Regional Sea Level Changes and Coastal Impacts

R. J. Nicholls, R. van de Wal

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United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

International Science Council

WCRP World Climate Research Programme

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Regional Sea-level Change and Coastal Impacts

Coastal sea level rise is among the most severe societal consequences of anthropogenic climate change. Contemporary global mean sea level rise will continue over many centuries as a consequence of anthropogenic climate warming, with the detailed pace and final amount of rise depending substantially on future greenhouse gas emissions.

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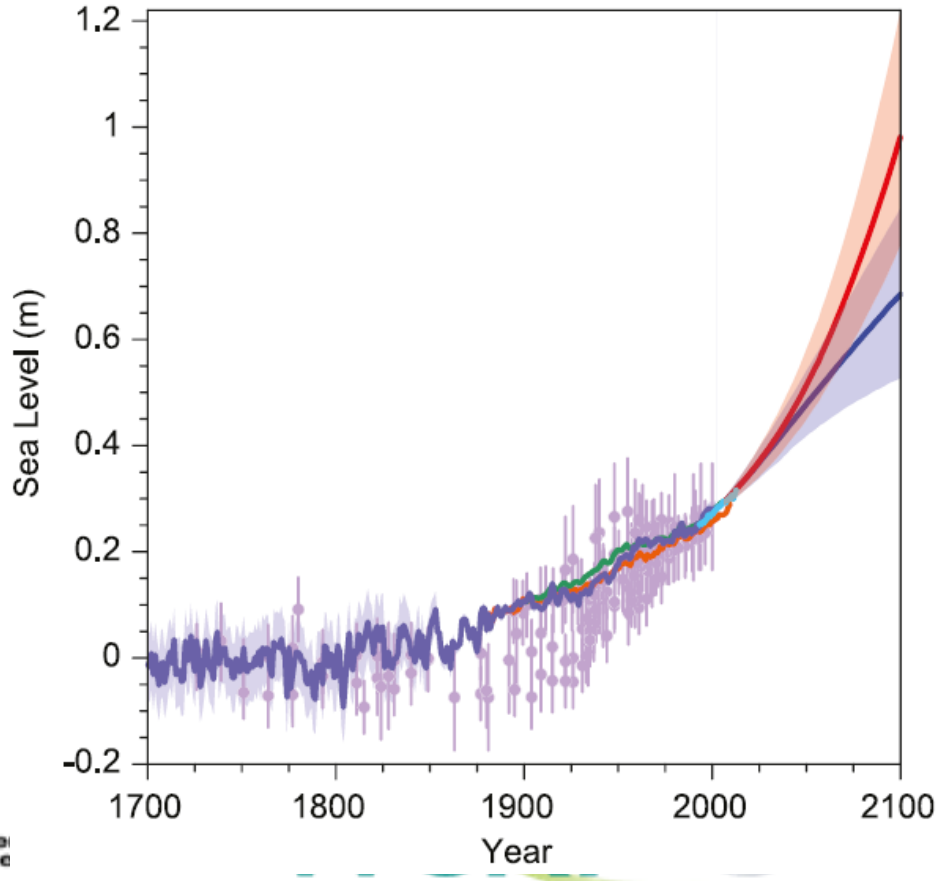
The Sea Level Rise Problem

On-going global sea level rise is projected to accelerate in the future.

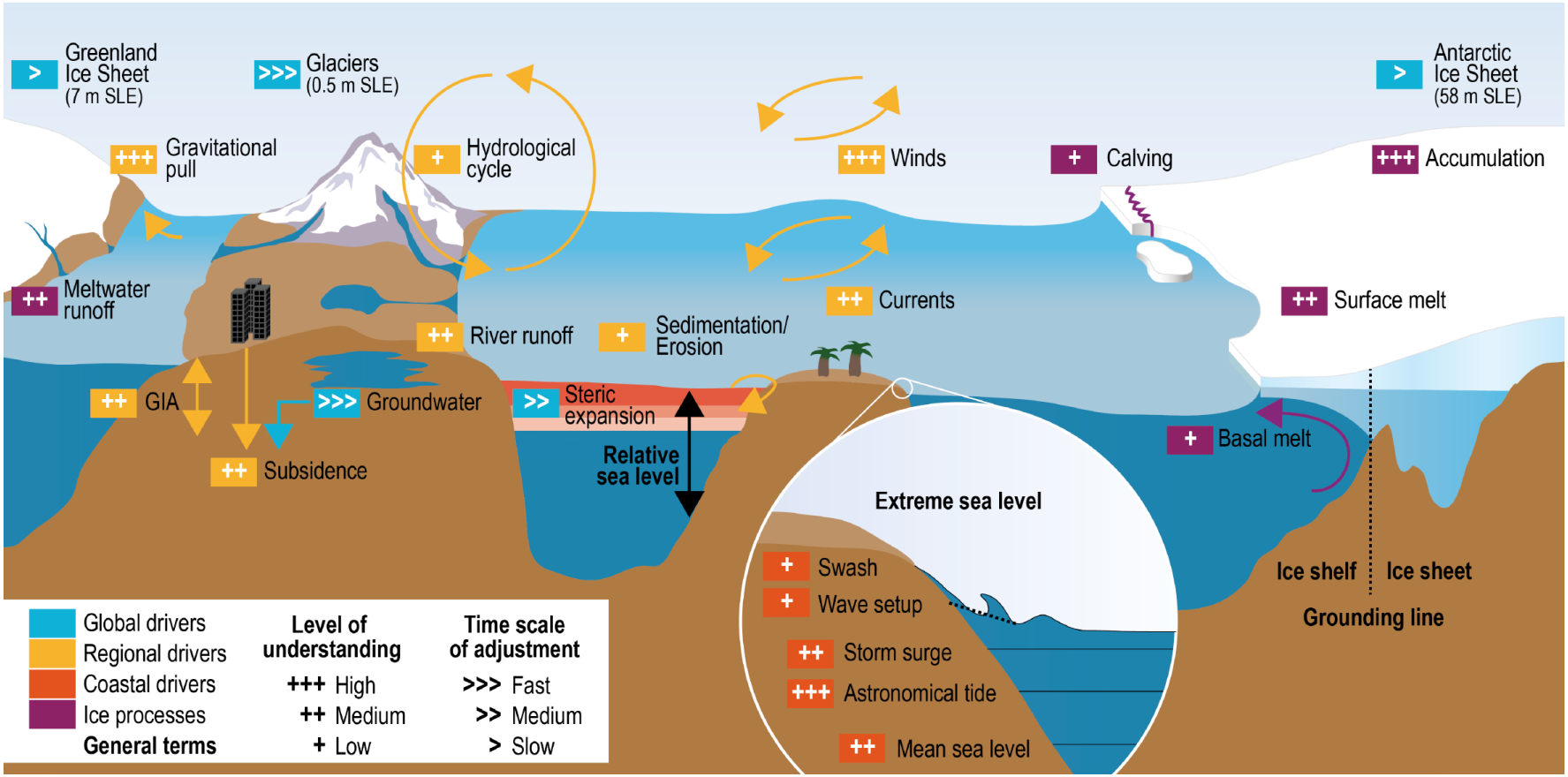
Sea level increase at the end of the century depends on emission scenarios.

Sea level rise will not stop at the end of the 21st century but will continue for many centuries



(Chapter 13 IPCC AR5 WG1 Report)

Regional Sea Level Changes and Coastal Impacts



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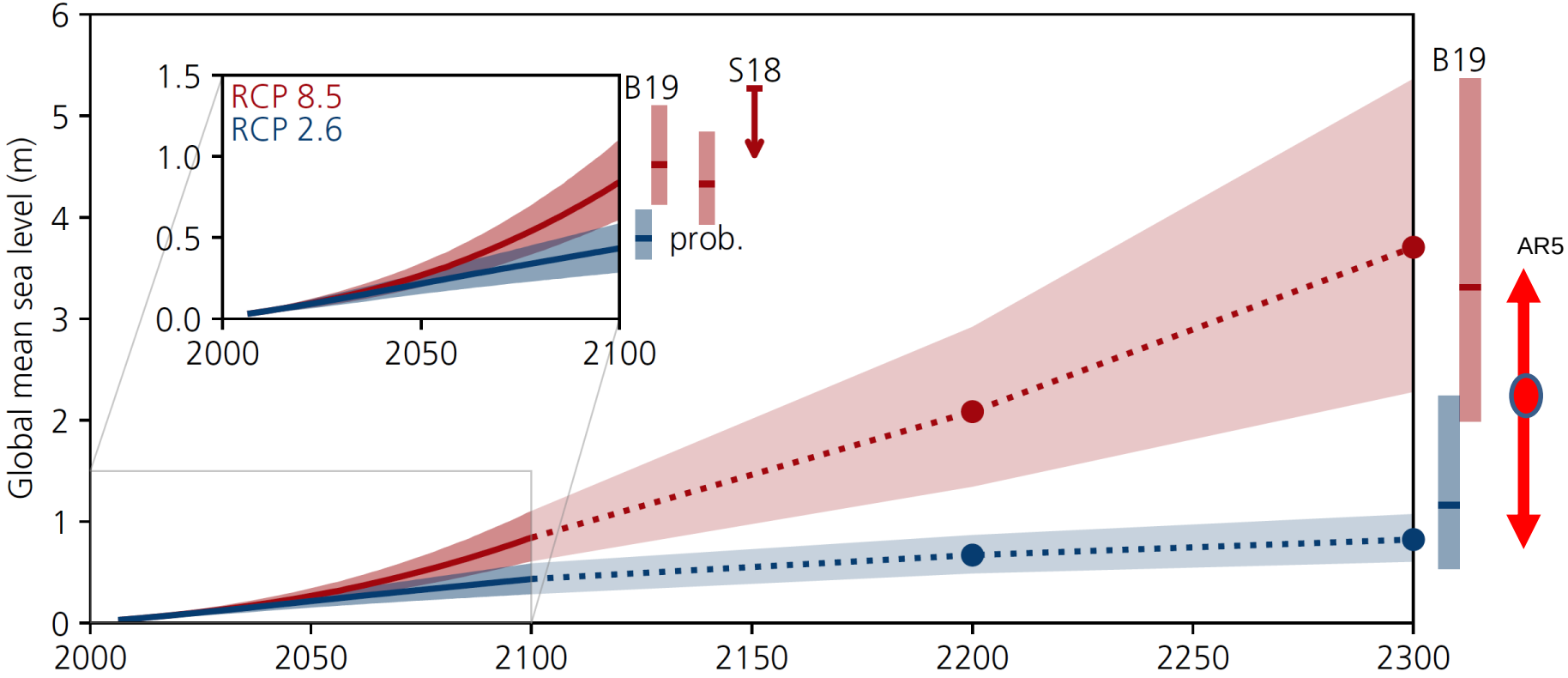
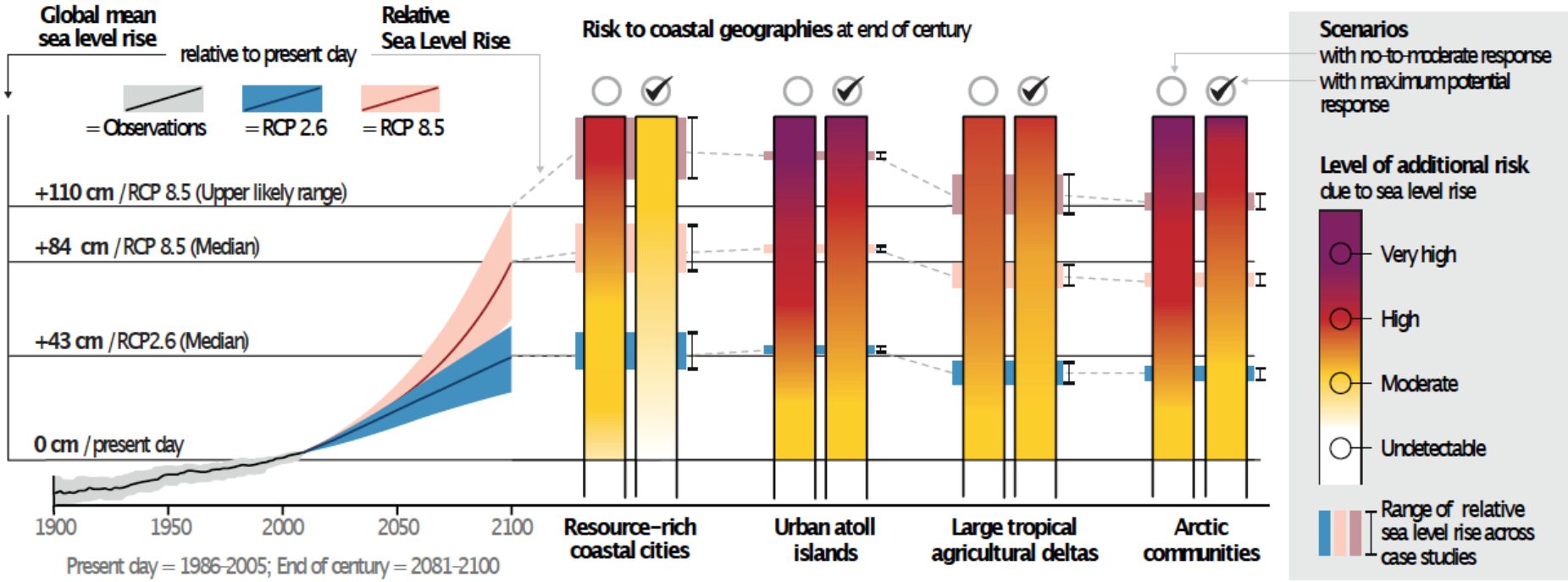
Medium Confidence

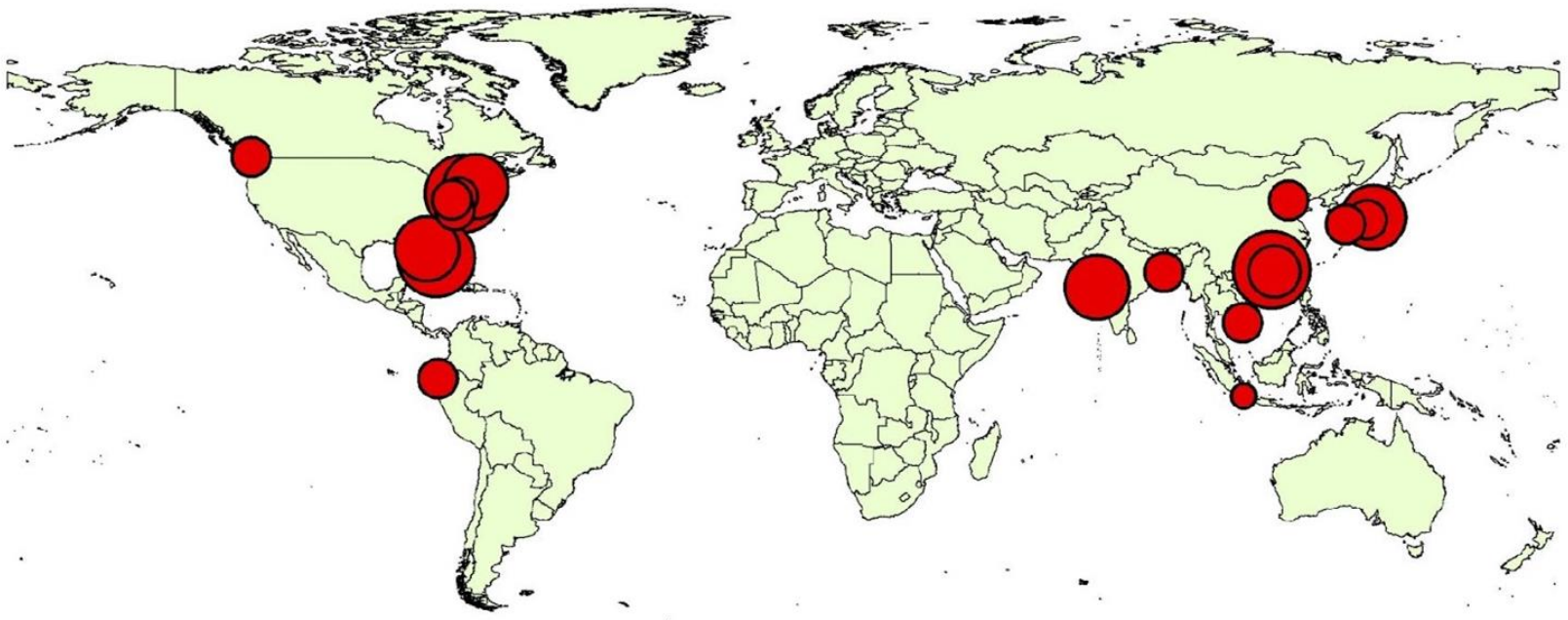
Low Confidence



Chapter 4 version of SPM Fig 5



Regional Sea Level Changes and Coastal Impacts



Top 20 cities ranking by risk, with protection in 2005.
Average annual losses. Millions US dollars.

< 75 | 76 - 150 | 151 - 225 | 226 - 300 | > 300

Based on Hallegatte et al (2013) Nature Climate Change

WCRP/GC on Regional Sea Level Change

- **To meet urgent societal needs for useful information on sea level change**, the World Climate Research Program (WCRP) has implemented the theme "**Regional Sea-Level Change and Coastal Impacts**" as of of its grand challenges.
- The GC Sea Level was designed as an **interdisciplinary program** on Sea Level research reaching from the global to the regional and coastal scales.
- It aims for **close interaction with relevant coastal stakeholders** to make sure that scientific results effectively **supports impact and adaptation efforts as well as coastal zone management**.

Regional Sea Level Changes and Coastal Impacts

WG1: An integrated approach to paleo time scale sea level estimates

WG2: Quantifying the contribution of land ice to near-future sea level rise

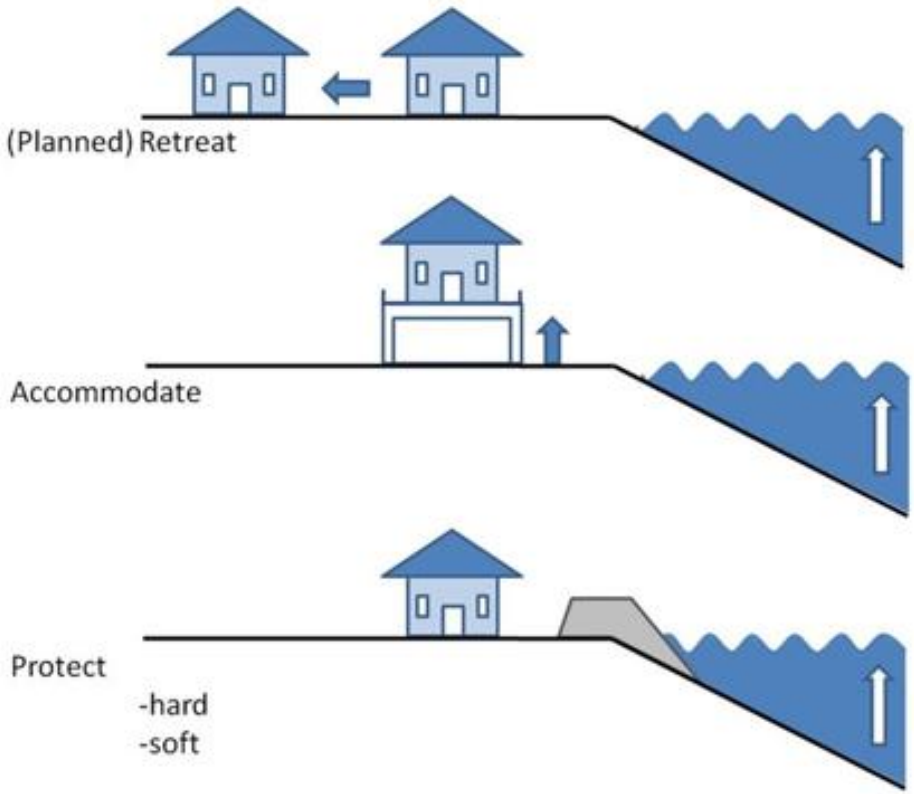
WG3: Causes for contemporary regional sea level variability and change

WG4: Predictability of regional sea level

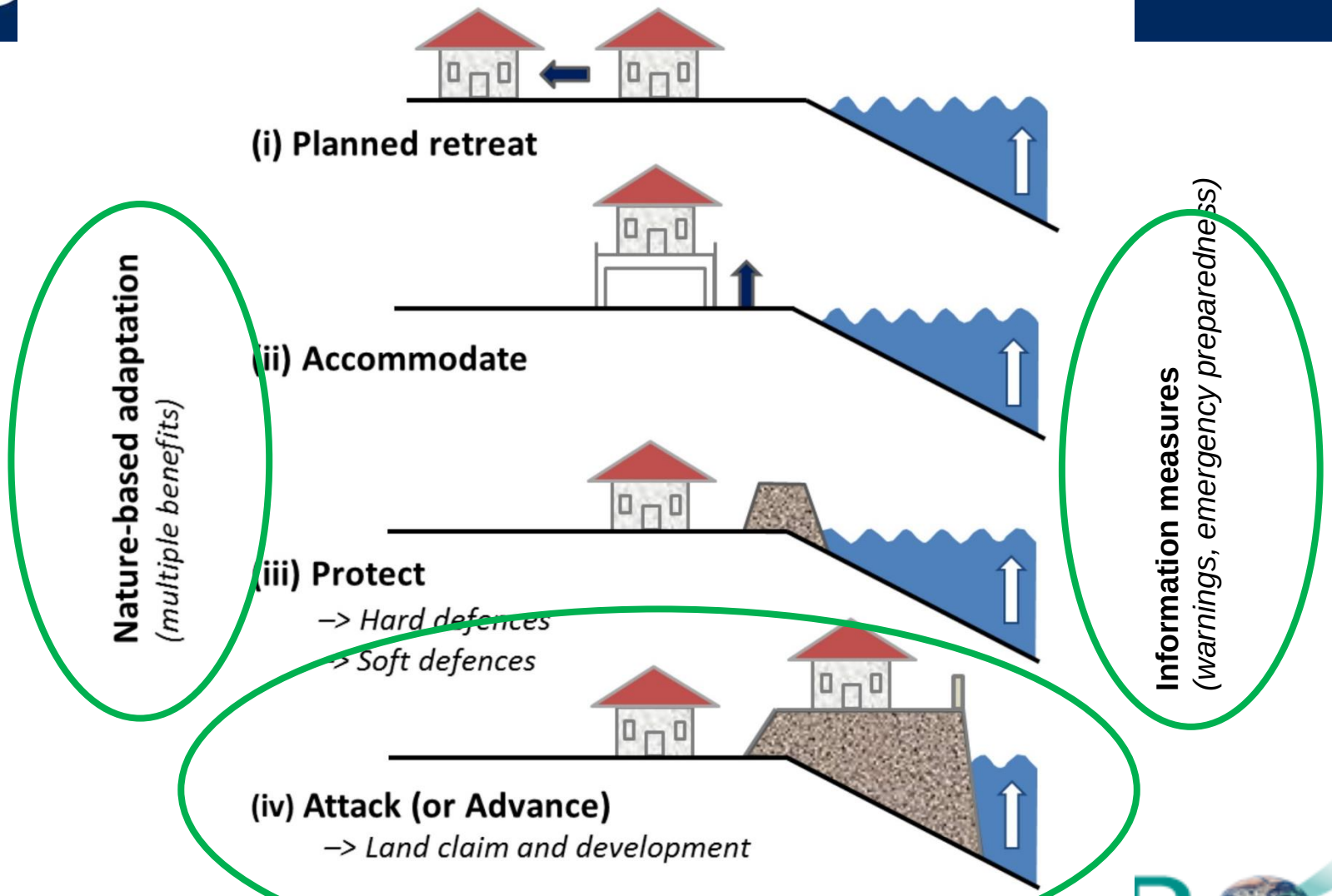
WG5: Sea level science for coastal zone management

WG6: Sea level budget

Classic IPCC (1990) Adaptation Options

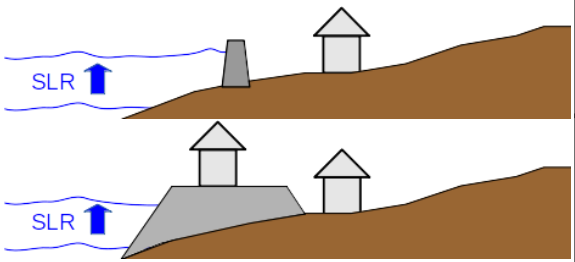


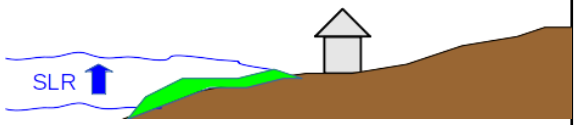
Regional Sea Level Changes

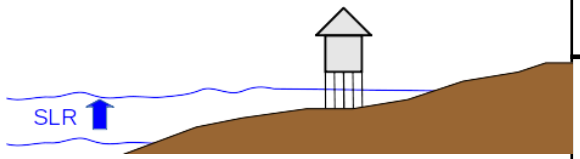


Source: adapted from Nicholls, 2018 in Alverson and Zommers (eds.), Resilience: the Science of Adaptation to Climate Change, Elsevier

SLR Adaptation Responses in IPCC (2019)

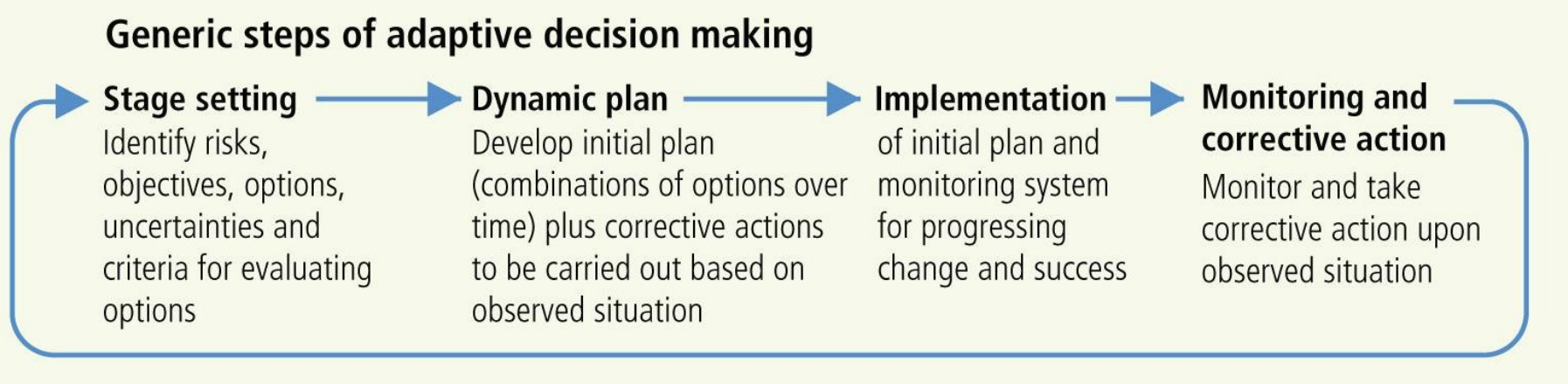






Measures		Potential effectiveness in reducing SLR risks	Caveat
Coastal protection		Up to several metres of SLR (*high confidence*)	Cost efficient for cities, not affordable for rural and poorer areas
Coastal advance			
Ecosystem-based adaptation	Corals	Effective up to 5 mm/yr SLR (*medium confidence*).	Widely lost at 2°C due to ocean warming and acidification (*high confidence*)
	Marshes, Mangroves	Effective up to 5-10 mm/yr SLR (*medium confidence*)	Decreased at 2°C, limited through pollution, infrastructure (*high confidence*)
Coastal accommodation		Very effective for small SLR (*high confidence*)	Insurance: moral hazard
Coastal retreat	Planned	Effective if alternative safe localities are available	Socially and politically very challenging
	Forced		Loss of life, livelihoods and sovereignty

Choosing and enabling sea level rise responses – an adaptation process



Enabling conditions

- Long-term perspective
- Cross-scale coordination
- Address vulnerability and equity
- Inclusive public participation
- Capability to address complexity

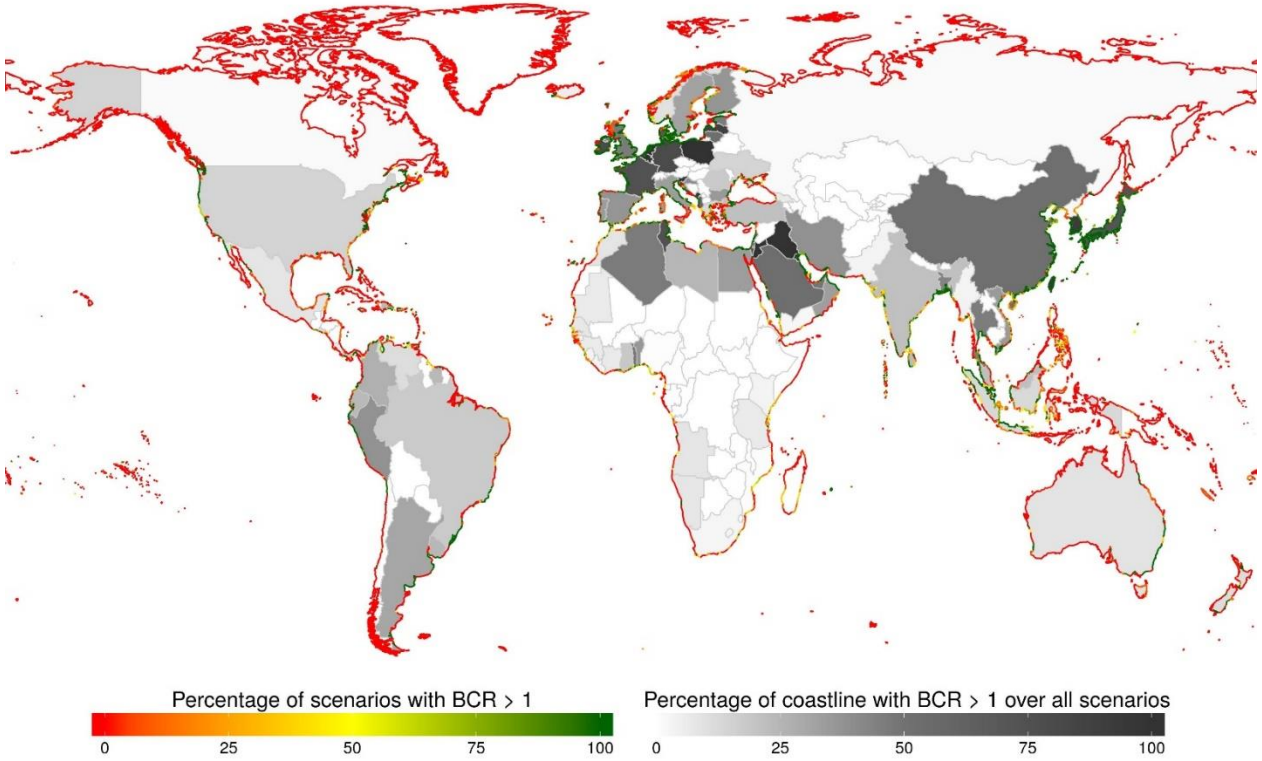
Nicholls viewpoint

Importance of information and community measures which are cross-cutting

Source; IPCC (2019)

Economic robustness of coastal protection SLR scenarios from 0.3 m to 2.0 m, the five SSPs and 10 discount rates of up to 6%.

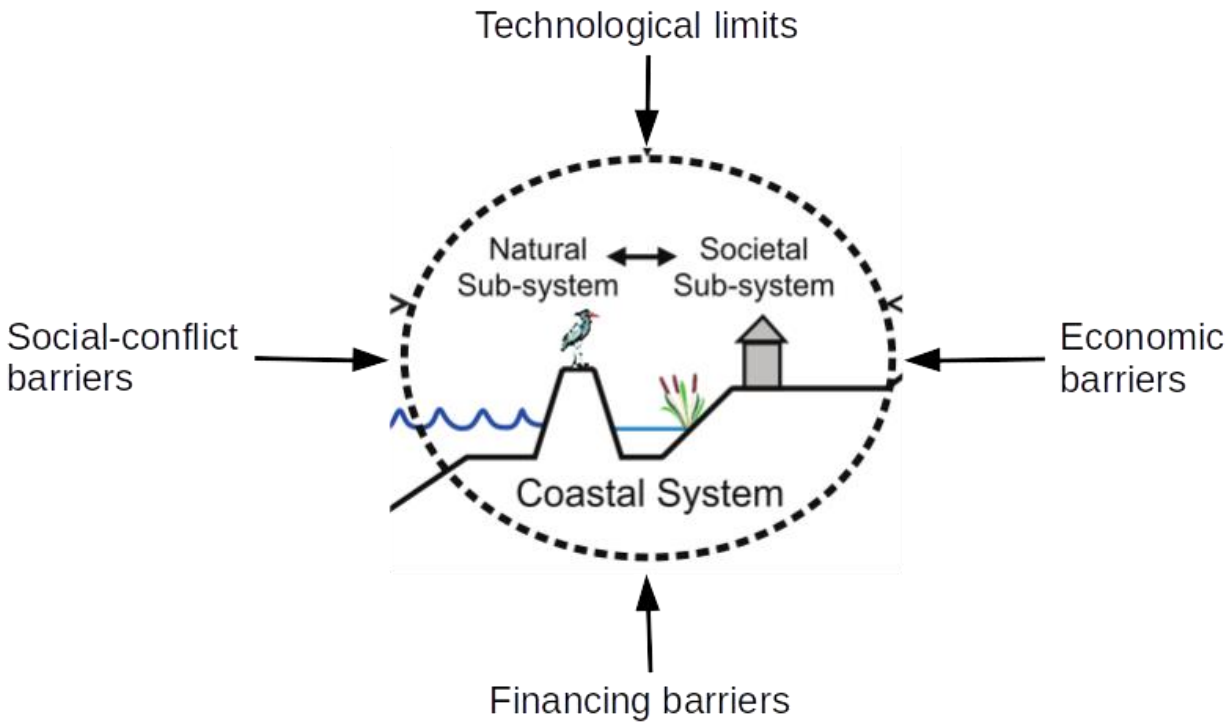
Source: Lincke and Hinkel (2018) Global Environmental Change



92,500 km is always protected (13%): 90% of global coastal floodplain population
451,000 km is never protected (65%): 0.2% of coastal floodplain population
22% world's coast and 9.8% of coastal flood plain population – result is scenario dependent

The ability of societies to adapt to twenty-first-century sea-level rise

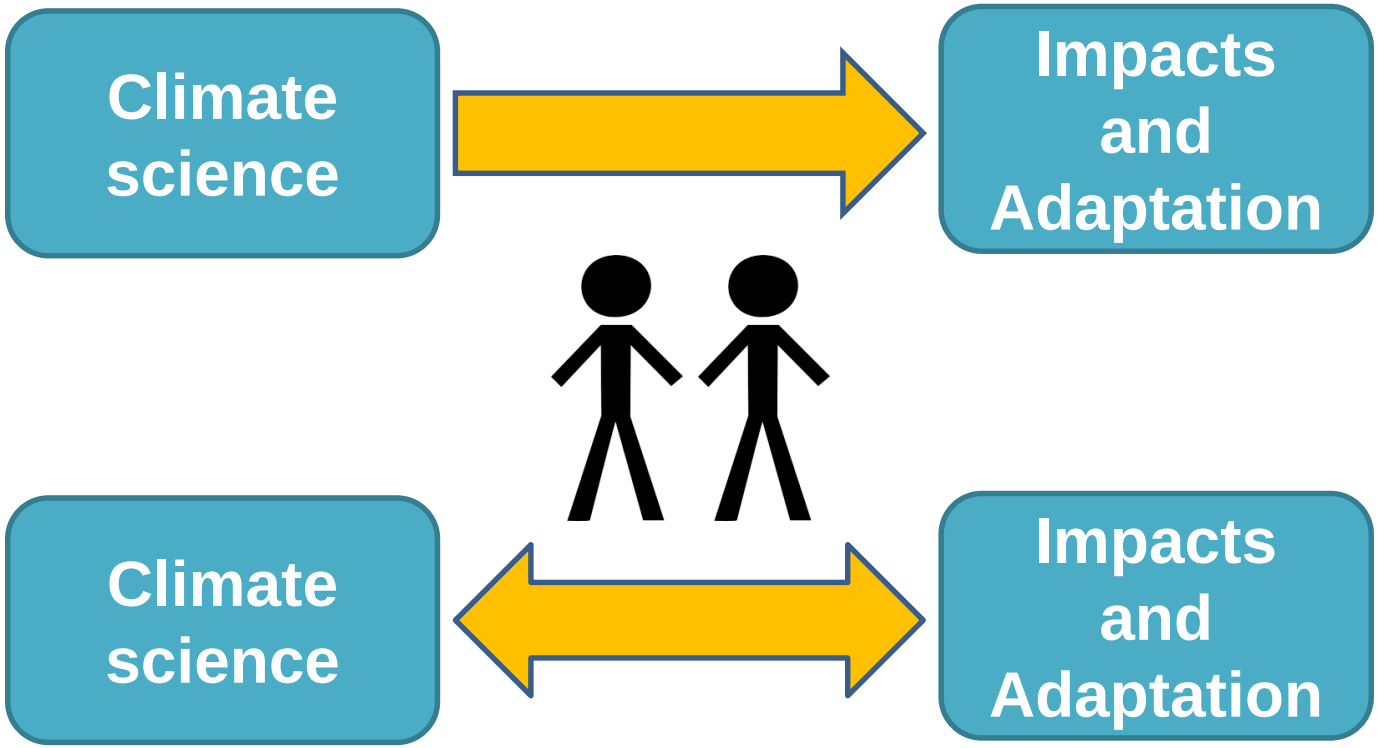
Source: Hinkel et al., 2018, NCC



Regional Sea Level Changes and Coastal Impacts

Case	Dominant coastal characteristics				Adaptation limits/barriers			
	Coastal landform	World Bank country income group (in 2017)	Land use	Population density (people/km²)	Techno-logy	Economic	Finance	Social conflict
Bangladesh	Delta	Lower middle income	Rural	*1,100			X	X
Catalonia	Beaches, deltas, cliffs	High income	Rural/ urban	*900				X
Ho Chi Minh City	Delta	Lower middle income	Urban	*3,900		Some	X	X
Maldives	Atoll islands	Higher middle income	Urban	**63,000				X
			Rural	*1,500		X	X	
New York City	Estuary	High income	Urban	*11,000			X	X
Netherlands	Delta, beaches	High income	Rural/ urban	*500				X

Climate Science, Impacts and Adaptation



Earth's Future

RESEARCH ARTICLE
10.1029/2019EF001163

Key Points:
- Previous publication of high end sea level differs in their meaning
- Development of new concept for high-end sea level estimates
- High-end estimates have to be a function of scenario and time frame considered

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Framework for Stakeho

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Abstract An app
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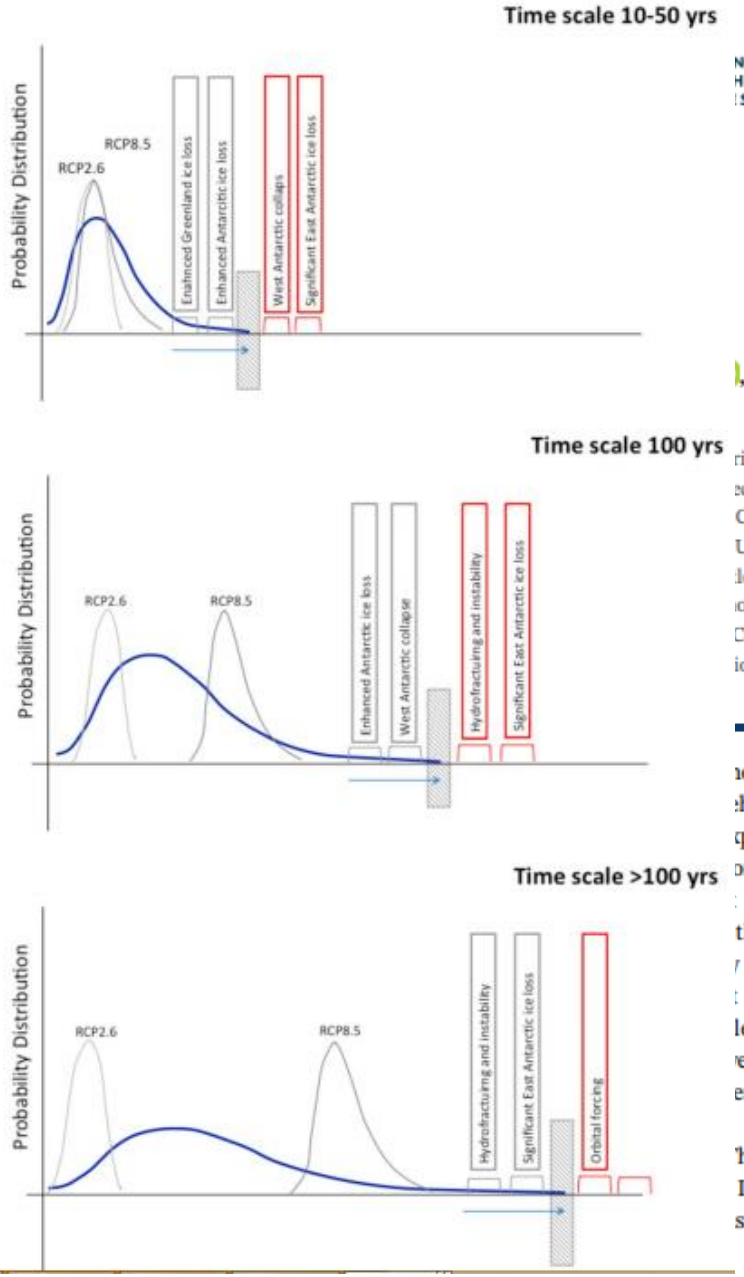

Outside the *likely* range (SROCC_SPMC3.4)

[redacted] The sea level rise range that needs to be considered for planning and implementing coastal responses depends on the risk tolerance of stakeholders. Stakeholders with higher risk tolerance (e.g., those planning for investments that can be very easily adapted to unforeseen conditions) often prefer to use the *likely* range of projections, while stakeholders with a lower risk tolerance (e.g., those deciding on critical infrastructure) also consider global and local mean sea level above the upper end of the *likely* range (globally 1.1 m under RCP8.5 by 2100) and from methods characterised by lower confidence such as from expert elicitation. {1.8.1, 1.9.2, 4.2.3, 4.4.4, Figure 4.2, Cross-Chapter Box 5 in Chapter 1, Figure SPM.5, SPM B3}

Some sea-level rise is unavoidable

A transformation in coastal adaptation is needed