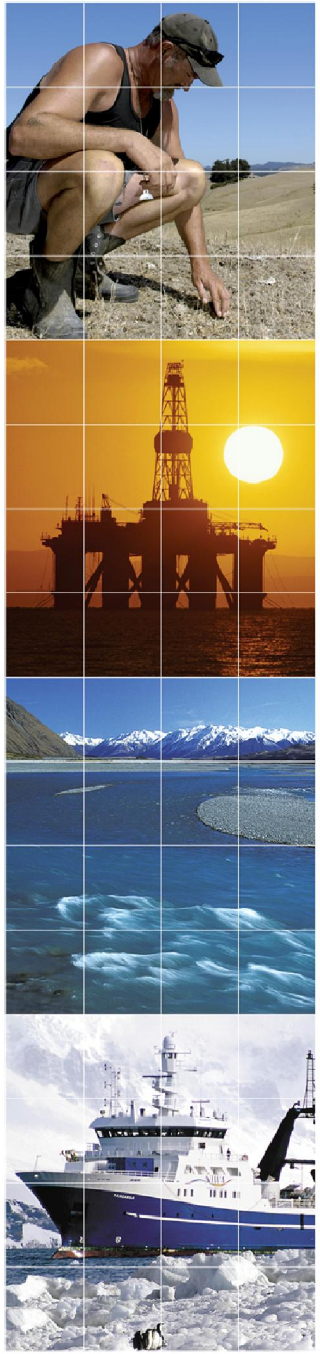


Climate Change & Lifeline Utilities

Rob Bell, NIWA

(with input from Andrew Tait)

National Lifelines Forum, 6-7 Nov 2013

NIWA
Taihoro Nukurangi

Outline

- Hot off the press
- Improving resilience to CC

Å Case Study 1: Coastal

Å Case Study 2: Flooding

Å Some musings

NZTA & Auck Motorway Alliance

Hot of the press: IPCC AR5

Working Group I Contribution to the IPCC Fifth Assessment Report
Climate Change 2013: The Physical Science Basis
Summary for Policymakers (27 Sept, 2013)

- **Working Group I: Physical Sciences Assessment Report (finalised online in January 2014)**
- **Working Group II: Impacts, Adaptation and Vulnerability (finalised 31 March 2014)**
- **Working Group III: Mitigation of Climate Change (finalised 12 April 2014)**

Å **Synthesis Report (finalised 1 November, 2014)**

IPCC AR5: Working Group I

- **9,200 publications cited: >75% have been published since the last IPCC assessment in 2007**
- **259 authors from 39 countries**
- **1089 expert reviews with 54,677 review comments to address**
- **Summary for Policymakers has to be agreed line-by-line**

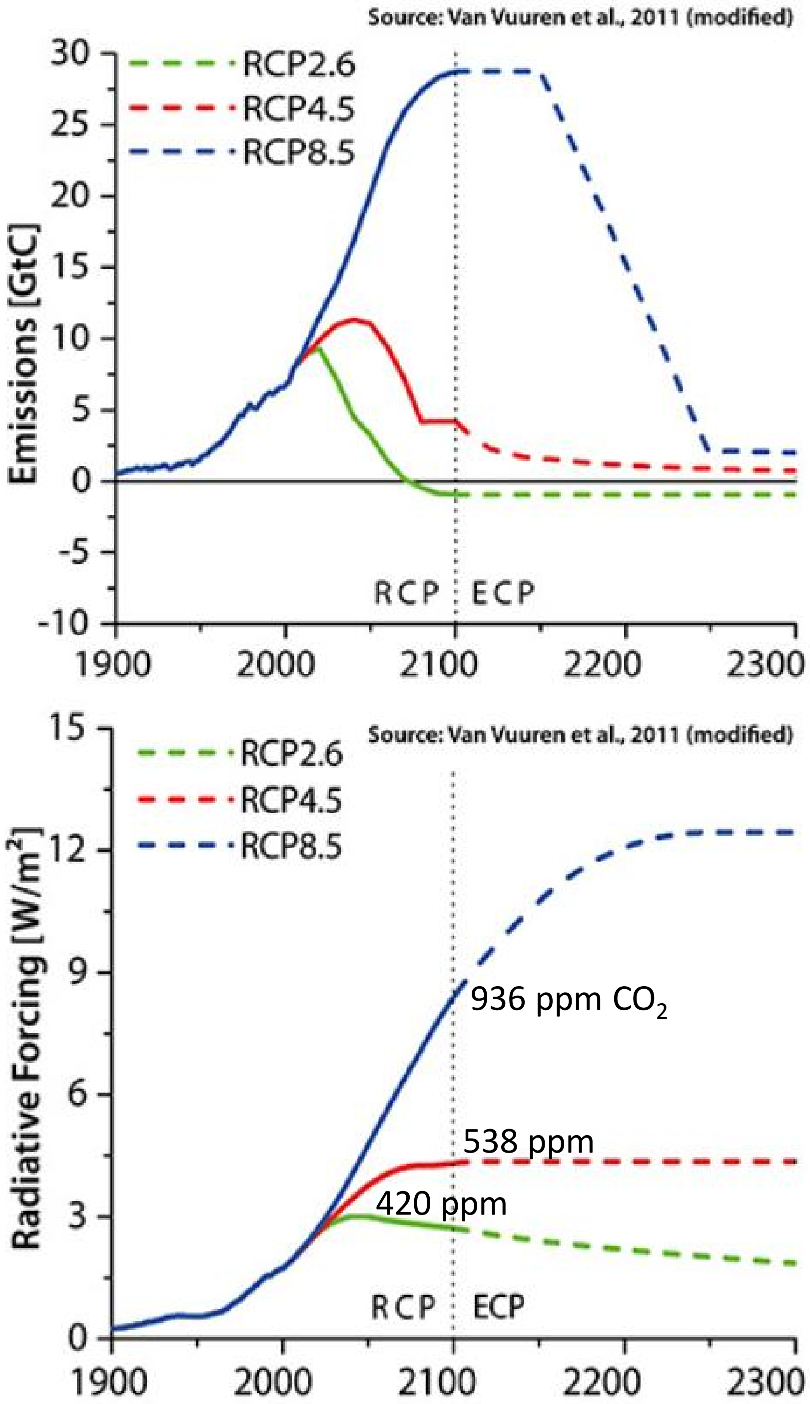
Å **New features:**
- Stated where there wasn't consensus e.g. upper SLR
- Regional Atlas of temperature and rainfall projections e.g., Oceania (NZ & Australia)

About choices

Representative Concentration Pathways (RCPs) are four greenhouse gas concentration trajectories for different climate futures - whichever we all choose.

The four RCPs used in IPCC AR5 are:
RCP2.6 (vigorous curbs)
RCP4.5
RCP6
RCP8.5 (business as usual)

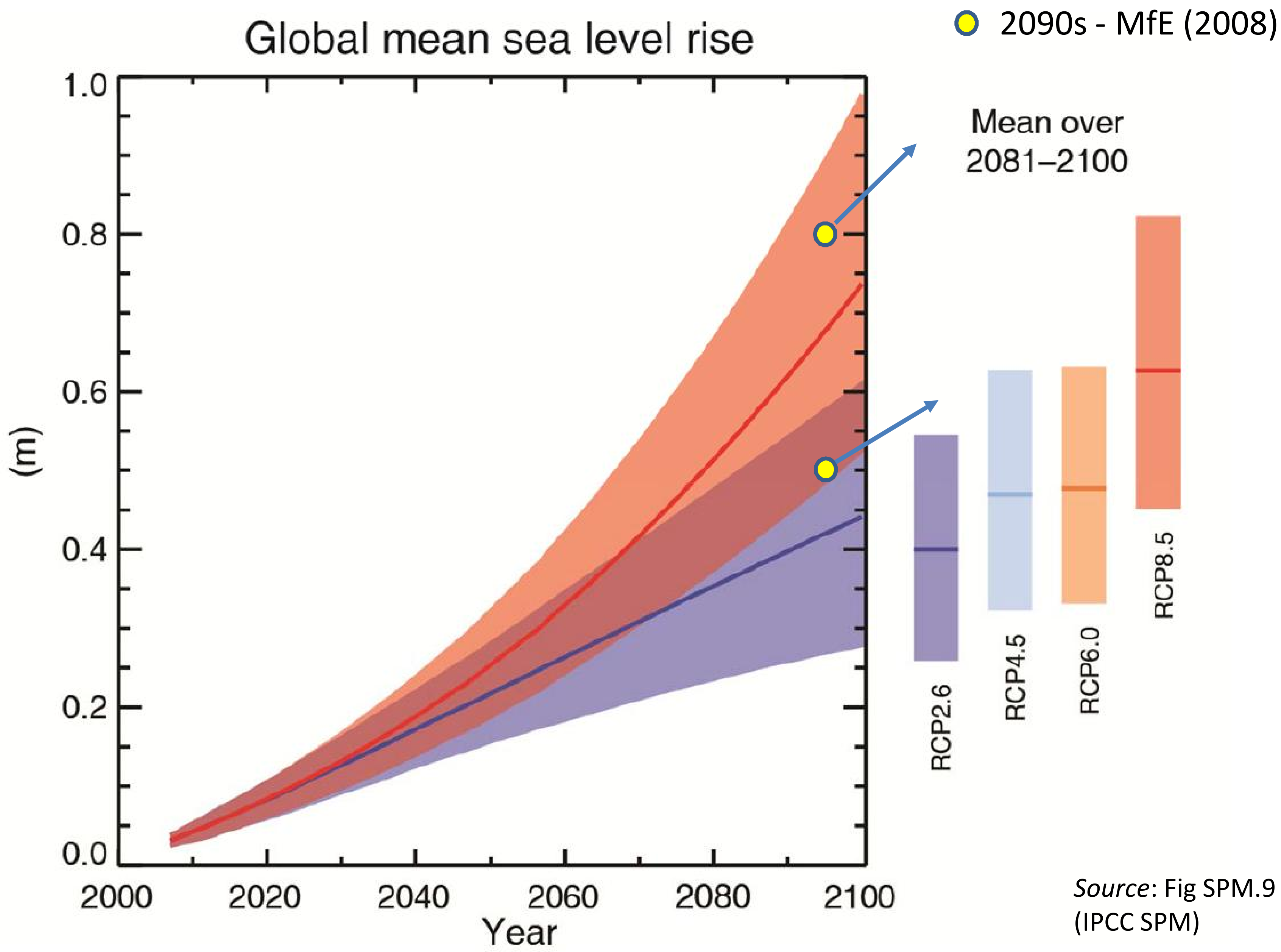
named after a possible range of radiative forcing values in the year 2100 in W/m^2



IPCC Working Group I: Key findings

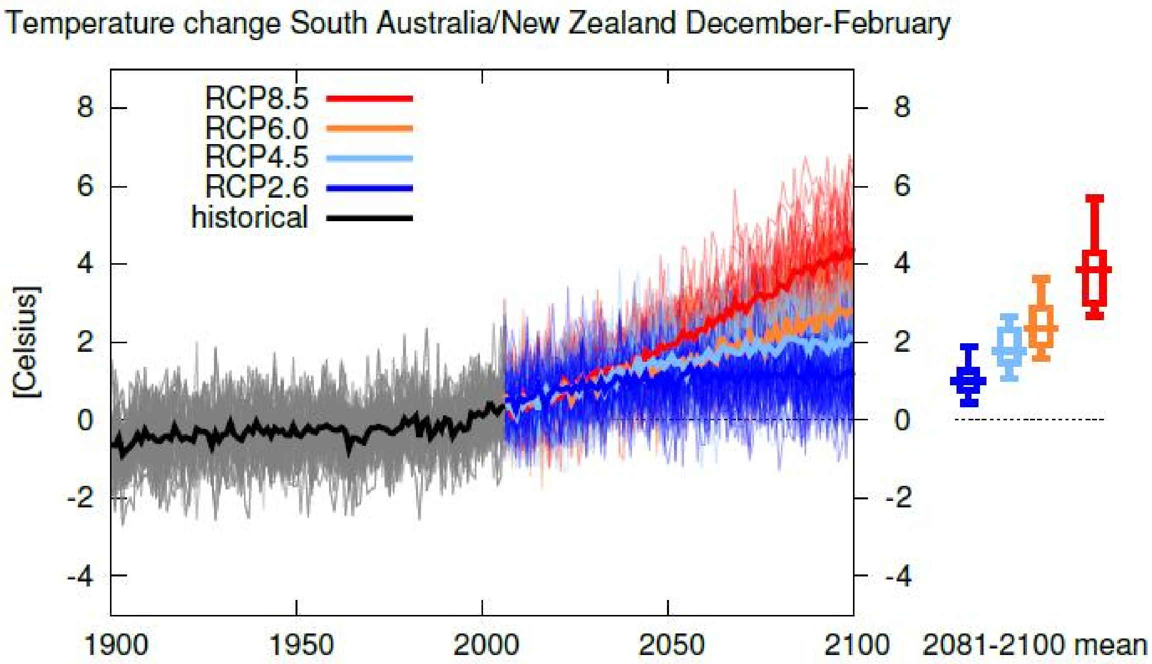
- Foremost, even with numerous new model simulations and journal publications, there is a consistent message, with similar projections to the previous two IPCC assessments
- Uncertainty in projections for a particular RCP now explicitly provided as 5% and 95% confidence levels – main uncertainty for users is which RCP to adopt (down to global choices)
- It is extremely likely that more than ½ of the global average surface temperature rise (1951 to 2010) was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together.
- Overall, frequency of storms may not increase, but more intense storms/rainfall is likely to occur
- Sea-level projections consistent with those in 2008 MfE Guidance Manual for Coastal Hazards & Climate Change
- Droughts, heat waves (NZ moderated by maritime climate)

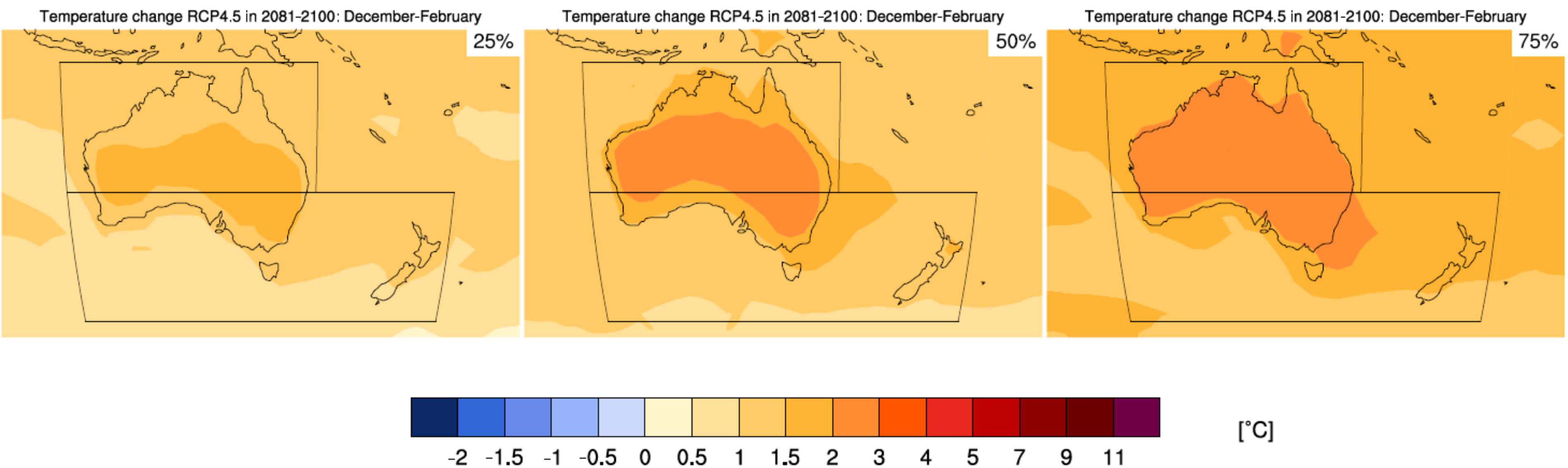
Sea-level rise (global mean)



Source: Fig SPM.9 (IPCC SPM)

Regional Atlas – Australia/NZ





Hot of the press from President Obama

Executive Order -- Preparing the United States for the Impacts of Climate Change

EXECUTIVE ORDER 1 November 2013

\- - - - - - -

PREPARING THE UNITED STATES FOR THE IMPACTS OF CLIMATE CHANGE

http://www.whitehouse.gov/the-press-office/2013/11/01/executive-order-preparing-united-states-impacts-climate-change

On Nov. 1, 2013, Pres. Obama issued a far-reaching executive order to improve "climate preparedness and resilience" in States and communities and "help safeguard our economy" from the threat of global warming impacts

Executive Order -- Preparing the United States for the Impacts of Climate Change

- Managing these risks requires deliberate preparation, close cooperation, and coordinated planning by the Federal Government, as well as by stakeholders, to facilitate Federal, State, local, tribal, private-sector, and nonprofit-sector efforts to improve climate preparedness and resilience; help safeguard our economy, infrastructure, ...

- In doing so, agencies should promote:
  (1) engaged and strong partnerships and information sharing at all levels of government;
  (2) risk-informed decision making and the tools to facilitate it;
  (3) adaptive learning, in which experiences serve as opportunities to inform and adjust future actions; and
  (4) preparedness planning.

Improving resilience of infrastructure

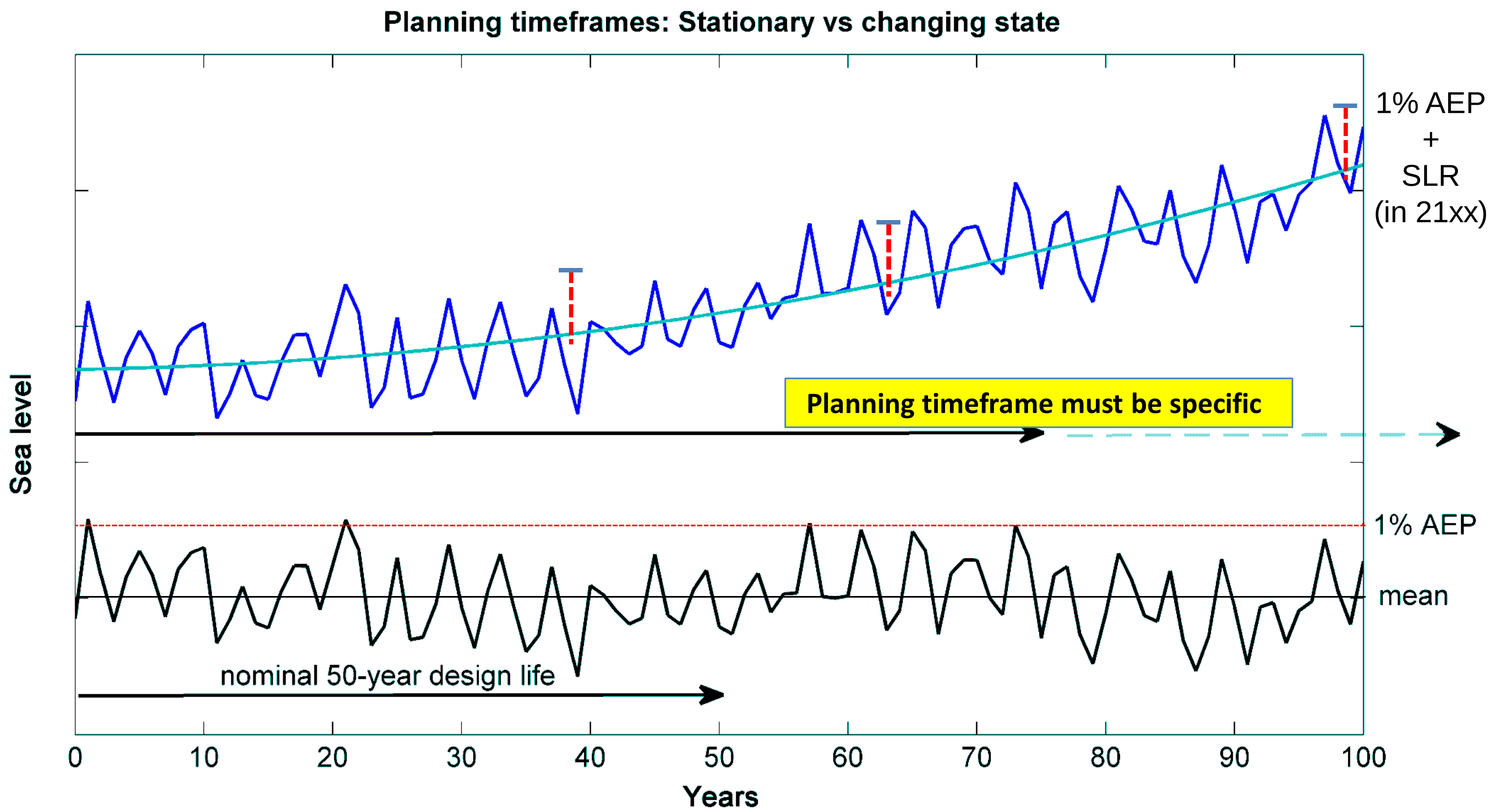
Source: NZPA

Climate-change impacts

Resilience of infrastructure will be affected by:

- higher intensity rainfall
- rain-induced landslides
- more intense storms & winds
- sea-level rise:
  - more frequent coastal inundation
  - salinization of fresh waters
- increase in prolonged periods of high temperatures
- an increase in wildfires
- more frequent or severe droughts
- fewer frosts-days and higher snow line (+ve and -ve)

Specifying planning timeframes now essential



Nelson/ Tasman CDEM 2G Plan

Affected by climate-change

	Hazard	Risk Rating	Risk Total
Higher Priority	Earthquake - Alpine Fault	Very High	**15**
	Earthquake - Regional (e.g. White Creek Fault Murchison)	High	**15**
	Earthquake – Waimea / Flaxmore Fault	High	**15**
	Human Pandemic	High	**12.9**
	Local tsunami	Moderate	**12.8**
	Electricity - infrastructure failure	Moderate	**12.65**
	Fuel supply - infrastructure failure	Moderate	**12.4**
	Plant & Animal Pests / disease	Moderate	**12.05**
	Dam break	Moderate	**11.55**
	High winds	Moderate	**11.5**
	Slope Failure - Large scale	Moderate	**11.3**
	Drought	Moderate	**11**
	Communications / Information systems - infrastructure failure	Moderate	**10.9**
	Large catchment flooding	High	**10.55**
	Coastal inundation (storm surge / tidal effects)	Moderate	**10.5**
Lower Priority	Wastewater - infrastructure failure	Moderate	**10.25**
	Snow	Moderate	**10**
	Rural Fire	Moderate	**10**
	Slope Failure - Small scale	Moderate	**9.8**
	Urban Fire	Moderate	**9.6**

Improving resilience: approaches

- Top-down approach to adaptation determines the most-likely or a credible scenario to apply and design/plan according to that scenario

- Bottom-up ("scenario-neutral") approach works with:
  - local-scale tipping points (at what level does climate-change start to bite?)
  - plan appropriate adaptation response – stages?
  - then adopt most-likely projection-time pathway for timing initially of stages
  - apply adaptive management – critical component is to monitor change & review staging as needed

Improving resilience: approaches

- Risk-assessment (risk-screening to quantitative analysis)
- Adaptation to climate-change and evaluation of options e.g., BCA, MCA, “deliberate preparation”
- Execution – where possible best mainstreamed with other drivers e.g., major upgrades, asset management
- Policy change e.g., NZ Coastal Policy Statement
- Governance will be critical for paradigm shift

- *Urban Impacts Toolbox* (tools & case studies)
  http://www.niwa.co.nz/climate/urban-impacts-toolbox
- *Pathways to Change* – focus on adaptation for councils
  http://www.niwa.co.nz/sites/default/files/pathways_to_change_nov2011.pdf

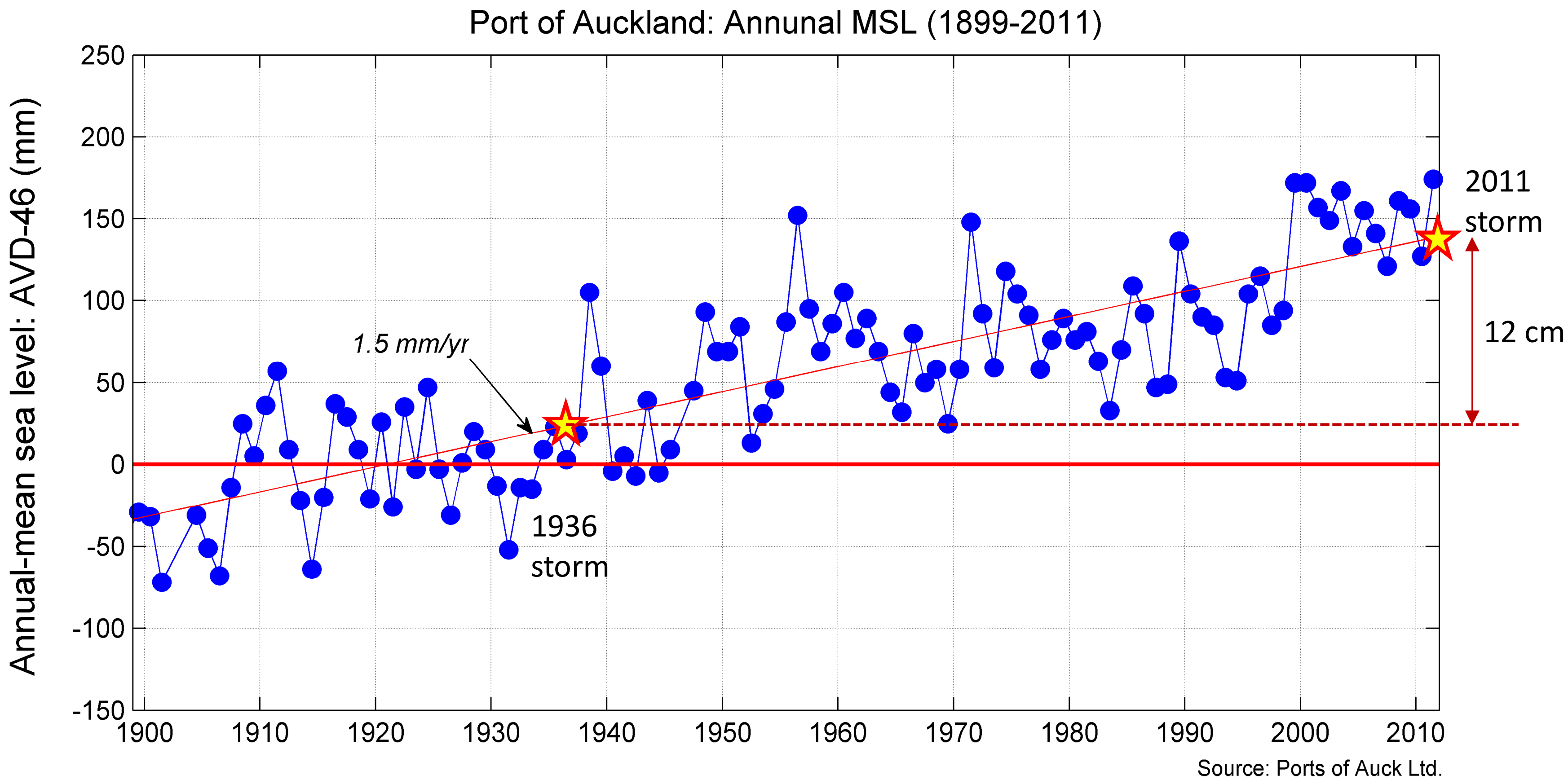
Auckland awash: 23 January 2011

NZTA: AMA

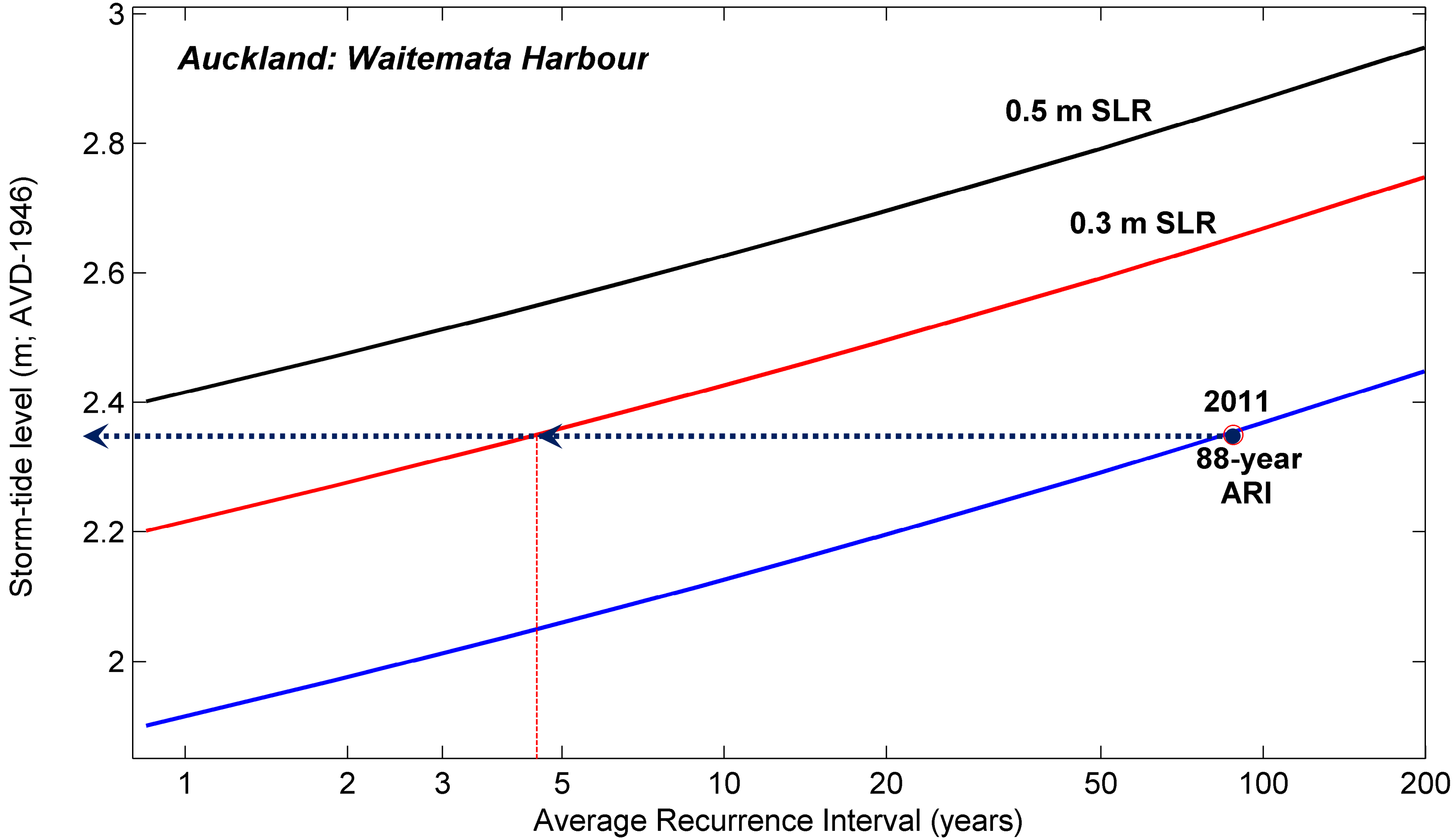
Geoff Blackmore

Emma Paterson

Sea-level trend: Auckland (1899ï 2011)

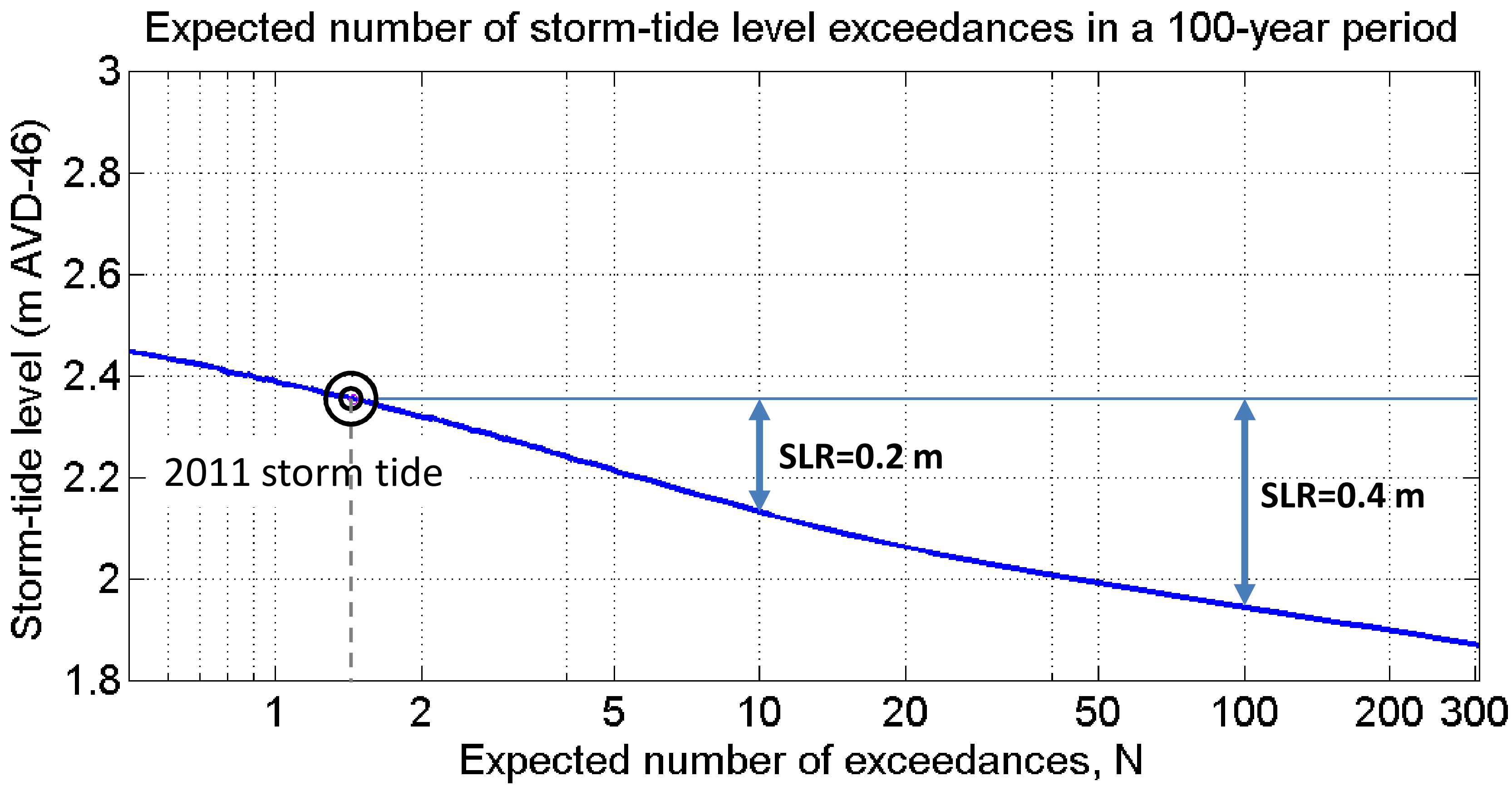


Changing state: Storm-tide frequency ↑



Much more frequent coastal inundation events & drainage/stormwater issues

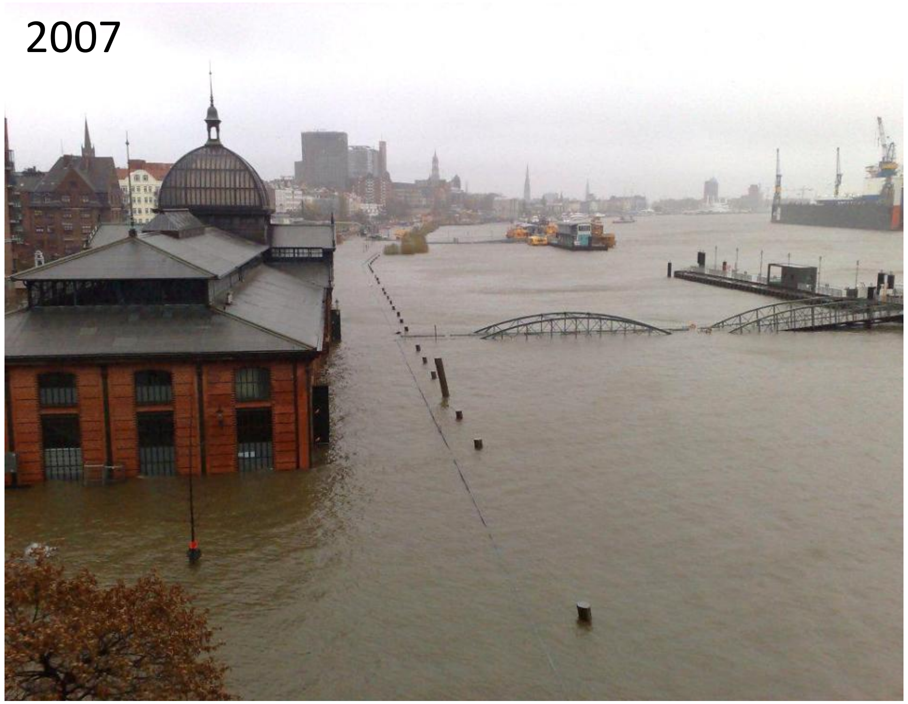
Expected number of exceedances in 100 years of a similar Jan 2011 event



As sea-level rises further, smaller more frequent storm tide events will be all that are needed to reach equivalent storm-tide levels to the Jan 2011 event

Overseas response: Port of Hamburg

2007



2009

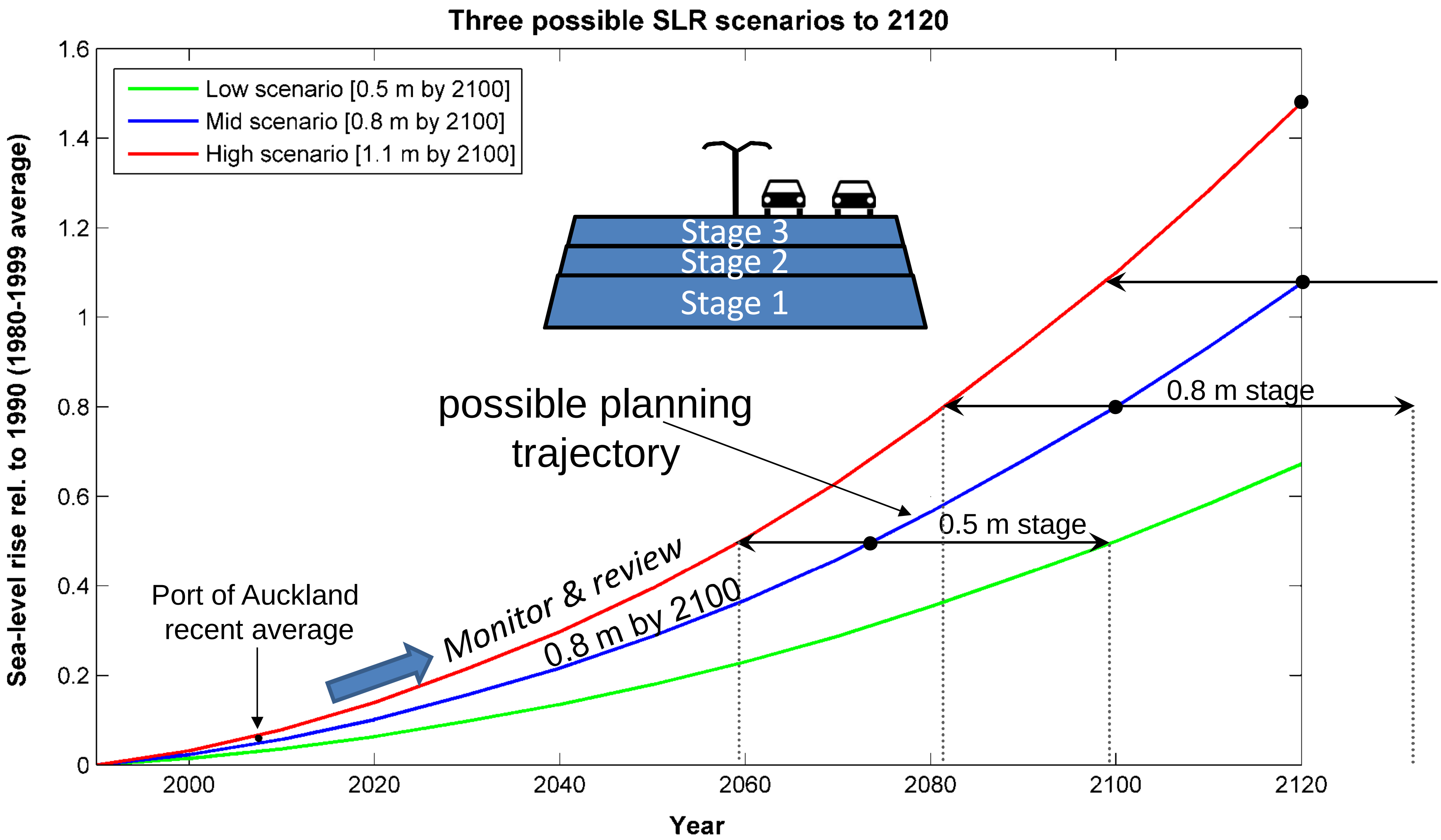
R Bell

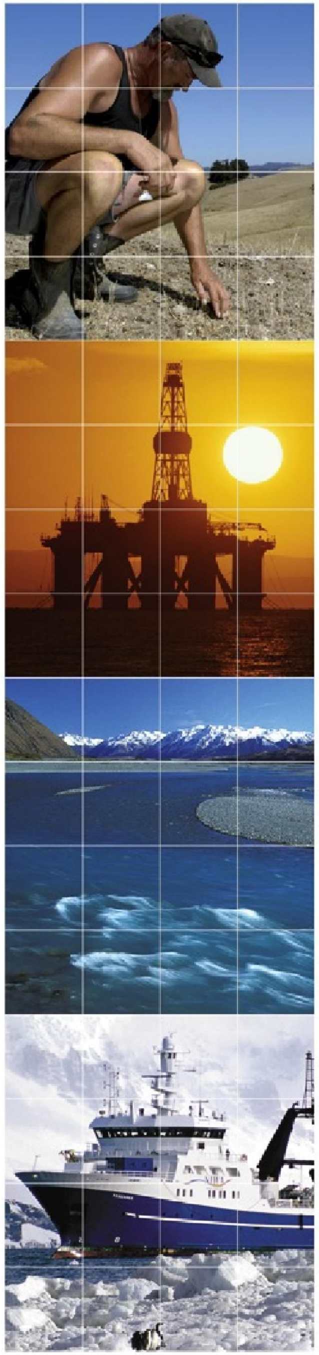
Feb 1962

3 m storm surge + rising rivers (rainfall)

340 deaths + 60,000 homes damaged

Example: Adaptive management approach to design by staging the construction or development e.g. motorway causeway





Westport case-study approach (*Urban Impacts Tool*)

Å Workshop #1, completed a sensitivity matrix (CC effects across assets and levels of service)

Å Chose an historical flood – 31 August 1970 (~0.02 AEP or 50-year ARI)

Å Adjusted historic rainfall and temperature, based on projected 50- and 100-year changes to mean values

Å Ran a calibrated hydrological model (Topnet)

Å Ran an inundation model (Hydro2de)

Å Ran the RiskScape model

Å Workshop #2, discussed adaptation options, followed by “rapid” BCA and final report

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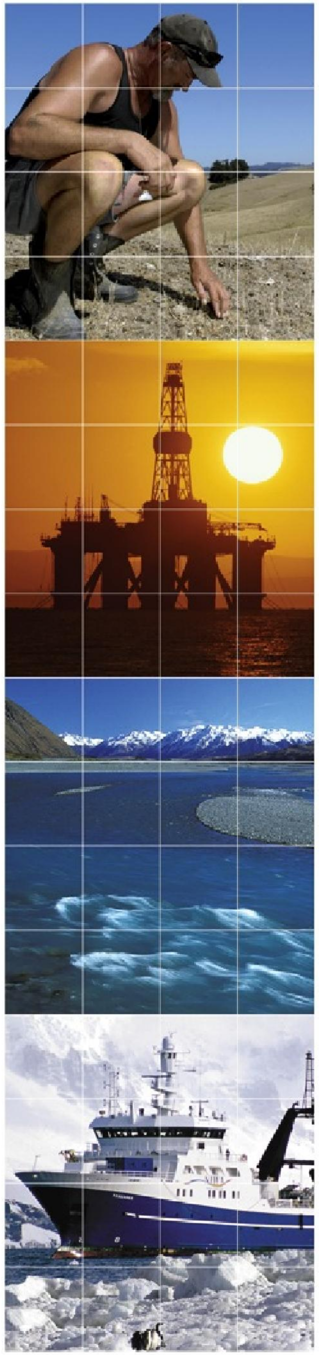

Climate Scenario	Period	Peak rainfall (mm/day)	Peak flow (m^3s^{-1})	AEP for current climate	ARI (years) for current climate
Base	Current	350	8500	0.0213	47
B1	2030-2049	362	8805	0.0152	66
A1B	2030-2049	368	8977	0.0132	76
A2	2030-2049	370	9083	0.0122	82
B1	2080-2099	371	9017	0.0128	78
A1B	2080-2099	381	9319	0.0102	98
A2	2080-2099	387	9512	0.0088	113

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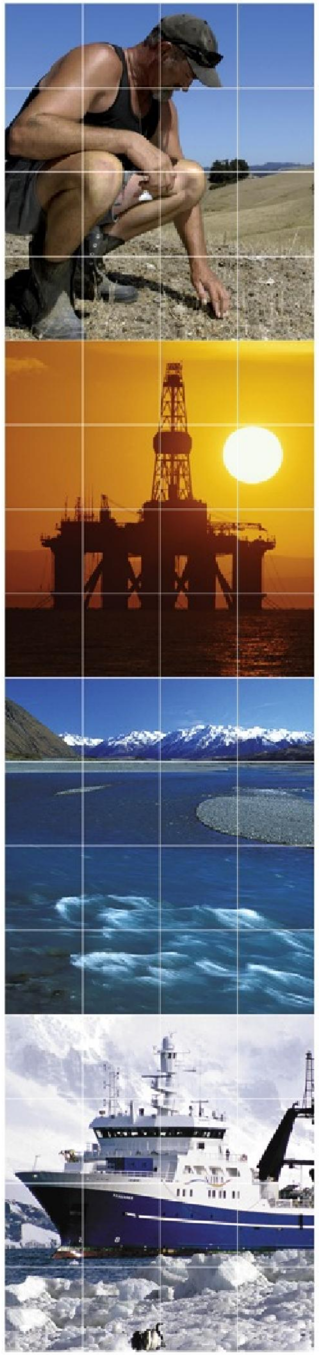
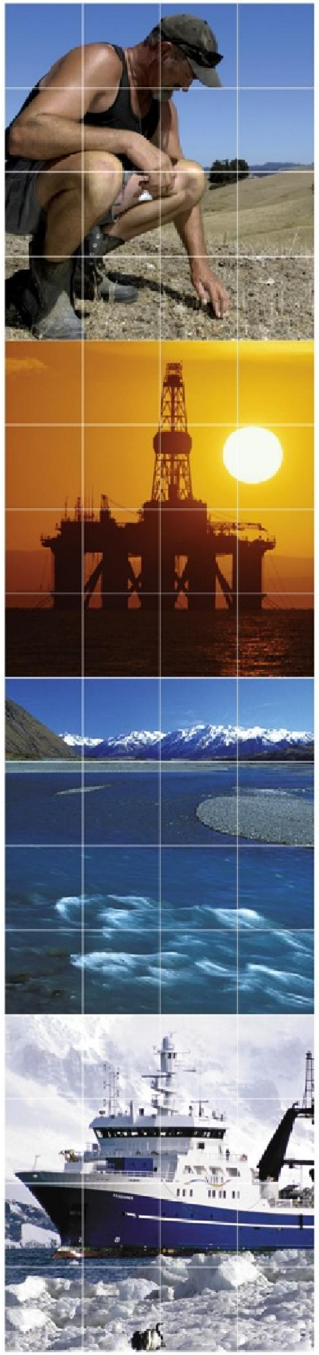
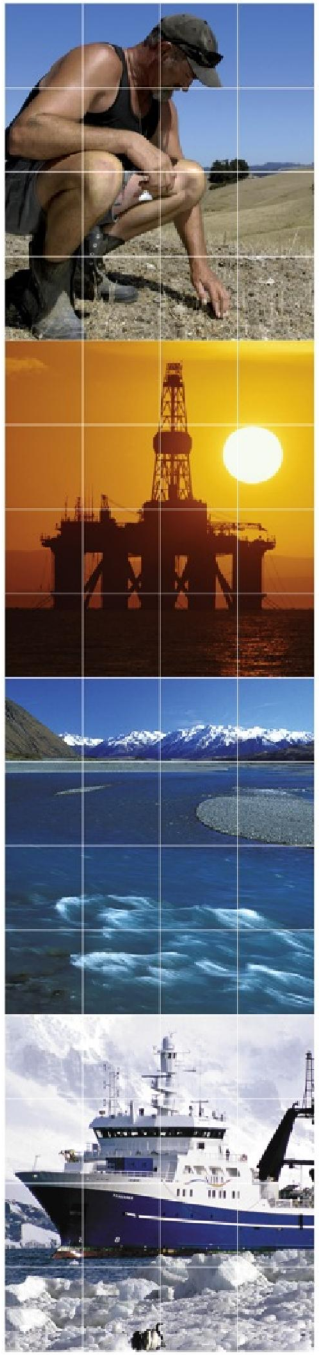


Climate scenario	Period	Inundation in Westport. % area with depth >0.2 m
Base	Current	51
B1	2030-2049	60
A1B	2030-2049	63
A2	2030-2049	64
B1	2080-2099	67
A1B	2080-2099	70
A2	2080-2099	72



RiskScape modelling

- Damage estimates to Westport buildings associated with the projected inundation levels were estimated using the tool ‘Riskscape’ (Schmidt et al., 2011; www.riskscape.org.nz)
- For a flood of the same magnitude as the 1970 flood, present day Westport could expect ‘medium’ or greater risk to life to 169 people (with no flood warning), building damage of $24M and contents damage of $22M
- Under the A1B 2080-2099 scenario, the corresponding present day Westport numbers are 560 people with medium^{+} risk to life, building damage of $72M and contents damage of $68M



Adaptation options and BCA

- Work-shopped an “optioneering” tool to whittle down flood adaptation options based on resource constraints, technical feasibility and likely benefits
- For Westport, four options (raise houses, more stopbanks, main channel widening, right bank diversion) were compared using a rapid benefit-cost ratio approach
- The Westport case study showed that more stopbanks was the preferred current and future flood protection option (for further more detailed study). Raising houses above the flood level was also an option deserving further investigation.

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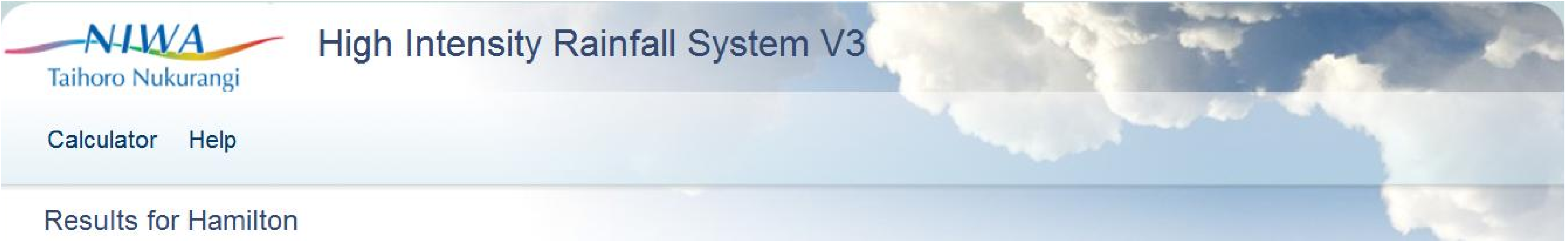

HAMILTON: Rainfall intensities (mm/hr)

ARI (y)	AEP	ΔT(°C)	10min	20min	30min	60min	2hr	6hr	12hr	24hr	48hr	72hr
100	0.01	0.0	150.0	102.6	82.2	56.3	35.6	17.2	10.9	6.9	4.2	3.1
100	0.01	2.0	174.0	119.1	95.4	65.3	41.3	20.0	12.7	8.0	4.8	3.6
100	0.01	3.0	186.0	127.2	102.0	69.8	44.1	21.4	13.5	8.6	5.2	3.8
100	0.01	4.0	198.0	135.3	108.6	74.3	47.0	22.8	14.4	9.1	5.5	4.1

http://hirds.niwa.co.nz/

Musings

- Last few IPCC reports convey a consistent message, with similar projections for effects on rainfall, temperature and sea-level rise
- ⇒ No excuse to wait for more certainty to undertake adaptation or deliberate planning
- Changes in frequency of coastal inundation and higher intensity of rainfall (flooding & landslides) likely to be largest effects
- Adaptation more likely to be implemented if mainstreamed into "normal" council/lifeline activities or engineering design– rather than isolated as a separate activity
- Tools are available incl. adaptive management
- Planning or design timeframes essential
- Governance & policy – paradigm shifts