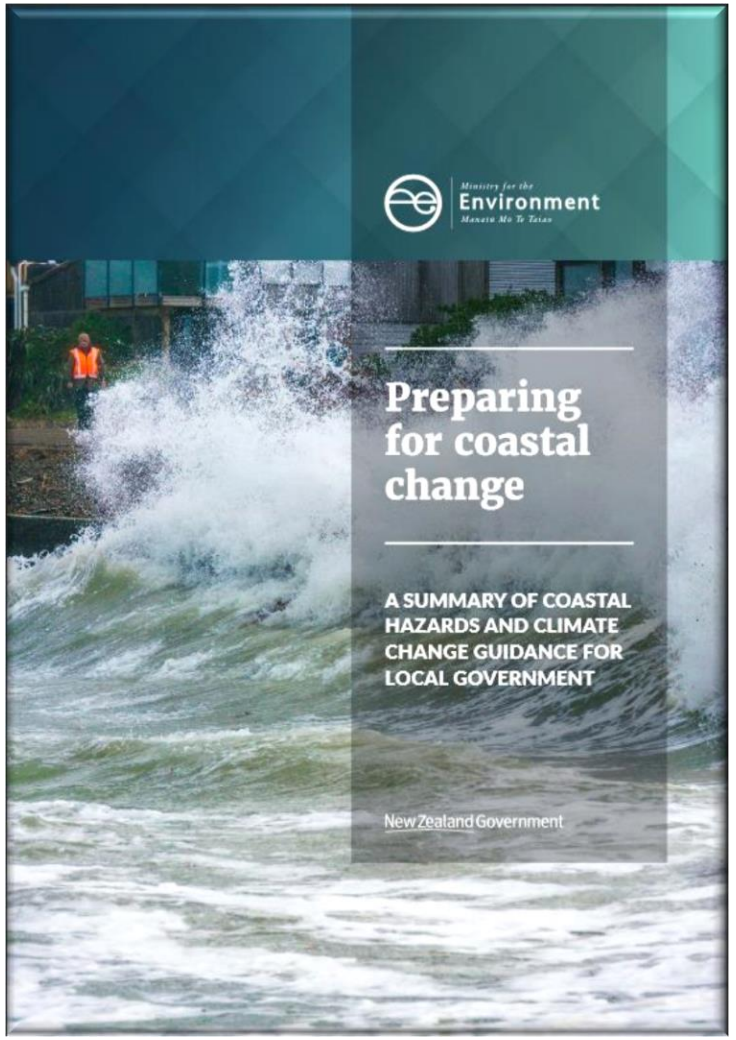
MfE Coastal Guidance





- Released Dec 2017 by Minister Shaw
- Supports communities, councils and infrastructure operators to address uncertainties and change
- Policy 24 (NZCPS) – "*take into account national guidance*" and "*best available information on effects of climate change …*"
- Aligned with DoC Implementation Guidance for NZCPS hazards policies

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Framing of Guidance: uncertainty & decisions

Michael Shepherd-Finch

- Some areas already at adaptation thresholds (or imminent in next 2-3 decades)
- If not imminent - decisions today will affect future adaptation options

- Ongoing rise in risk (for centuries)
- Uncertainties widen (deepen) towards latter part of century and beyond (emissions/warming govern rate of SLR)
- Moves away from “best-number”
- Decisions can’t wait until uncertainties are reduced? - may take decades to resolve how SLR is tracking within the scenario set

Michael Allis

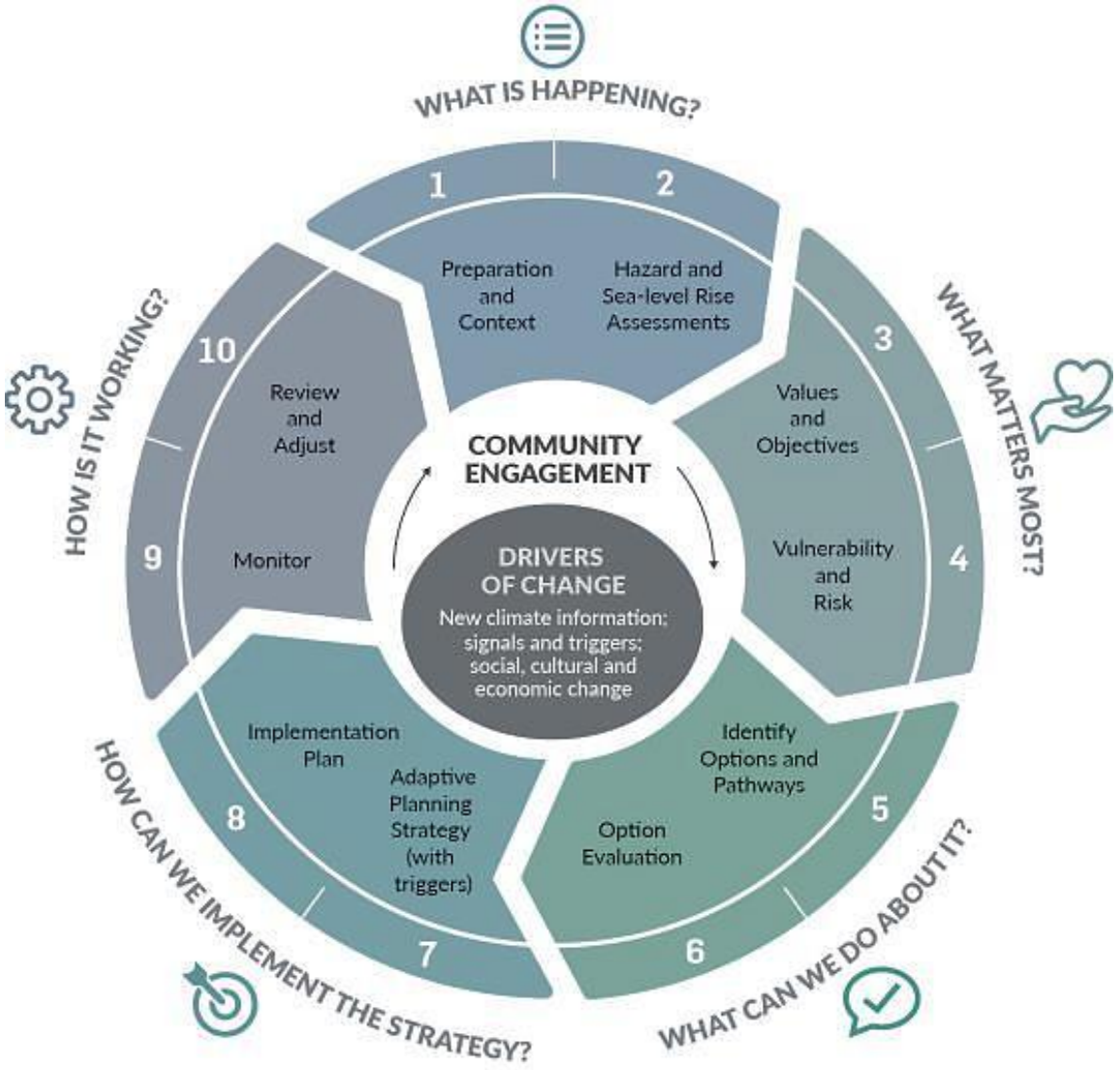
10-step decision cycle

- Centered on community engagement

- <u>Five key questions:</u>

  A. What is happening?
  B. What matters most?
  C. What can we do about it?
  D. How can we implement the strategy?
  E. How is it working?

- New information, social & economic change, or if a large event occurs
  → re-enter cycle where appropriate



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NZ SLR scenarios

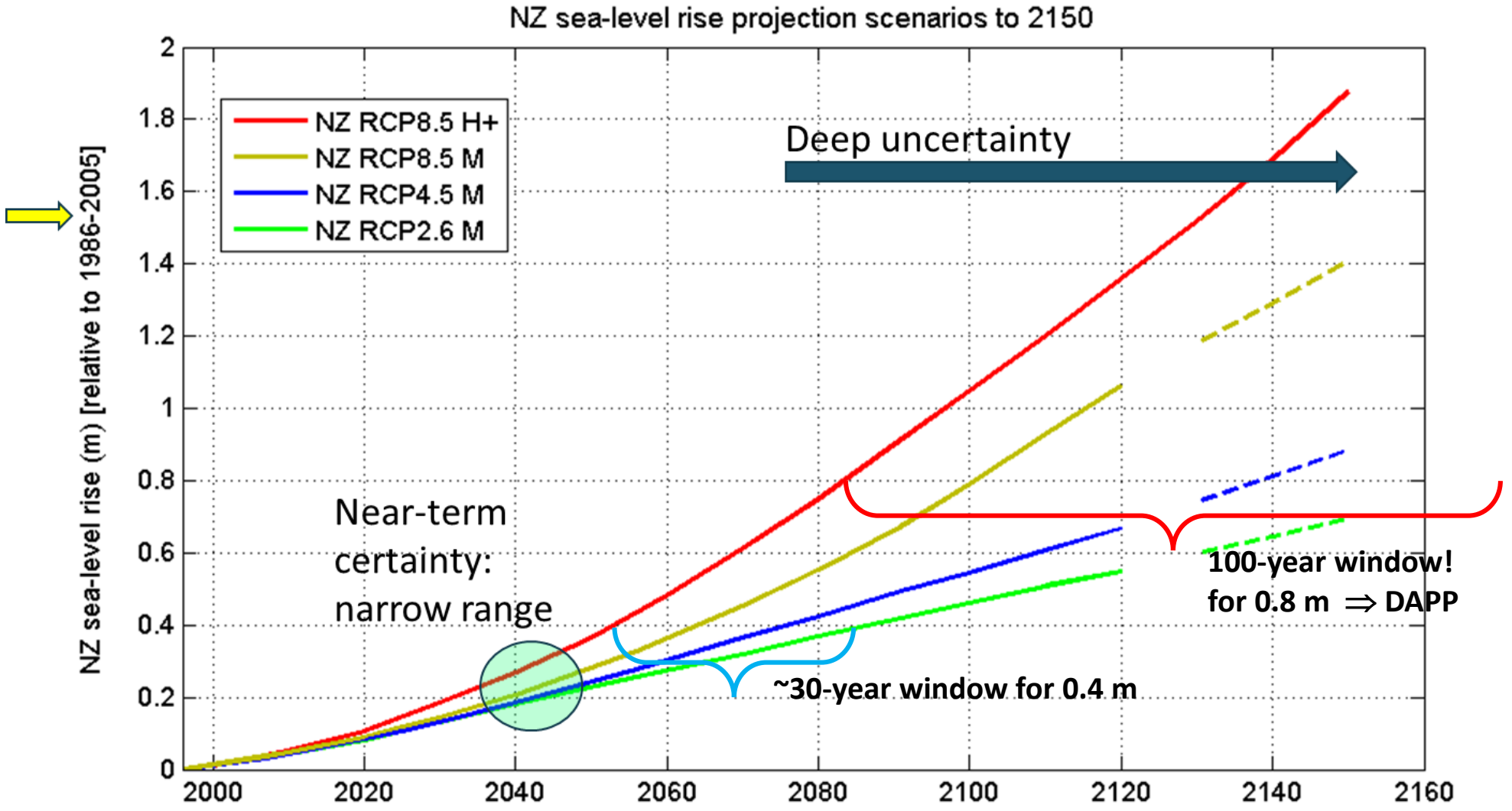


Figure 27: MfE Coastal Hazards & Climate Change

Risk assessments

- The "***effect of uncertainty on objectives***" ISO 31000: 2009 (now 2018 version)
- Usually expressed in terms of:
  - **risk sources** (hazard + exposure)
  - **types of impacts** (incl. compound hazards or changing conditions)
  - **consequences** (affecting objectives)
  - **likelihood** (chance of happening)

R Bell

- <u>For councils</u> – additional climate-related **risk sources** are:

  legal liabilities, changing social-economic situation, reputational risks, abandoned assets, cascading climate-change effects across sectors + services

Vulnerability assessments

- ***Vulnerability*** = **Predisposition to be adversely affected** from exposure to hazards & ongoing SLR

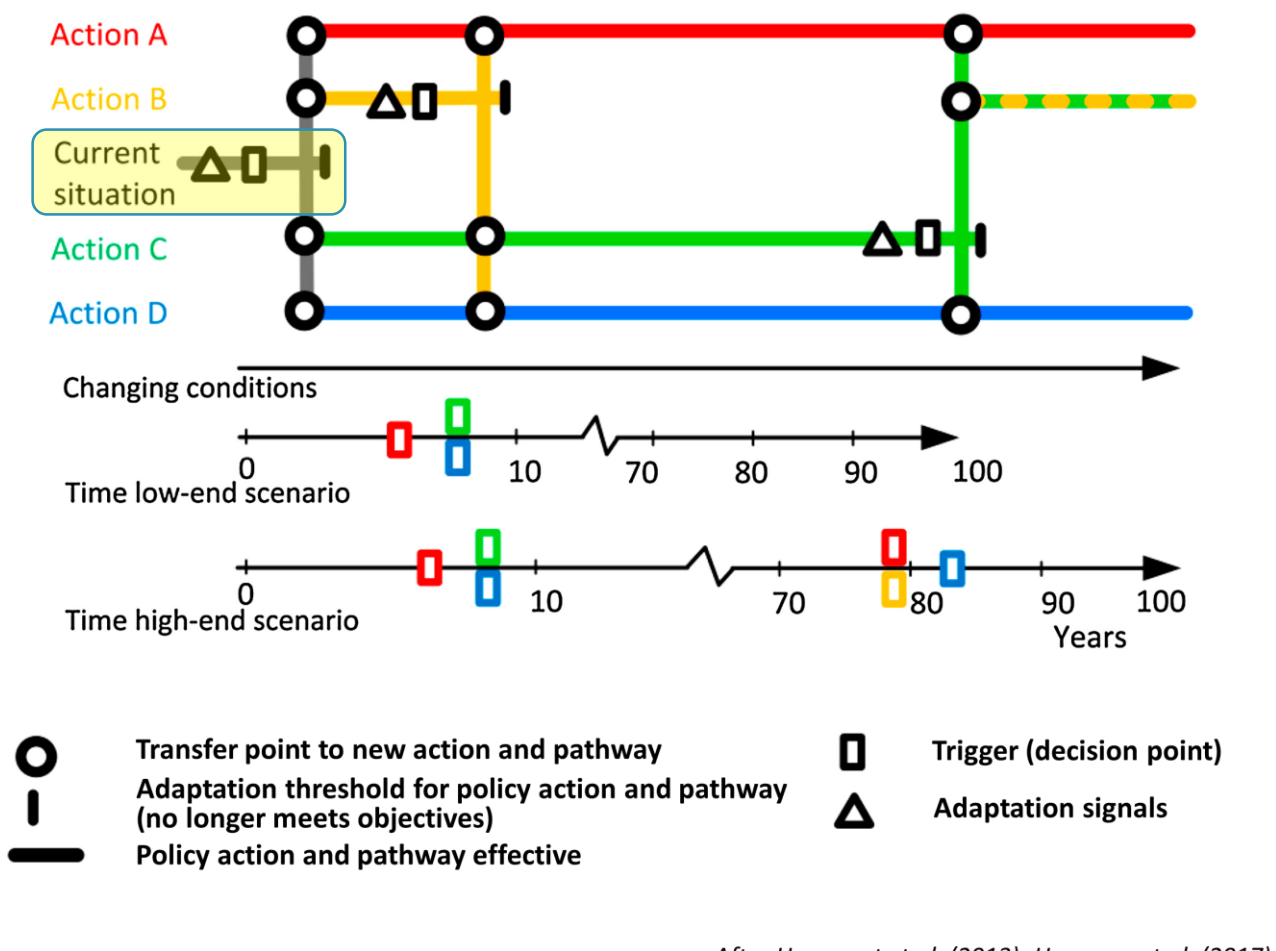
- **Broader** than conventional risk assessments – dependency between communities & services and their ability to cope – includes extra aspects:

  - **Adaptive capacity** of people, services, utilities, institutions (planning, funding) and supporting organisations
  - **Sensitivity** of things people value to harm or damage (e.g. flooding: getting wet *vs* damage)
  - **Attachment to place** e.g. loss of amenity, public access, cultural significance
  - **Viability** of local economy & businesses
  - **Social equity** and social cohesion factors
  - **Insurance** cover (private/civic) & bank mortgages
  - **Reduced levels of service**: 3 waters, frequent flooded roads – gamebreakers?

Braden Fastier

Dynamic adaptive pathways planning

- **Dynamic** – ability to respond to changing conditions and perceptions
- Not dependent on time – focuses on **thresholds**
- Mix of short-term **actions** and long-term **options** – to avoid locking in inflexibility
- **Stress test options** versus 4 SLR scenarios
- **Anticipatory** (avoid adaptation threshold) rather than reactive
- **Timely adaptation** by monitoring early signals and triggers (decision point)



After Haasnoot et al. (2013), Hermans et al. (2017)

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Updated national coastal risk exposure (DSC)

- Impacts & Implications: Deep South Science Challenge project
- Update of 2015 PCE national exposure study
- Based on 1% AEP flood layers for each region (incl. residual risk areas behind walls, stopbanks)
- Uses 0.1 m increments in SLR where LiDAR is available
- Improved LiDAR coverage (now includes parts of Southland, Marlborough, Horizons, Taranaki)
- Wider set of national asset datasets
- Due for release Sept/Oct

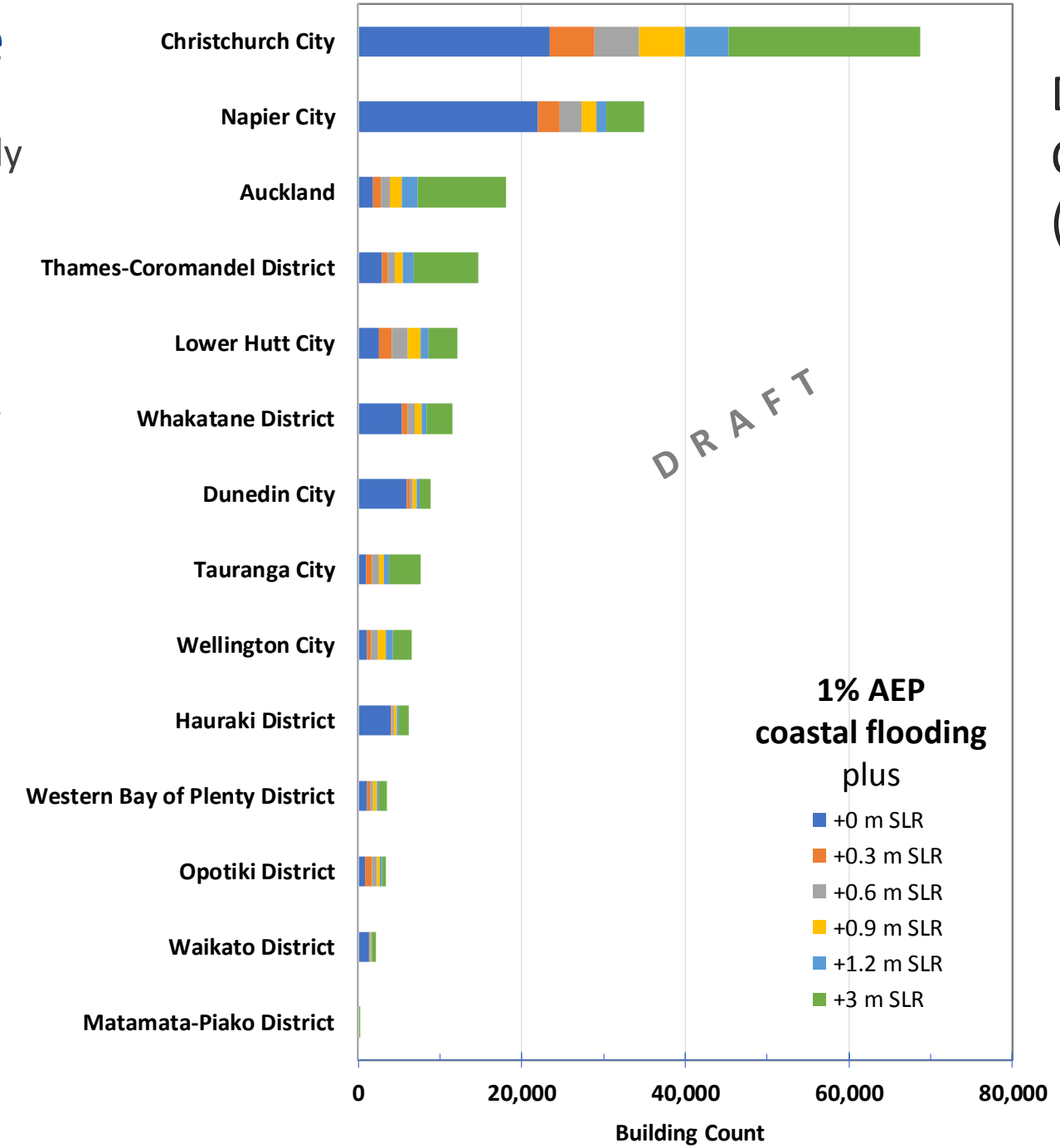
Waikato RC FB page

Building exposure

- All building types nationally
- All TLA areas with LiDAR
- Already high exposure presently at 0 m SLR e.g.

Present 1% AEP nationally

1. Christchurch
2. Napier
3. Dunedin
4. **Whakatane**
5. **Hauraki**
8. **TCDC**
15. **Waikato**
17. **Western BoP**
18. **Tauranga**
19. **Opotiki**



Deep South Science Challenge project (NIWA)

Note: includes direct and indirect exposure (e.g. residual risk)

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Road (km) exposure

- All road types nationally
- All TLA areas with LiDAR
- Already high exposure presently at 0 m SLR e.g.

Present 1% AEP nationally

1. Christchurch
2. **Hauraki**
3. Napier
4. Dunedin
5. **Whakatane**
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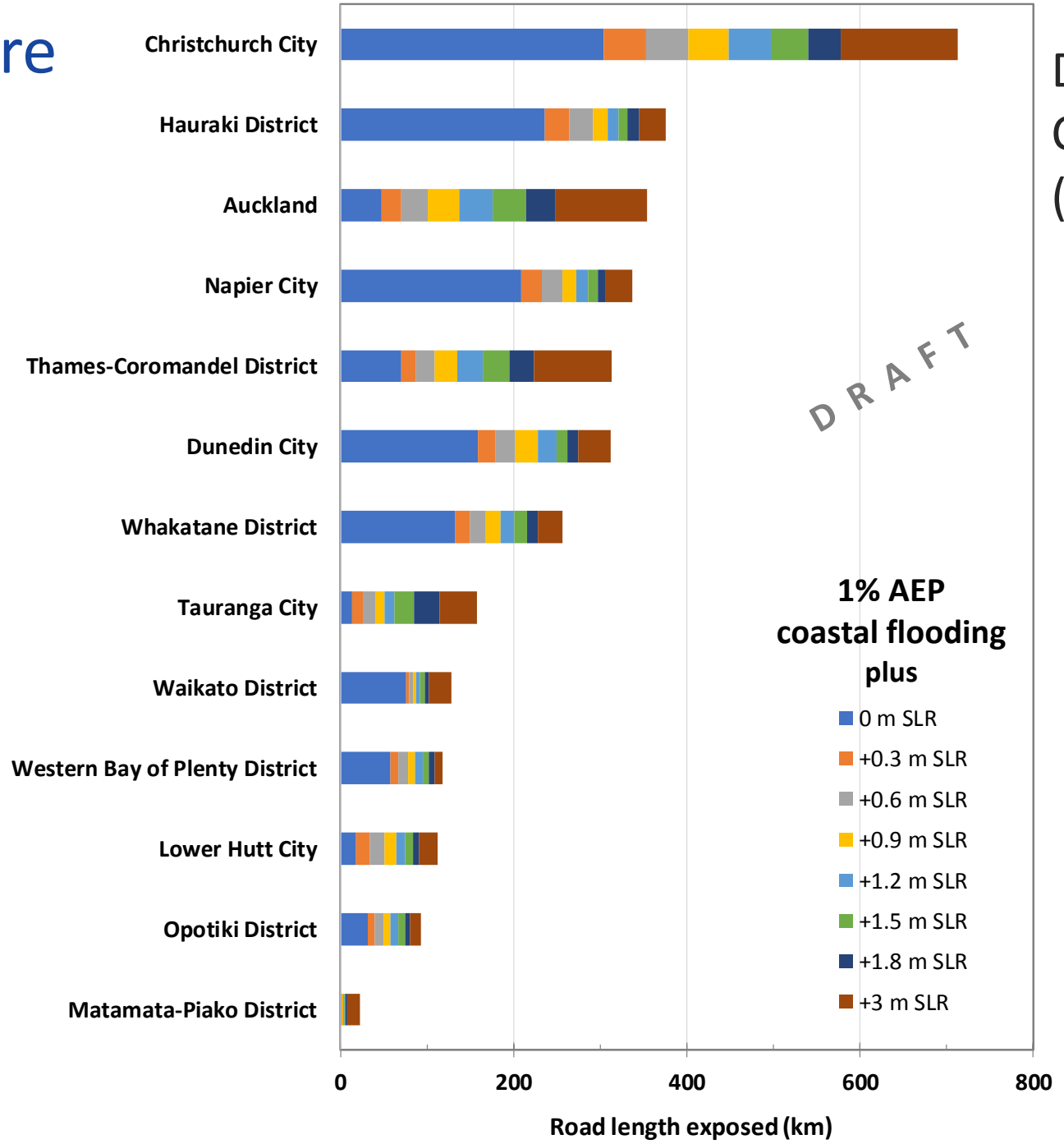

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Implications for engineering lifelines

- Public expectation that the design and maintenance of assets will consider the implications of climate change (CC) *[often raised in aftermath of events]*

- CC will lead to increasingly changing environmental conditions – no longer a static regime with realisable extremes. Historic variability and extremes no longer a useful guide to future performance

- Tiered risk & vulnerability assessments: screening → detailed

- Design and standards will need to be more adaptive to:
  - ✓ deal with scenario uncertainty (multiple possible futures) and deep uncertainty (known unknowns) – but not adapt prematurely (high present value) or too late (adverse risk)
  - ✓ build in signals and triggers (decision points) with lead time – monitoring change becomes crucial
  - ✓ avoid locking in path dependence (eg, a fix for today - but may have a short shelf life)
  - ✓ changing community expectations, values and performance relative to service levels

Thank you

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