Implications of a 1.5°C rise in temperature: What does this mean for sea-level and coasts?

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With thanks to numerous co-authors of 1.5°C papers, particularly Phil Goodwin, Robert Nicholls, Ivan Haigh

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Paris Agreement

The Paris Agreement committed signatories to:

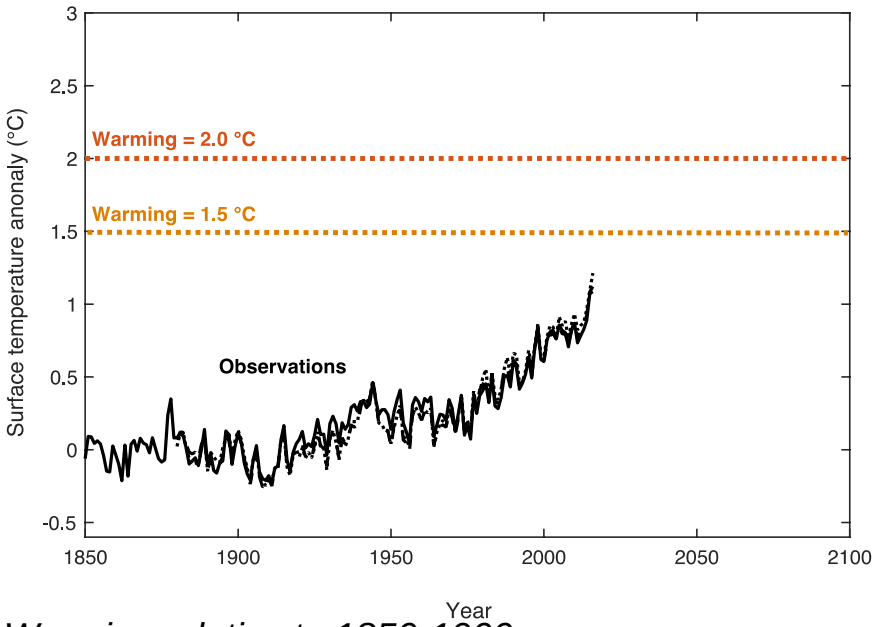
'Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels recognizing that this would significantly reduce the risks and impacts of climate change'.

Structure

- Climate projections
- Sea-level rise projections
- Impacts of sea-level rise
- Adaptation

Climate projections

Observations



Warming relative to 1850-1900

1 °C warming so far (*likely* range 0.8 to 1.2 °C)

On course to exceed 1.5 °C between 2030 and 2052 at current rate.

To stabilize climate at 1.5 °C, we need to reduce emissions of greenhouse gases.

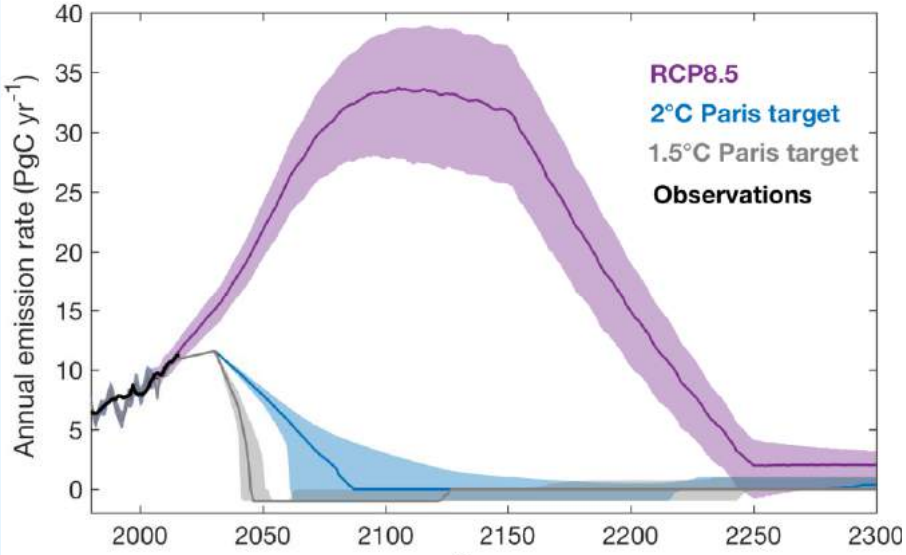
This includes CO_2, methane and nitrous oxide

Fig. adapted from Goodwin et al, (2018) Nature Geoscience. doi: 10.1038/s41561-017-0054-8

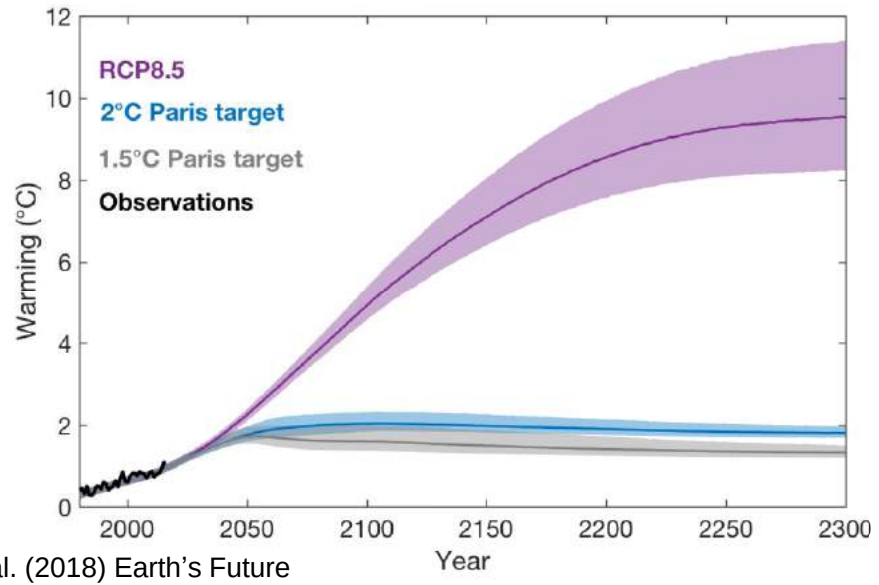
Projections for 1.5°C

- For 1.5 °C with little/no overshoot, need to reach net-zero emissions by **2050** (**2045 – 2055** interquartile range)
- For 2 °C, net zero emissions by **2075** (**2065 – 2080**)

Emission rate over time



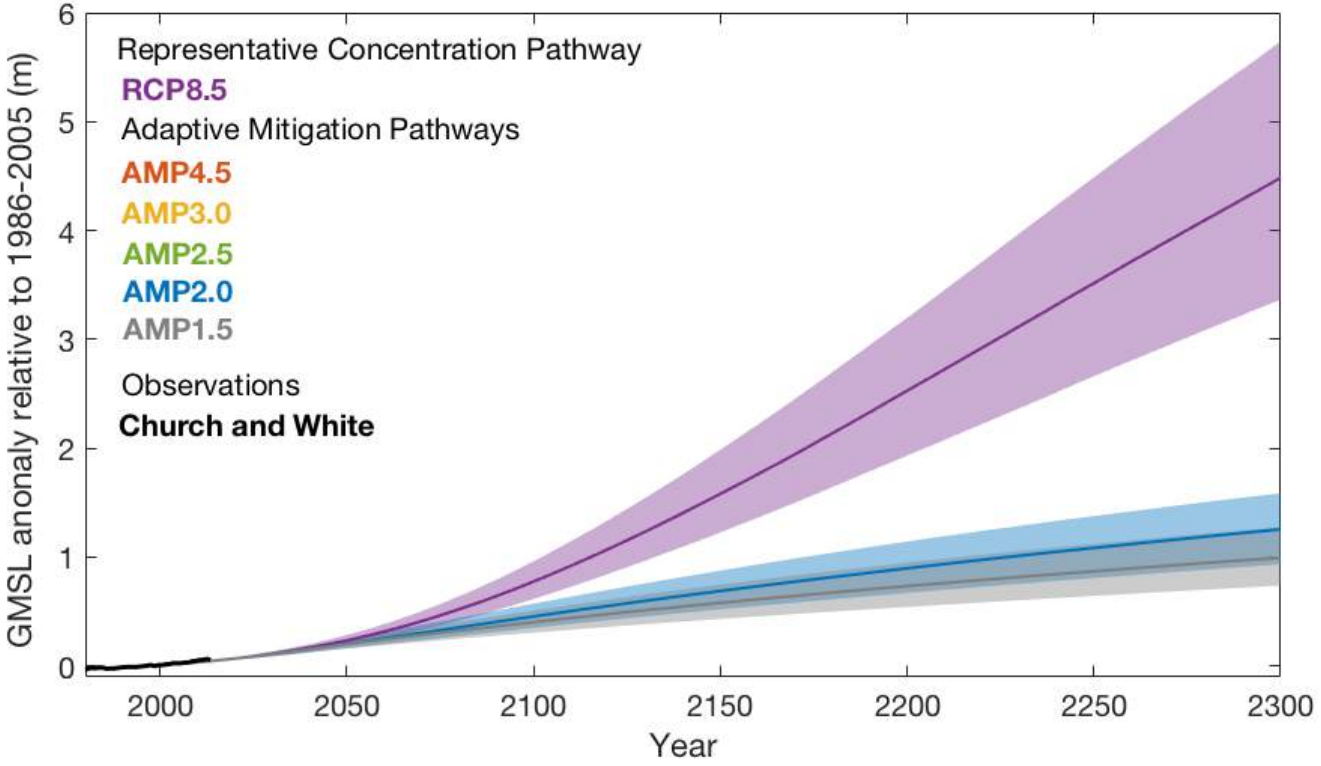
Warming over time



Figs. adapted from Goodwin et al. (2018) Earth's Future

Sea-level rise projections

What will this mean for sea-level?



Goodwin et al. 2018 doi: 10.1038/s41561-017-0054-8

How does this compare with other studies?

Table 3.1: Compilation of recent projections for sea level at 2100 (in cm) for Representative Concentration Pathway (RCP)2.6, and 1.5 and 2.0 °C scenarios. Upper and lower limits are shown for the 17-84% and 5-95% confidence intervals quoted in the original papers.

Study	Baseline	RCP2.6		1.5°C		2°C	
		67%	90%	67%	90%	67%	90%
AR5	1986-2005	28-61					
Kopp et al. (2014)	2000	37-65	29-82				
Jevrejeva et al. (2016)	1986-2005		29-58				
Kopp et al. (2016)	2000	28-51	24-61				
Mengel et al. (2016)	1986-2005	28-56					
Nauels et al. (2017)	1986-2005	35-56					
Goodwin et al. (2017)	1986-2005		31-59 45-70 45-72				
Schaeffer et al. (2012)	2000		52-96		54-99		56-105
Schleussner et al. (2016b)	2000			26-53		36-65	
Bittermann et al. (2017)	2000				29-46		39-61
Jackson et al. (2018)	1986-2005			30-58 40-77	20-67 28-93	35-64 47-93	24-74 32-117
Sanderson et al. (2017)					50-80		60-90
Nicholls et al. (2018)	1986-2005				24-54		31-65
Rasmussen et al. (2018)	2000			35-64	28-82	39-76	28-96
Goodwin et al. (2018)	1986-2005				26-62		30-69

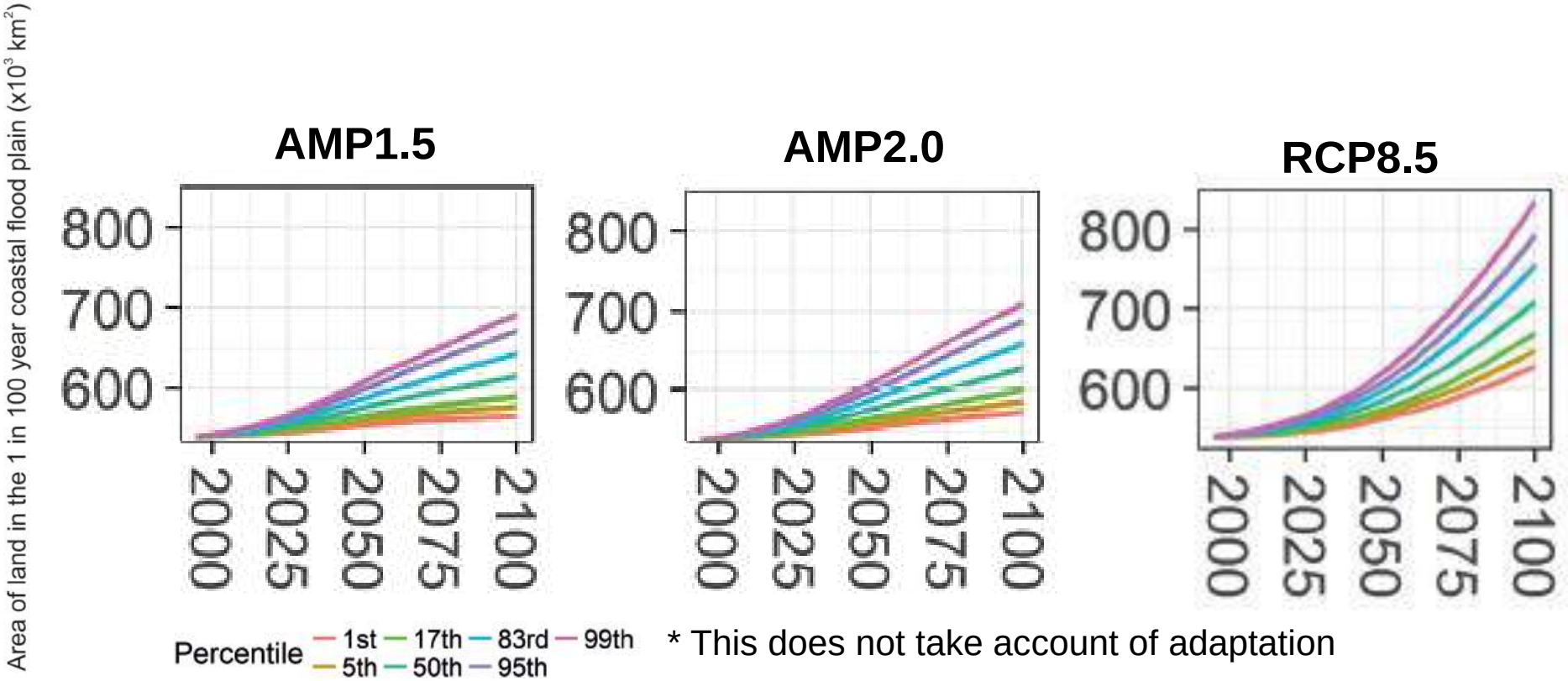
IPCC range for 1.5°C in 2100: 0.20-0.93m.

IPCC range for 2.0°C in 2100: 0.24-1.17m.

Hoegh-Guldberg et al. (2018) IPCC 1.5 report chapter

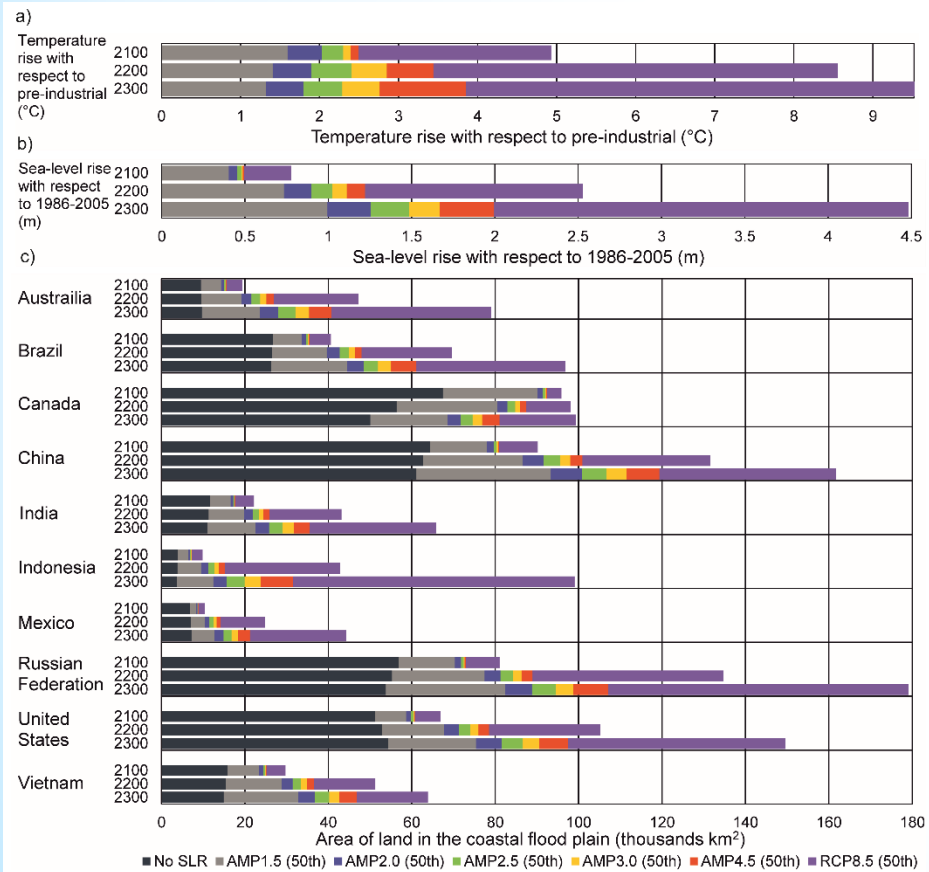
Impacts of sea-level rise

Land exposed to sea-level rise: Global



* This does not take account of adaptation

Land exposed to sea-level rise: Nationally

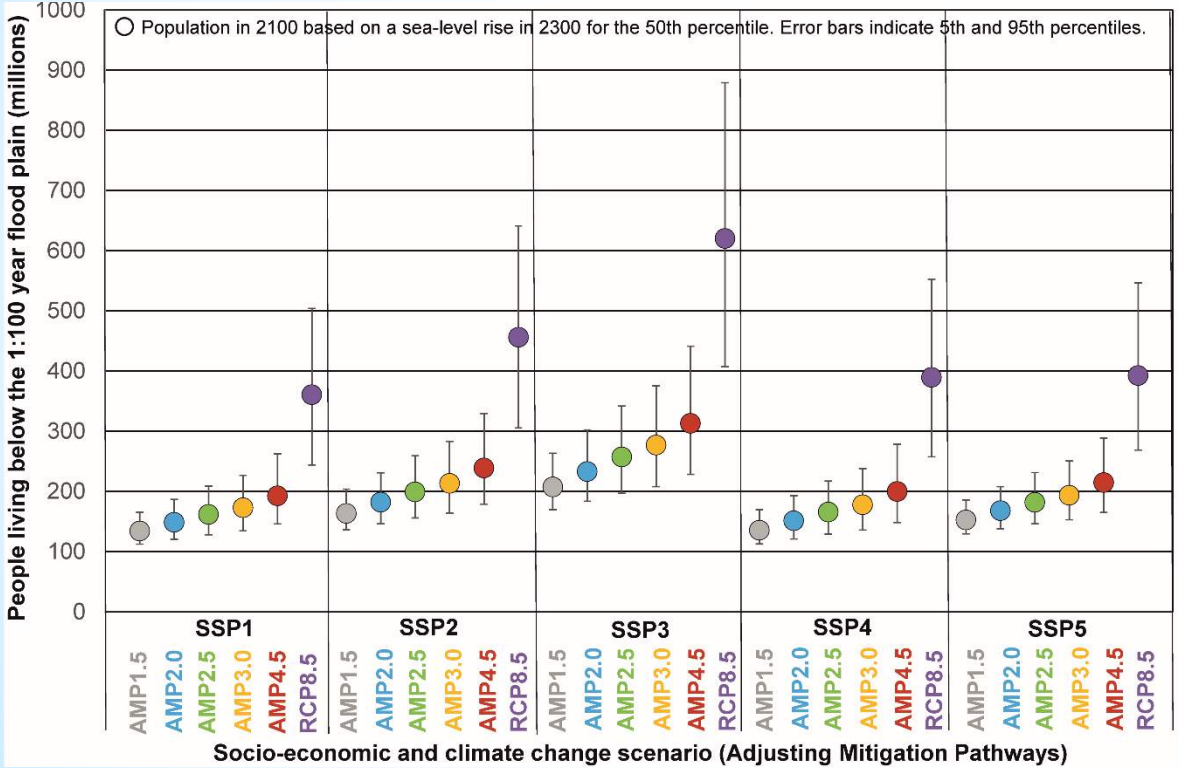


* This does not take account of adaptation

* The top 10 country level exposure for the area in the 1 in 100 year coastal flood plain in 2100, 2200, and 2300 for each AMP and RCP8.5 (50th percentile)

Brown et al. (2018) doi:10.1002/2017EF000738

Population exposed

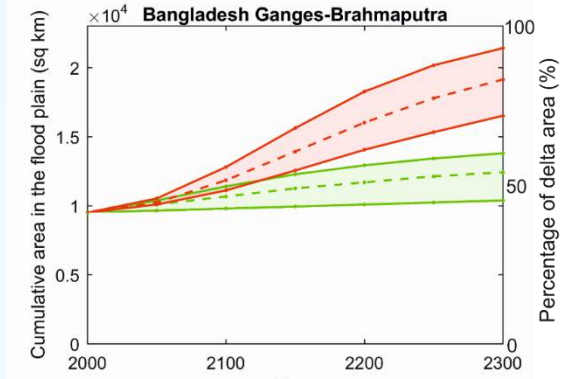


* This does not take account of adaptation

* 1.5% to 5.4% of the world's population exposed to flooding in 2300.

Brown et al. (2018) doi:10.1002/2017EF000738

Area exposure in deltas

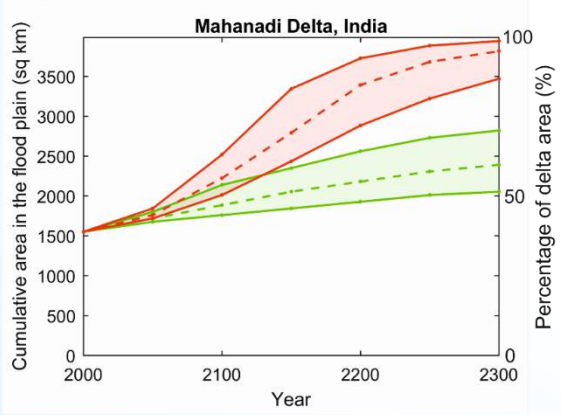


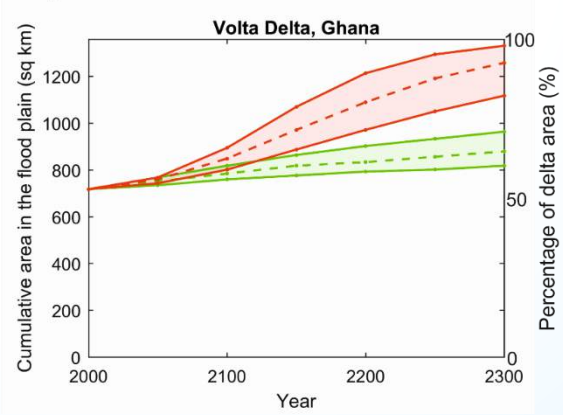
Red = Non-mitigation scenario (RCP8.5)

Green = Climate change mitigation

Dashed lines = 50th percentile of SLR

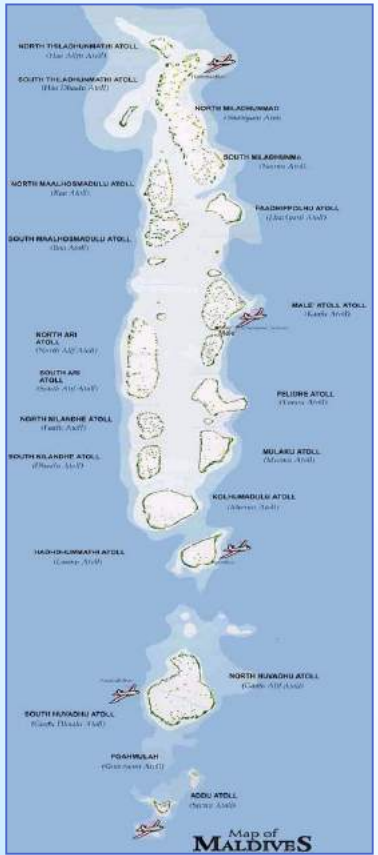
Solid lines = 5th and 95th percentile of SLR

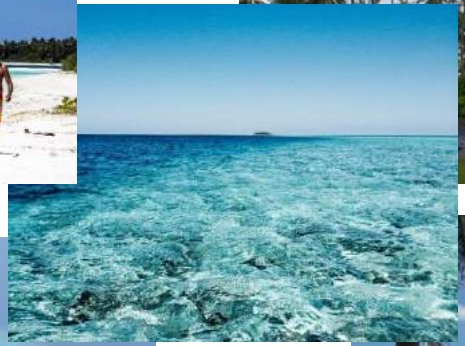




Brown et al. (2018) doi: 10.1007/s10113-018-1311-0

Small islands





Cities

Cities with more than 1 million people in 2005

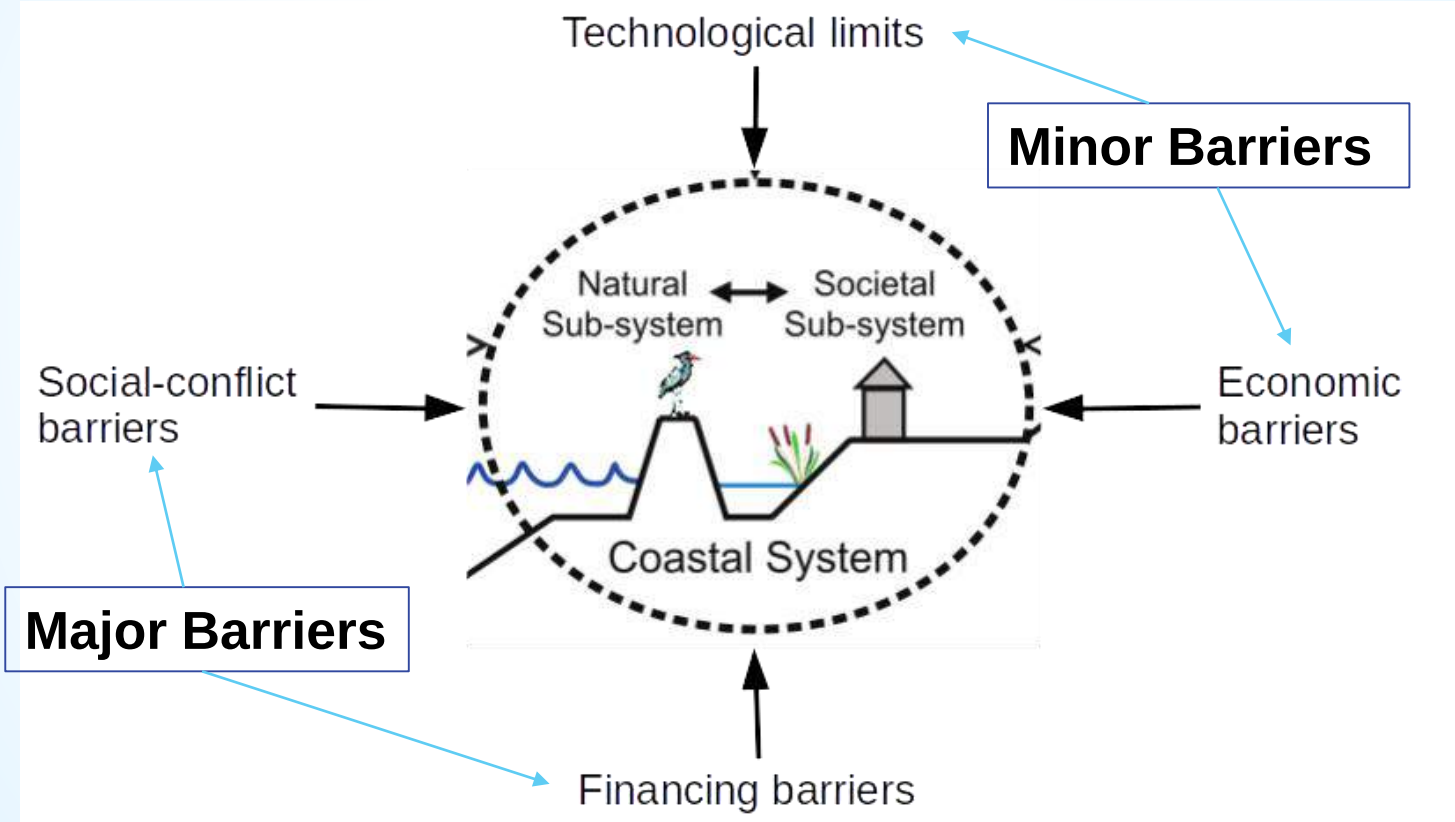
0 5,000 10,000 Kilometers

N

Nicholls et al. 2008 OECD report

Adaptation

Barriers to adaptation



Conclusions

Conclusions

- 1.5°C could be reached by 2030 and 2052.
- Projections of sea-level rise at 1.5°C are between 0.20-0.93m in 2100. They will continue to rise after 2100.
- Sea-level rise will have significant impacts world wide, with 610×10^3 km^2 of land loss by 2100, increasing to 700×10^3 km^2 in 2300. 1.5% to 5.4% of the world's population exposed to flooding in 2300, particularly in vulnerable areas.
- Social and financing barriers are hardest to overcome when deciding whether to and how to adapt.

Papers and briefing notes

1. Goodwin et al. 2018 **Pathways to 1.5 °C and 2 °C warming based on observational and geological constraints** Nature Geoscience, 11, 102-107 doi: 10.1038/s41561-017-0054-8

2. Goodwin et al. 2018. **Adjusting Mitigation Pathways to stabilize climate at 1.5 and 2.0 °C rise in global temperatures to year 2300** Earth's Future, 6, 601-615 . doi: 10.1002/2017EF000732

3. Brown et al. 2018. **Quantifying land and people exposed to sea-level rise with no mitigation and 1.5 and 2.0 °C rise in global temperatures to year 2300** Earth's Future, 6, 583-600. doi: 10.1002/2017EF000738

4. Brown et al (2018) **What are the implications of sea-level rise for a 1.5, 2 and 3 °C rise in global mean temperatures in the Ganges-Brahmaputra-Meghna and other vulnerable deltas?** Regional Environmental Change, 18, 1829–1842 doi: 10.1007/s10113-018-1311-0

5. Nicholls et al (2018) **Stabilization of global temperature at 1.5°C and 2.0°C: Implications for coastal areas.** Philosophical Transactions of The Royal Society A, 376(2119) doi: 10.1098/rsta.2016.0448

6. Warren et al (2018) **Risks associated with global warming of 1.5°C or 2°C.** Briefing note to BEIS. https://tyndall.ac.uk/sites/default/files/publications/briefing_note_risks_warren_r1-1.pdf