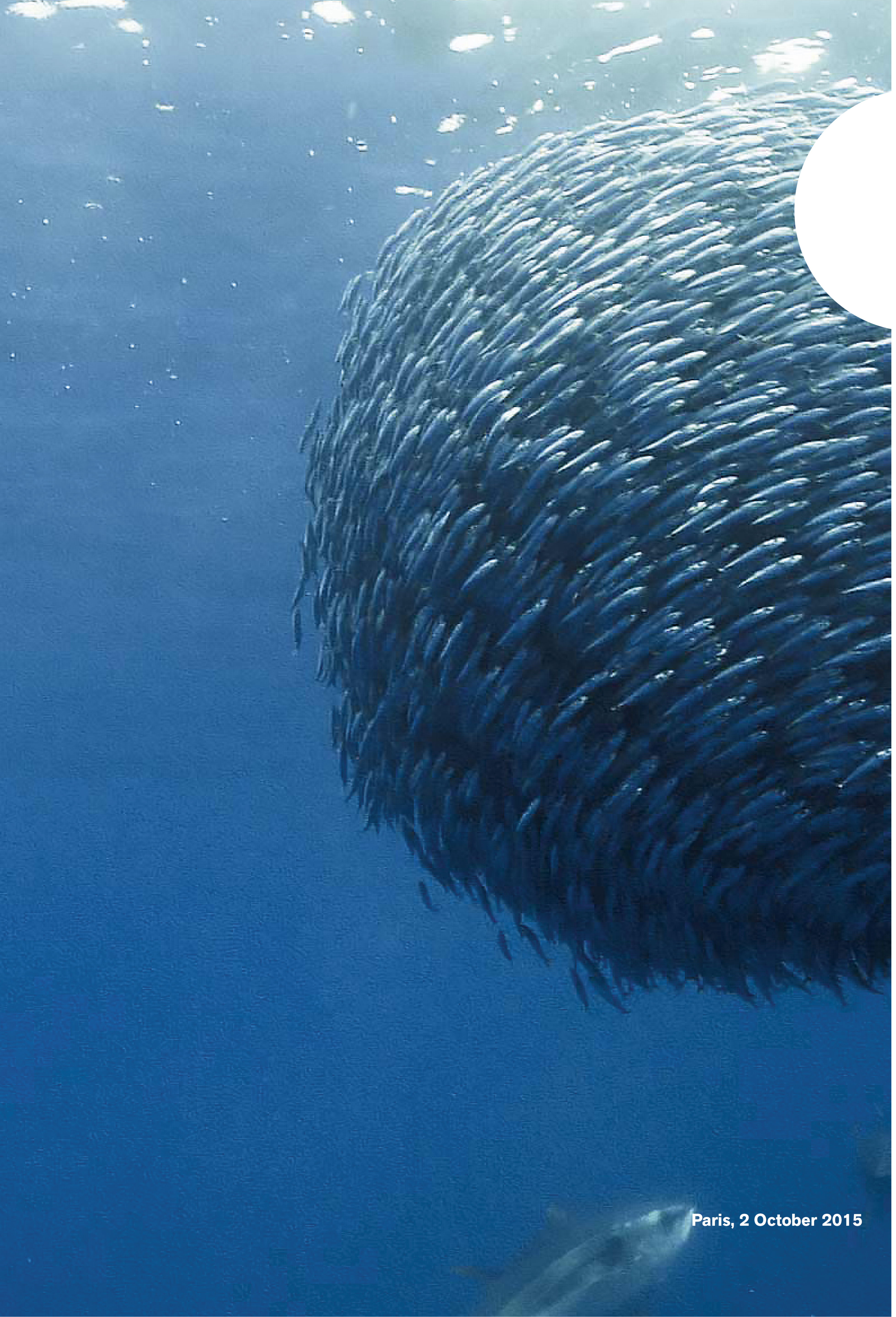

Sea level rise: impacts and adaptation options

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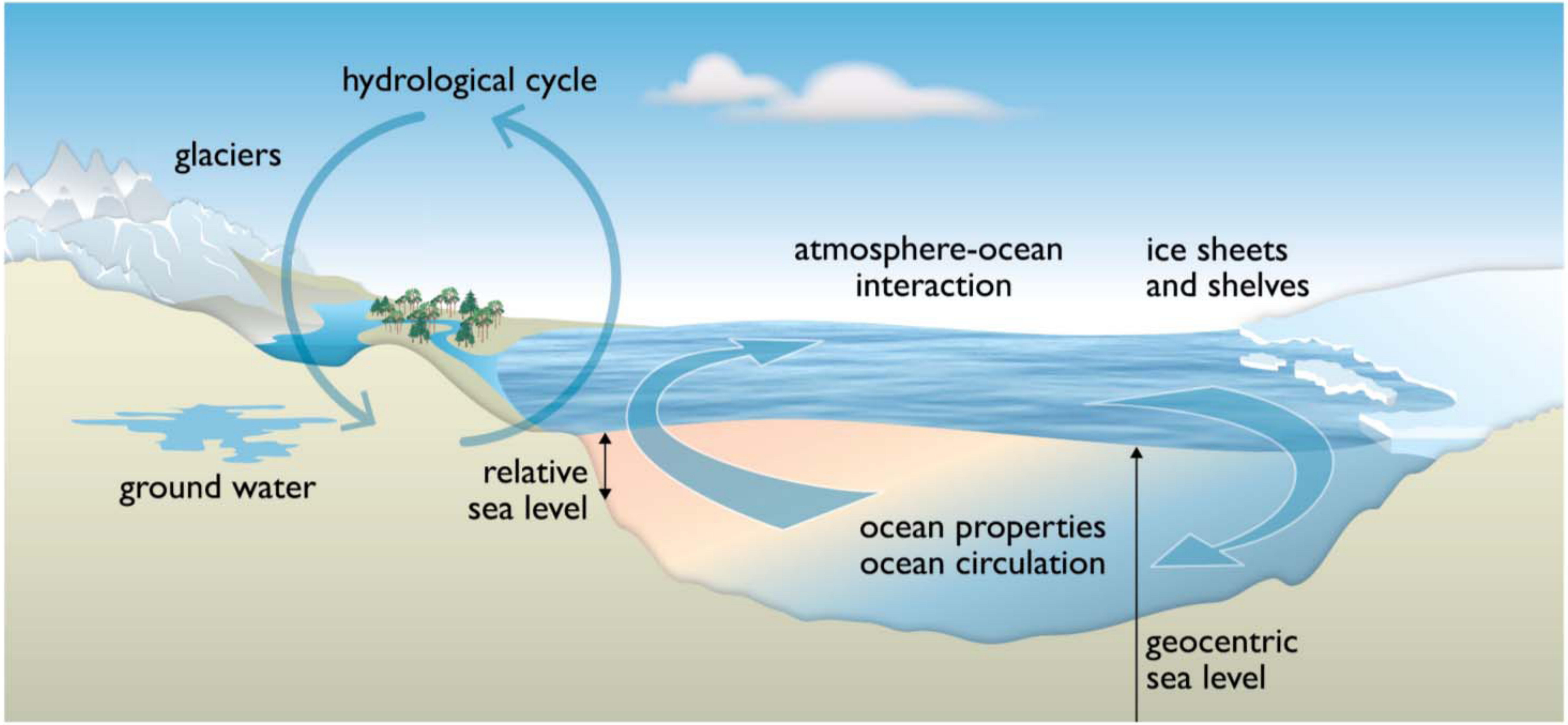
Implementing the Ocean SDG: from knowledge to action

IDDRI

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

Sea Level rise: a signature of global warming



Volume expansion + melting of major stores of land ice + land water storage

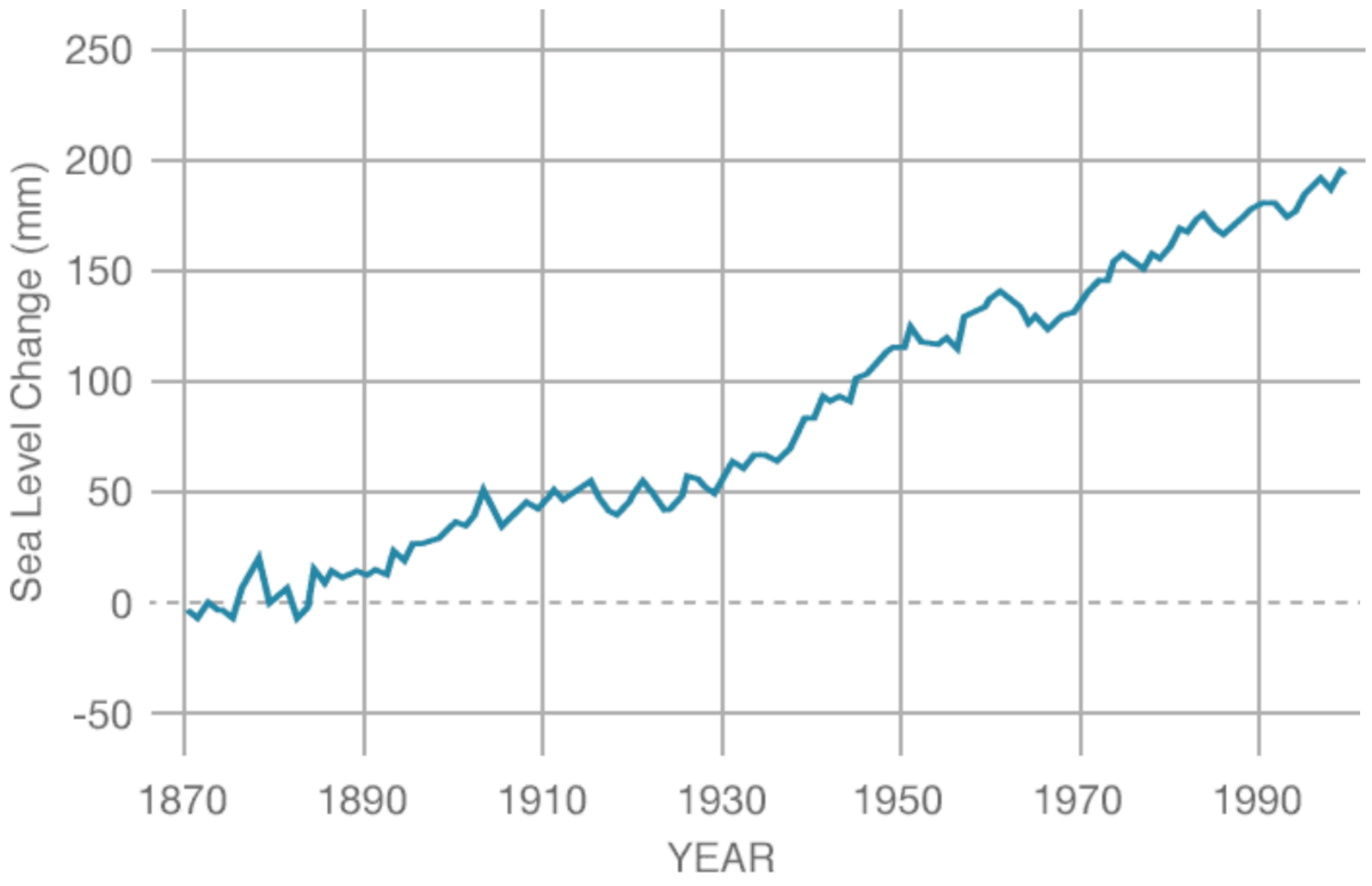
SOURCE: IPCC

GMSLR: a signature of global warming

GROUND DATA: 1870-2000

Data source: Coastal tide gauge records.
Credit: CSIRO

1870-2000



20 cm in 125 years

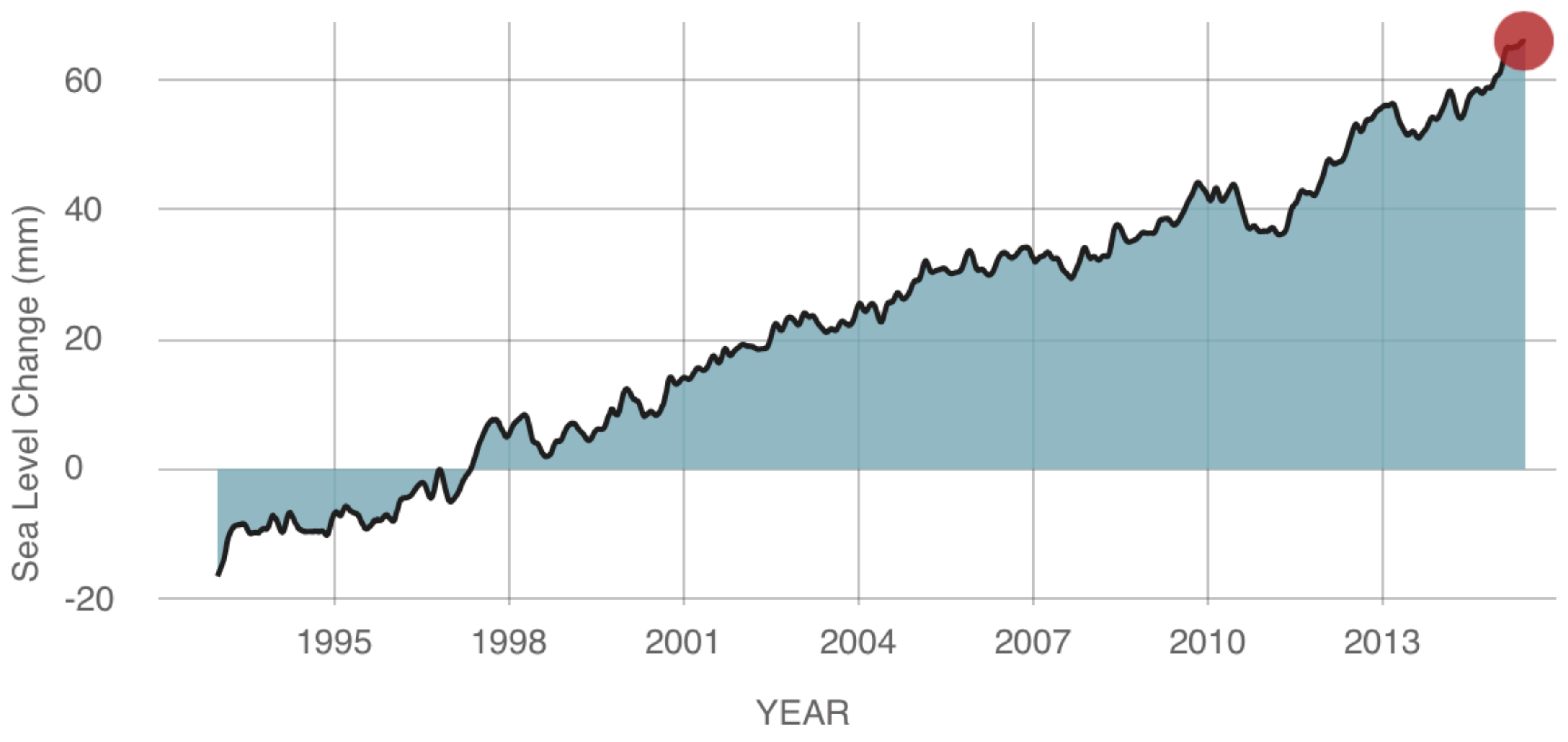
1993-

6 cm in 22 years

SATELLITE DATA: 1993-PRESENT

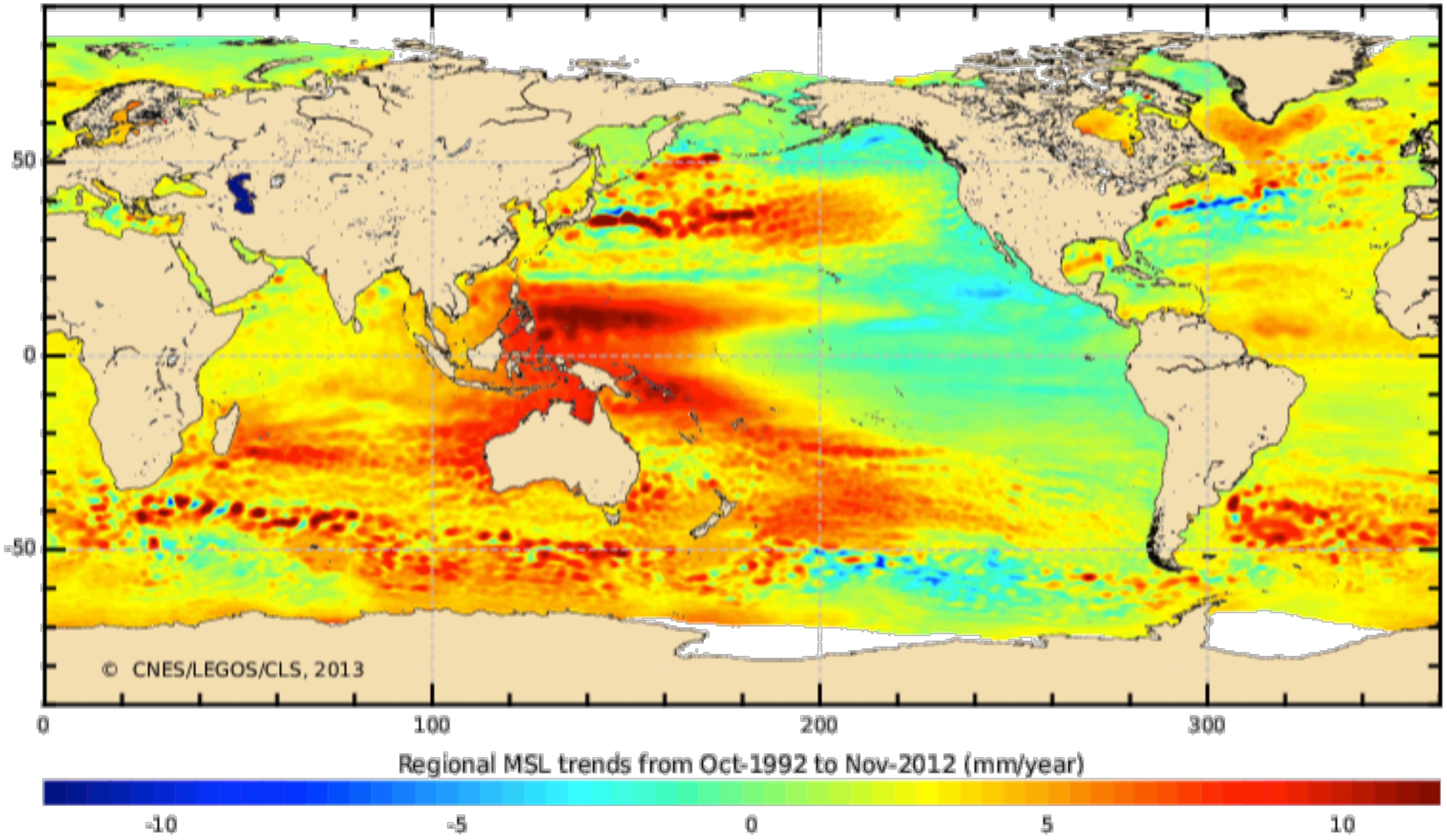
Data source: Satellite sea level observations.
Credit: NASA Goddard Space Flight Center

RATE OF CHANGE
↑ 3.22
mm per year



SOURCE: NASA

Regional variability (1993-)



SOURCE: NASA

GMSLR Projections

Table 5-2 | Projections of global mean sea level rise in meters relative to 1986–2005 are based on ocean thermal expansion calculated from climate models, the contributions from glaciers, Greenland and Antarctica from surface mass balance calculations using climate model temperature projections, the range of the contribution from Greenland and Antarctica due to dynamical processes, and the terrestrial contribution to sea levels, estimated from available studies. For sea levels up to and including 2100, the central values and the 5–95% range are given whereas for projections from 2200 onwards, the range represents the model spread due to the small number of model projections available and the high scenario includes projections based on RCP6.0 and RCP8.5. Source: WGI AR5 Summary for Policymakers and Sections 12.4.1, 13.5.1, and 13.5.4.

Emission scenario	Representative Concentration Pathway (RCP)	2100 CO_2 concentration (ppm)	Temperature increase (°C)	Mean sea level rise (m)					
			2081–2100	2046–2065	2100	Scenario	2200	2300	2500
Low	2.6	421	1.0 [0.3–1.7]	0.24 [0.17–0.32]	0.44 [0.28–0.61]	Low	0.35–0.72	0.41–0.85	0.50–1.02
Medium low	4.5	538	1.8 [1.1–2.6]	0.26 [0.19–0.33]	0.53 [0.36–0.71]	Medium	0.26–1.09	0.27–1.51	0.18–2.32
Medium high	6.0	670	2.2 [1.4–3.1]	0.25 [0.18–0.32]	0.55 [0.38–0.73]	High	0.58–2.03	0.92–3.59	1.51–6.63
High	8.5	936	3.7 [2.6–4.8]	0.29 [0.22–0.38]	0.74 [0.52–0.98]				

SOURCE: IPCC

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Impacts of SLR

Table 5-3 | Main impacts of relative sea level rise. Source: Adapted from Nicholls et al. (2010).

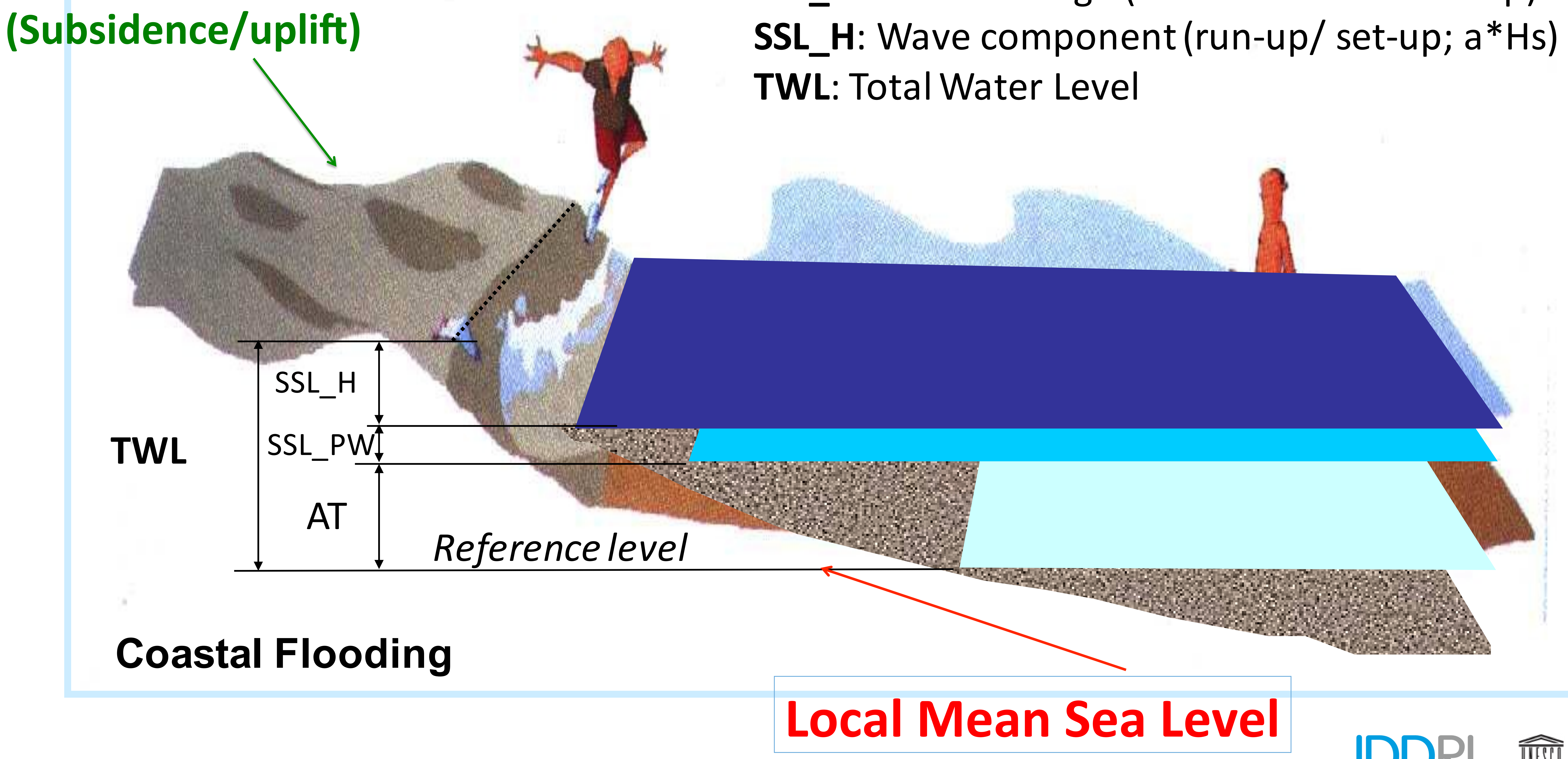
Biophysical impacts of relative sea level rise	Other climate-related drivers	Other human drivers
Dryland loss due to erosion	Sediment supply, wave and storm climate	Activities altering sediment supply (e.g., sand mining)
Dryland loss due to submergence	Wave and storm climate, morphological change, sediment supply	Sediment supply, flood management, morphological change, land claim
Wetland loss and change	Sediment supply, CO_2 fertilization	Sediment supply, migration space, direct destruction
Increased flood damage through extreme sea level events (storm surges, tropical cyclones, etc.)	Wave and storm climate, morphological change, sediment supply	Sediment supply, flood management, morphological change, land claim
Saltwater intrusion into surface waters (backwater effect)	Runoff	Catchment management and land use (e.g., sand mining and dretching)
Saltwater intrusion into groundwaters leading to rising water tables and impeded drainage	Precipitation	Land use, aquifer use

SOURCE: IPCC

Flooding components

0.1<a<0.4

AT: Astronomical Tide
SSL_PW: Storm surge (Pressure + Wind set-up)
SSL_H: Wave component (run-up/ set-up; a*Hs)
TWL: Total Water Level



Coastal Development

60’s

today

Spanish Mediterranean coast: 1st Km - 40% urbanized !

Implications for coastal protection

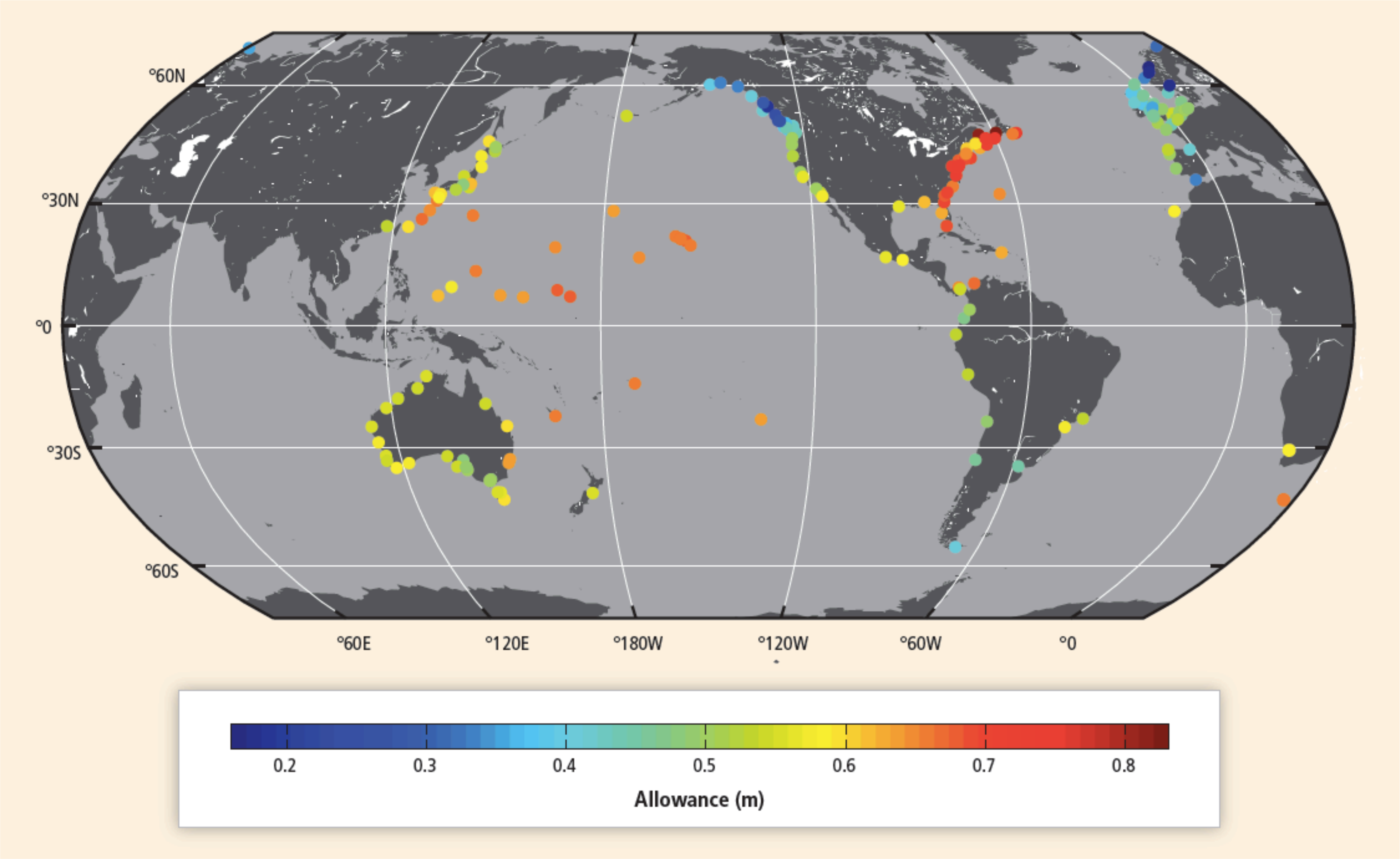
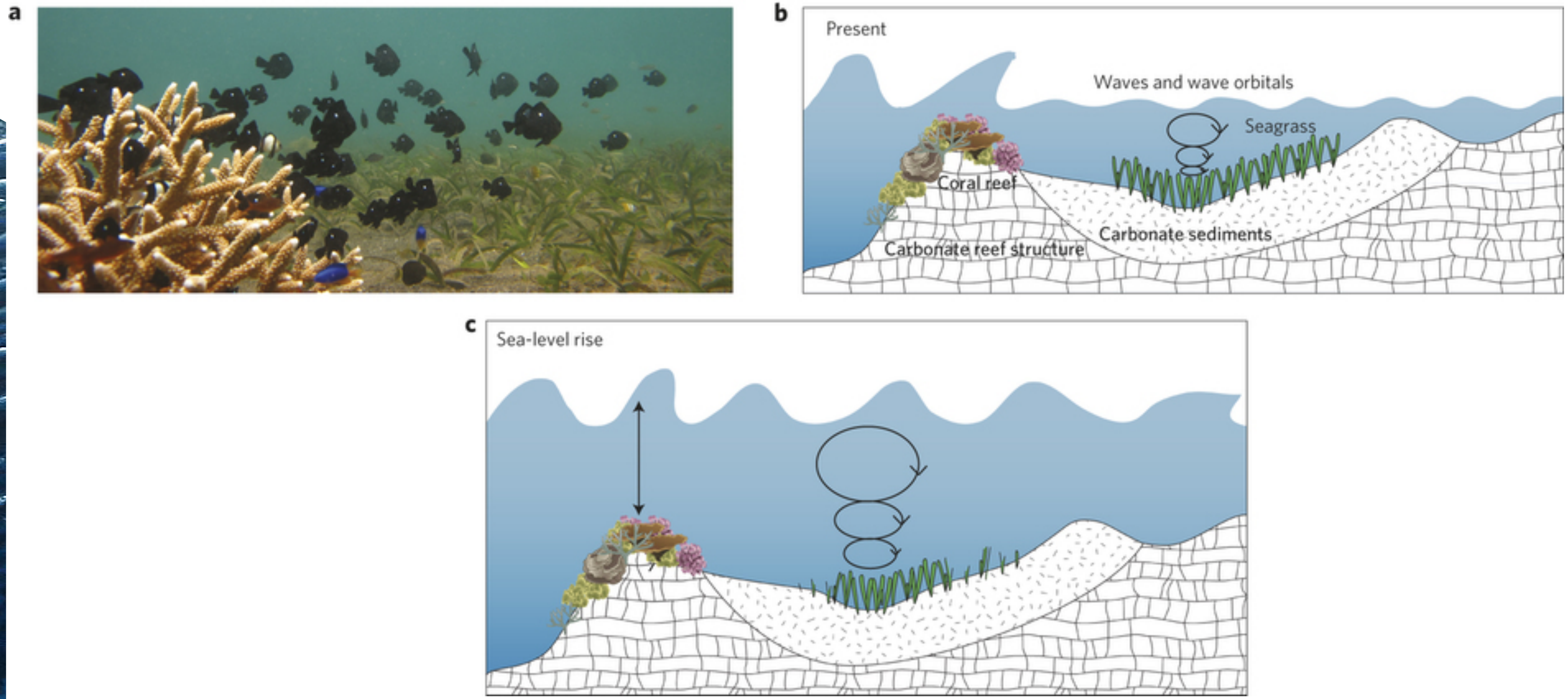


Figure 5-2 | The estimated increase in height (m) that flood protection structures would need to be raised in the 2081–2100 period to preserve the same frequency of exceedences that was experienced for the 1986–2005 period, shown for 182 tide gauge locations and assuming regionally varying relative sea level rise projections under an Representative Concentration Pathway 4.5 (RCP4.5) scenario (adapted from Hunter et al., 2013).

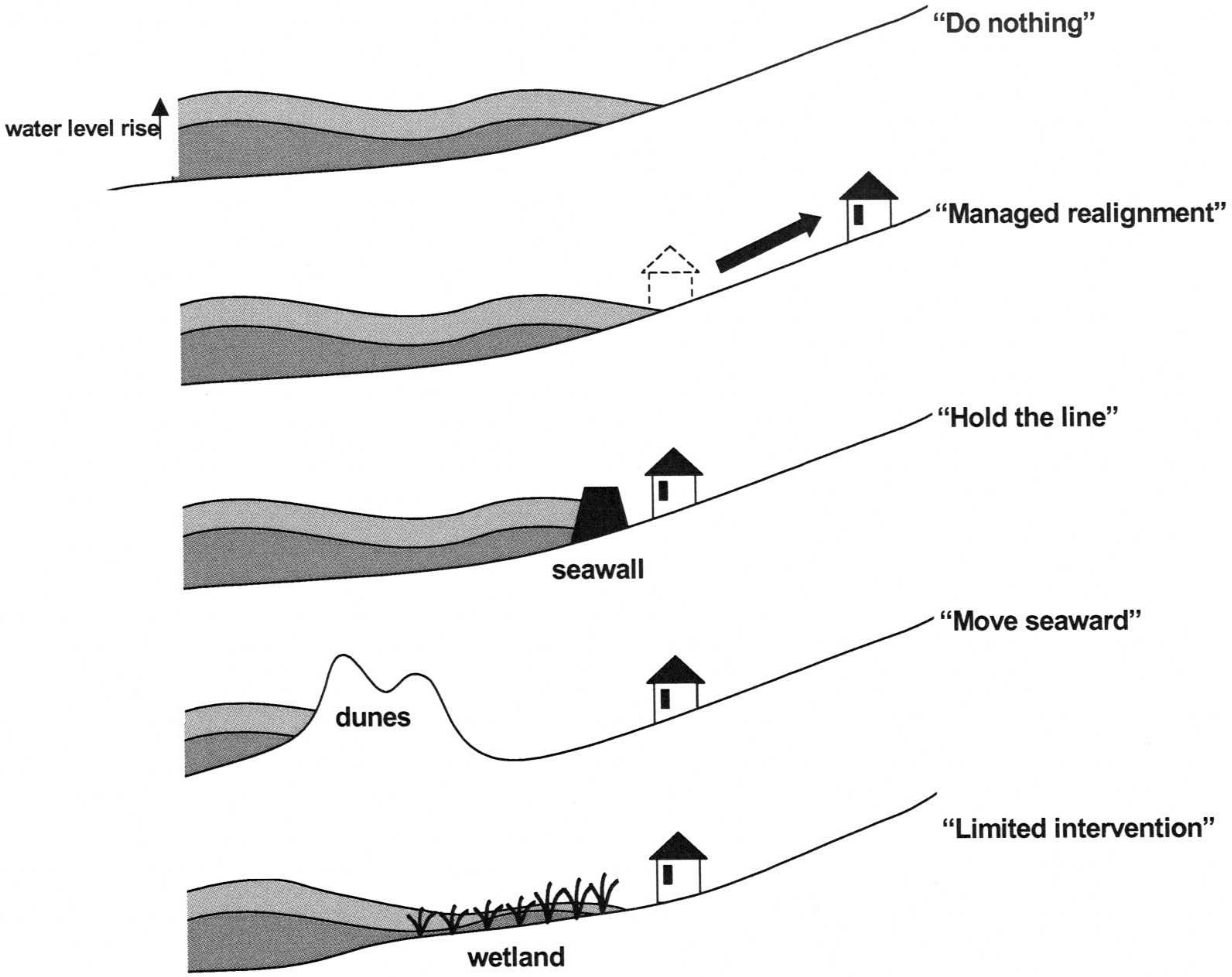
SOURCE:IPCC

Impacts on natural systems



a, Seagrass meadows and coral reefs form distinct ecosystems, yet often live in close proximity in linked tropical marine ecosystems. b, Coral reefs block and dissipate wave energy and permit seagrass, which is less wave tolerant, to exist in protected lagoons. c, Deepening water from sea-level rise will allow larger, more energetic waves to traverse the reef into the lagoon, reducing habitat suitability for seagrass

The need for adaptation



technological

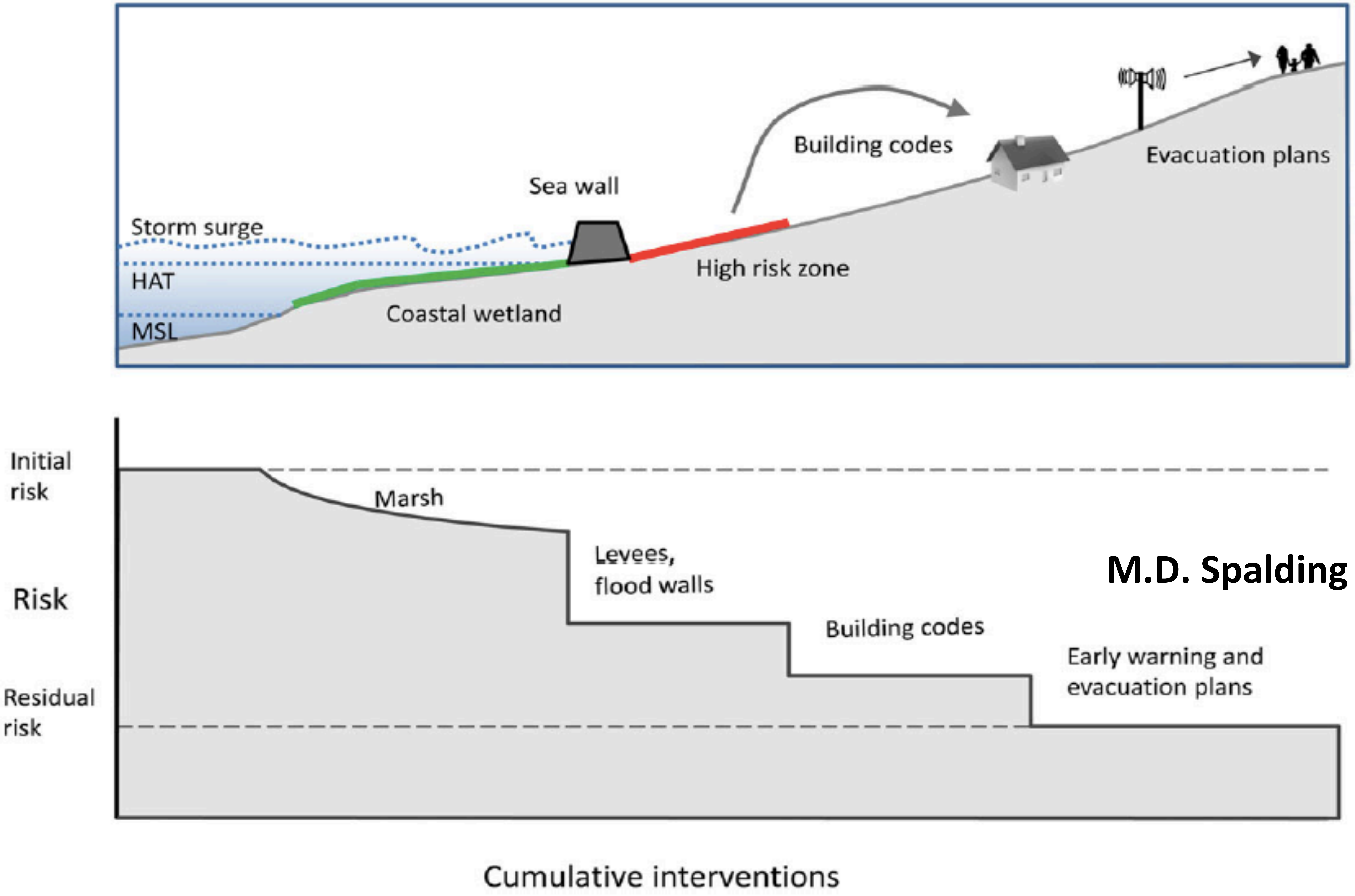
policy related

financial

institutional

ecosystem-based

Combined options/Cumulative interventions



M.D. Spalding *et al.* (2014)

Figure 2 Ecosystems can form an important part of risk reduction, which is typically achieved through a combination of environmental, engineered, social, cultural, and legal approaches as illustrated in the upper figure. Cumulative interventions (lower figure) cannot remove risk, but rather reduce it to an acceptable level of residual risk.

Take home messages

Coastal systems and low-lying areas will increasingly experience adverse impacts due to relative sea level rise

Adaptation is already occurring

Not reaching an immediate stringent reduction of emissions will extend our commitment to SLR for centuries due to delayed response of MSL to warming