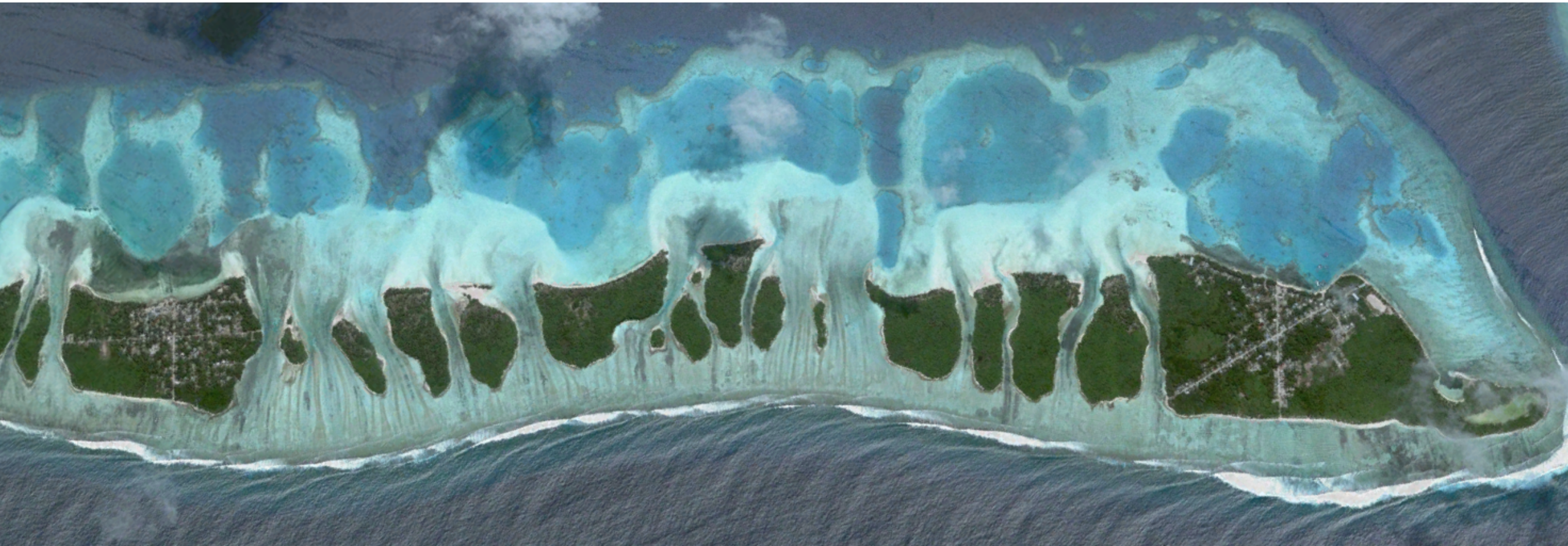


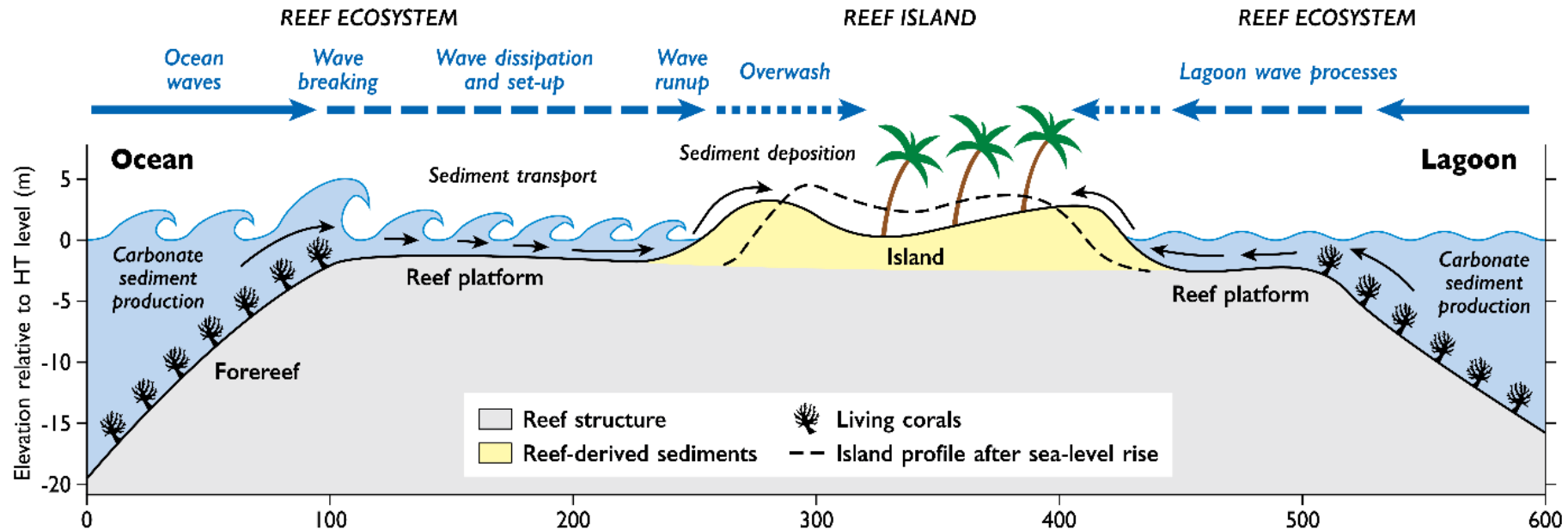
Natural adaptation of coral reef islands to sea-level rise offering opportunities for ongoing human occupation (ARISE)



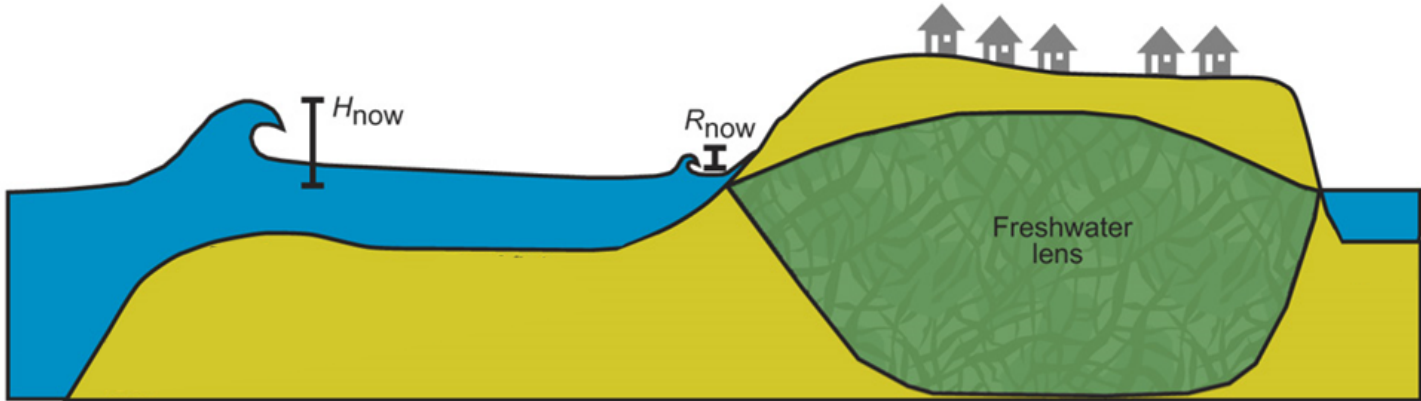
Gerd Masselink
Coastal Processes Research Group
University of Plymouth



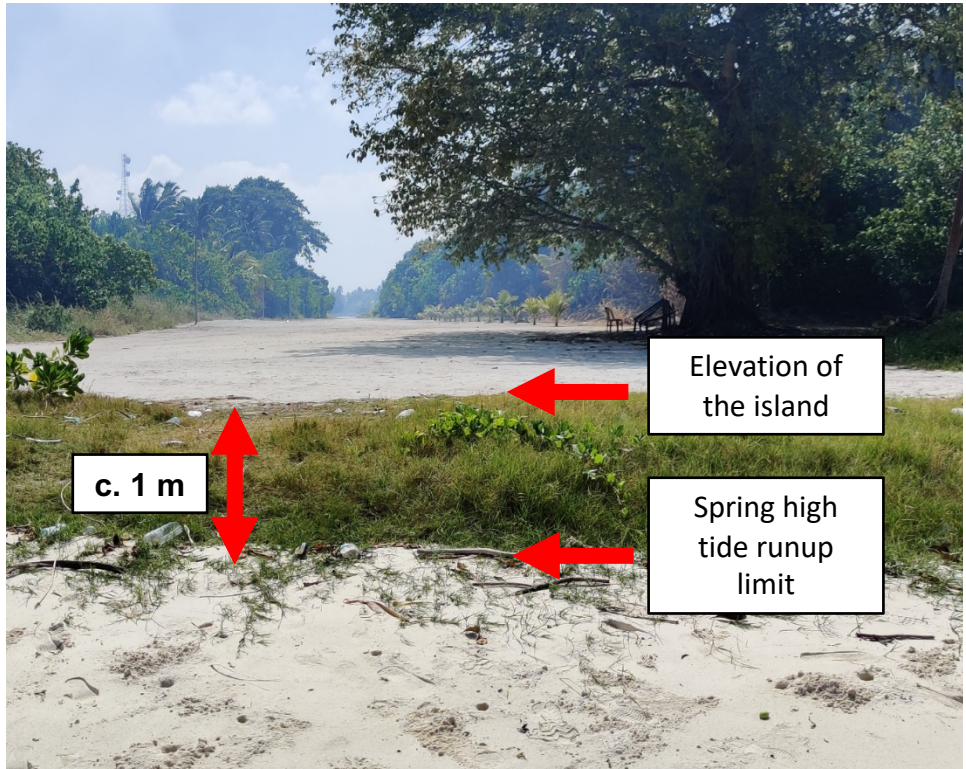
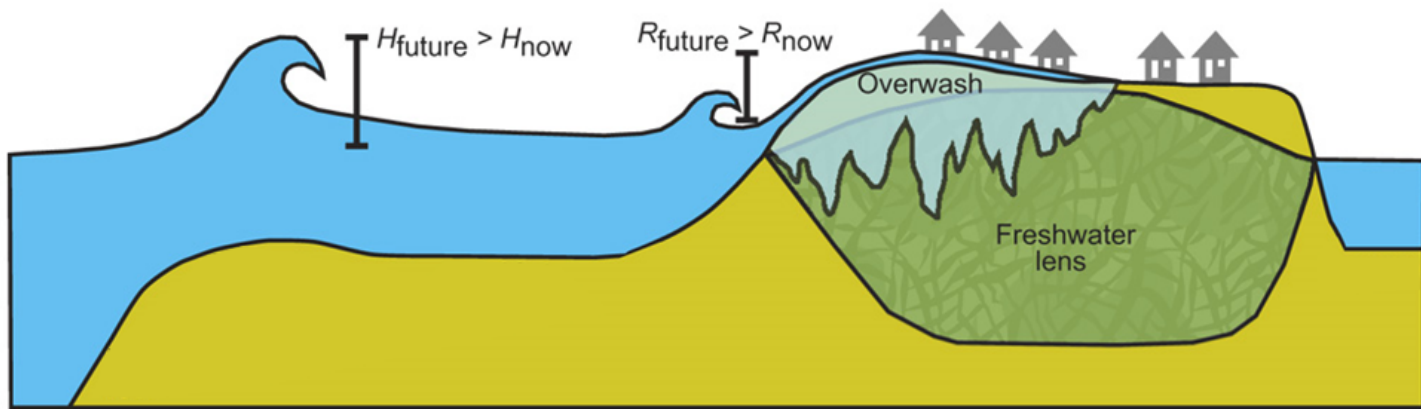
Atoll islands sit on top of a reef structure and are protected from the direct impact of storm waves by the reef platform



Increased flooding of low-lying atoll islands due to sea-level rise and potentially increased storminess



- = Atoll
- = Present sea level
- = Future elevated sea level



OCEANOGRAPHY

Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding

Curt D. Storlazzi,^{1*} Stephen B. Gingerich,² Ap van Dongeren,³ Olivia M. Cheriton,¹ Peter W. Swarzenski,⁴ Ellen Quataert,³ Clifford I. Voss,⁵ Donald W. Field,⁶ Hariharasubramanian Annamalai,⁷ Greg A. Piniak,⁶ Robert McCall³

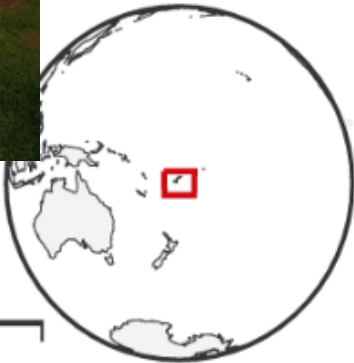
Pessimistic outlook offers limited adaptation solutions



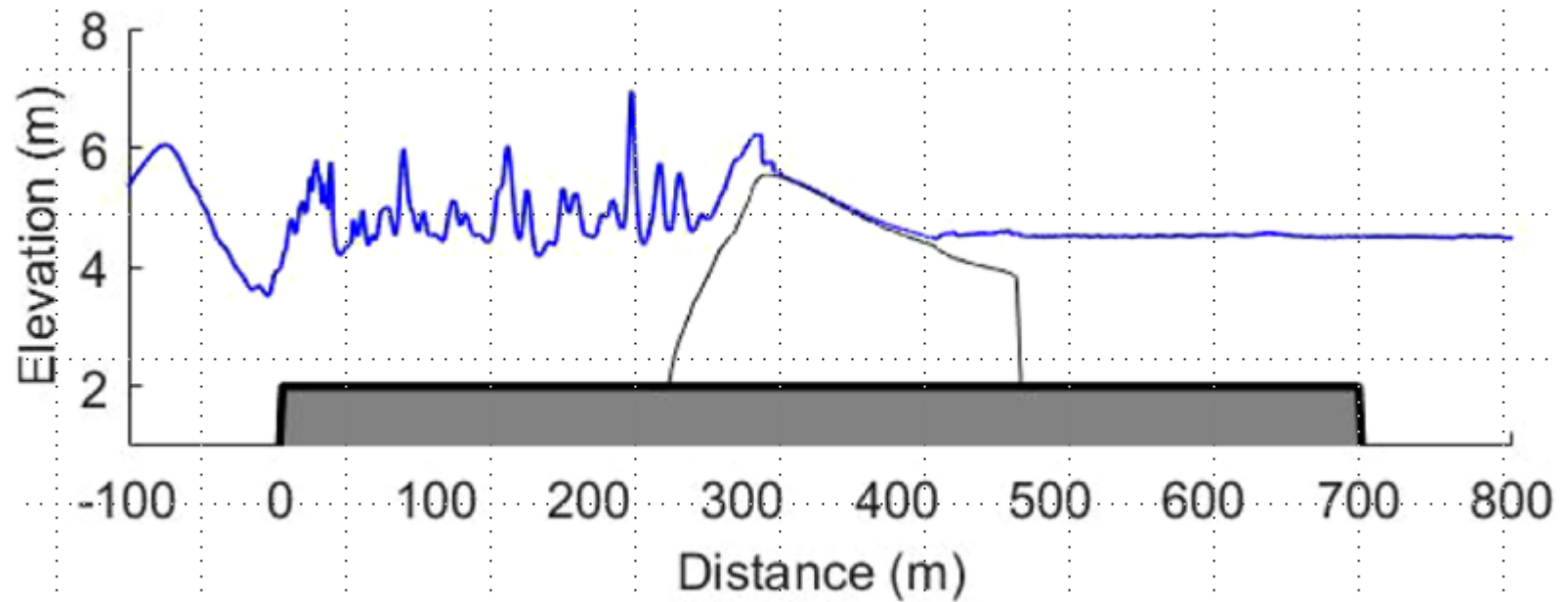
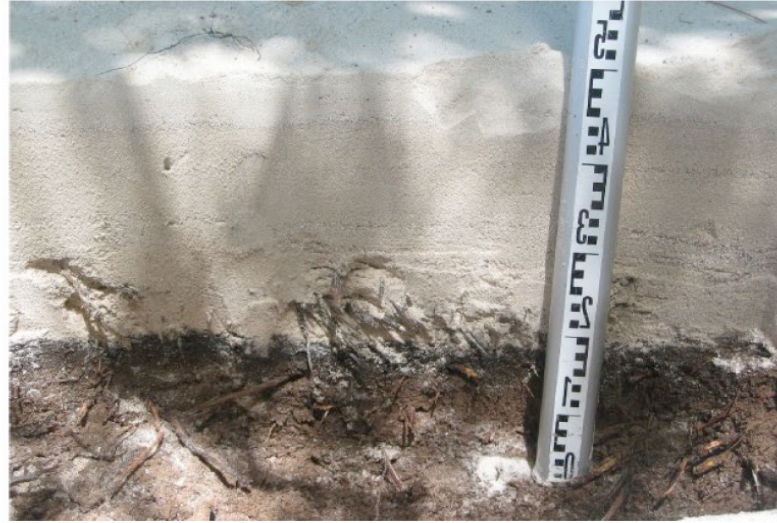
South Pacific



50 km
50 miles



Island overwash occurs under extreme wave conditions and high water level and transports sediment from coral reef system to top of the island.



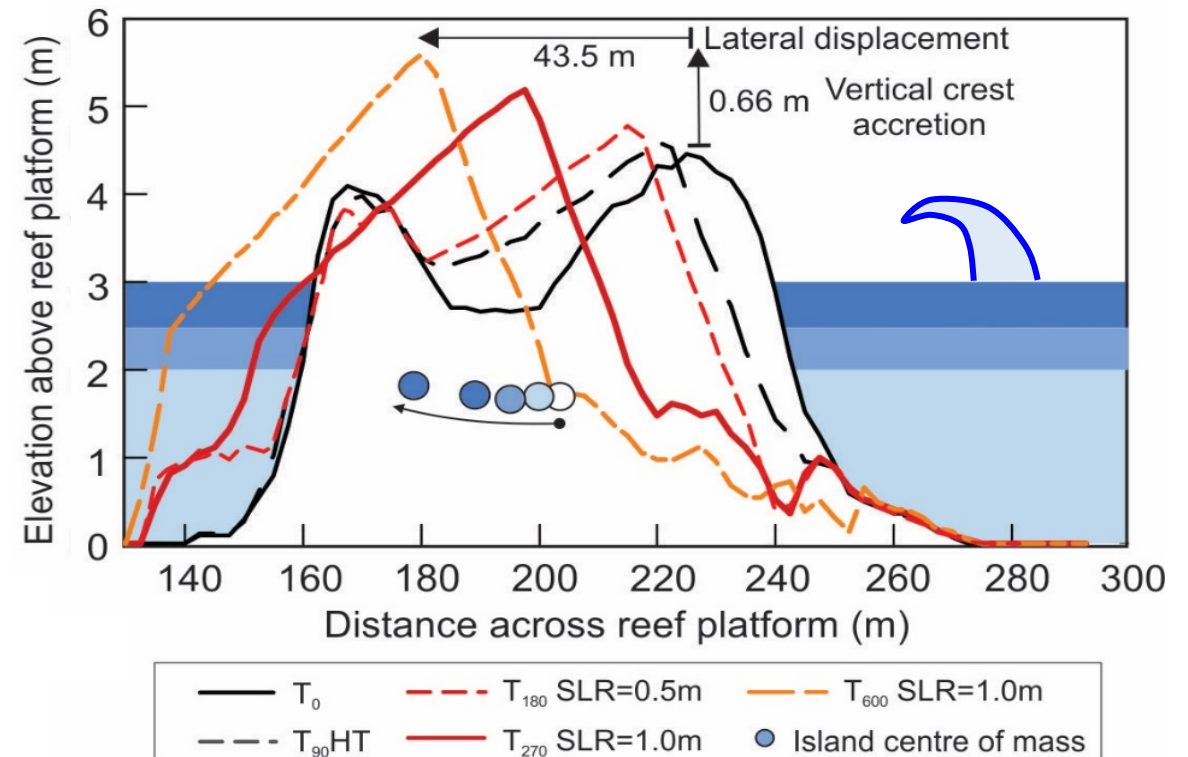
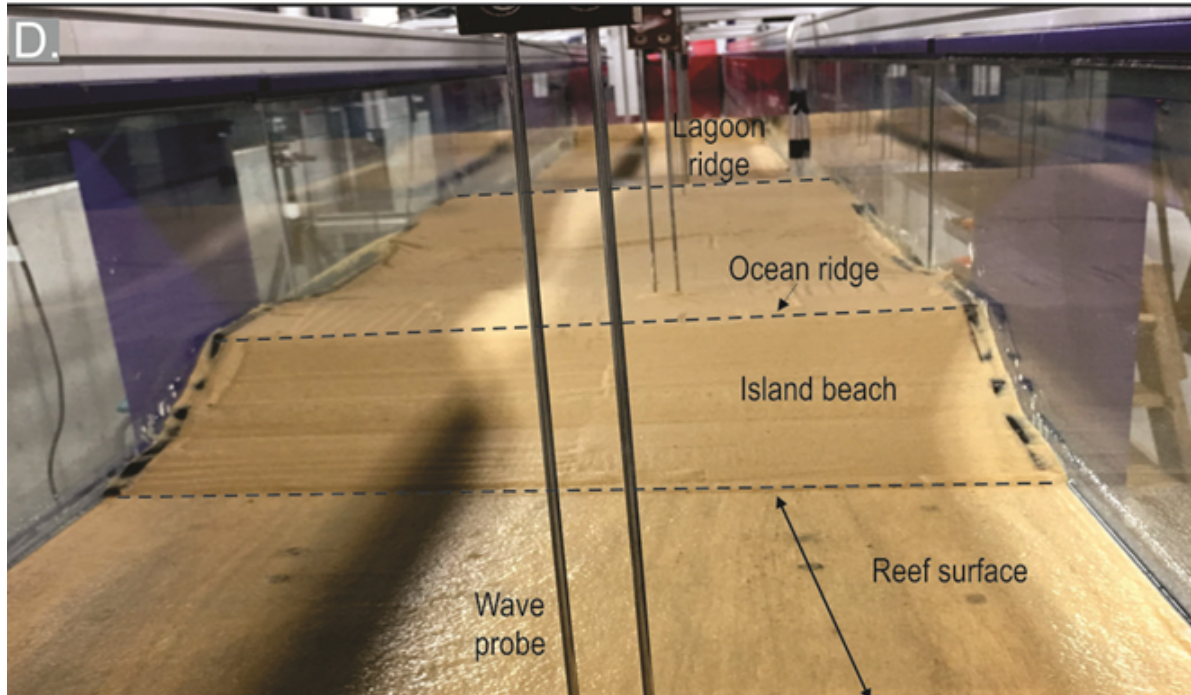
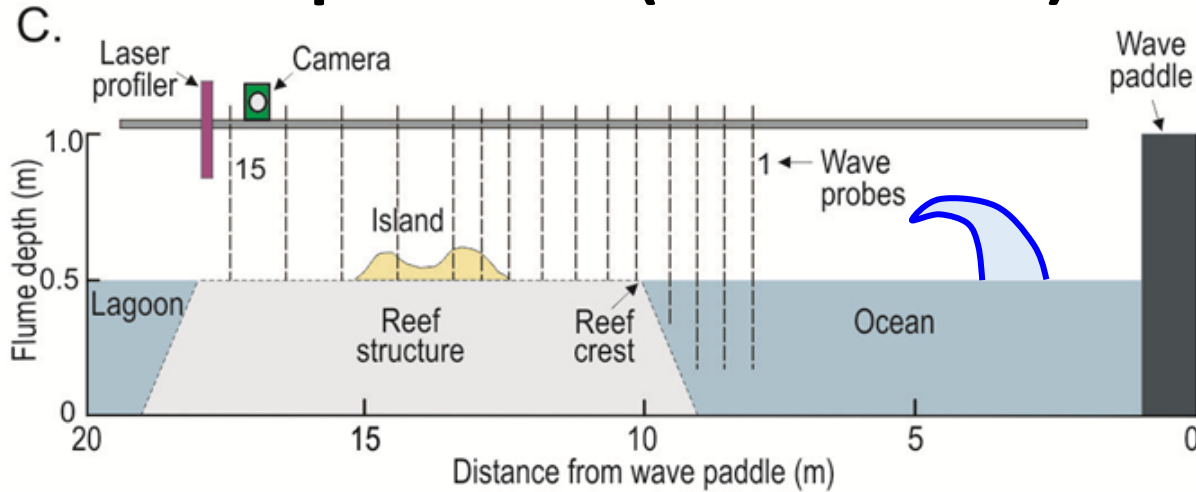
Footage of the 1 July 2023 flooding event that affected many of the islands on the SW rim of Huvadhoo atoll, Maldives



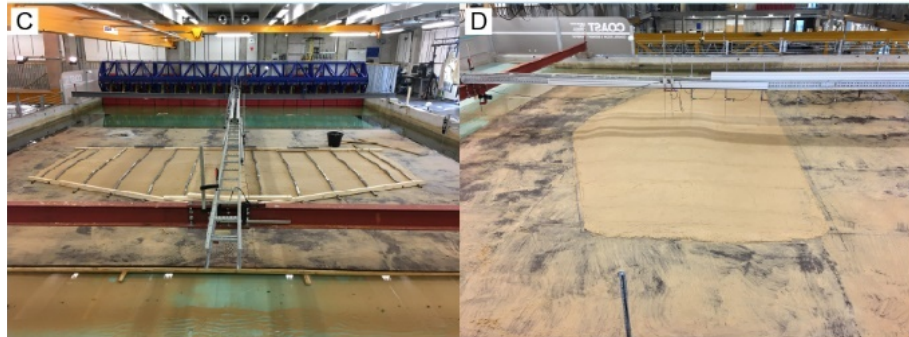
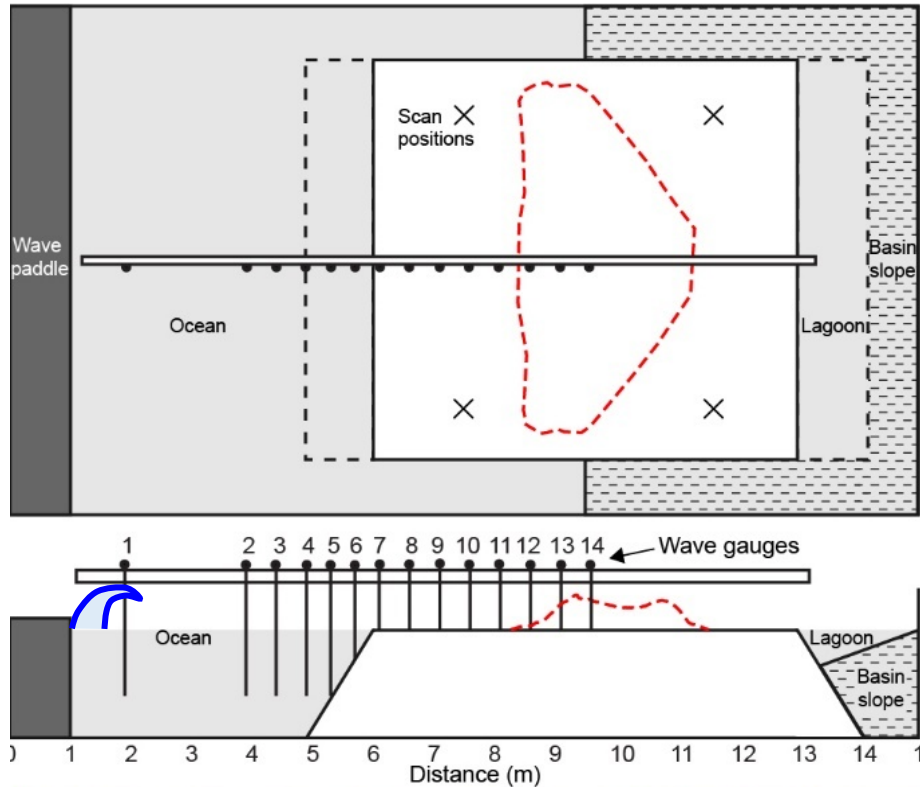
Photographs of the impacts of the 1 July 2023 flooding event that affected many of the islands on the SW rim of Huvadhoo atoll, Maldives



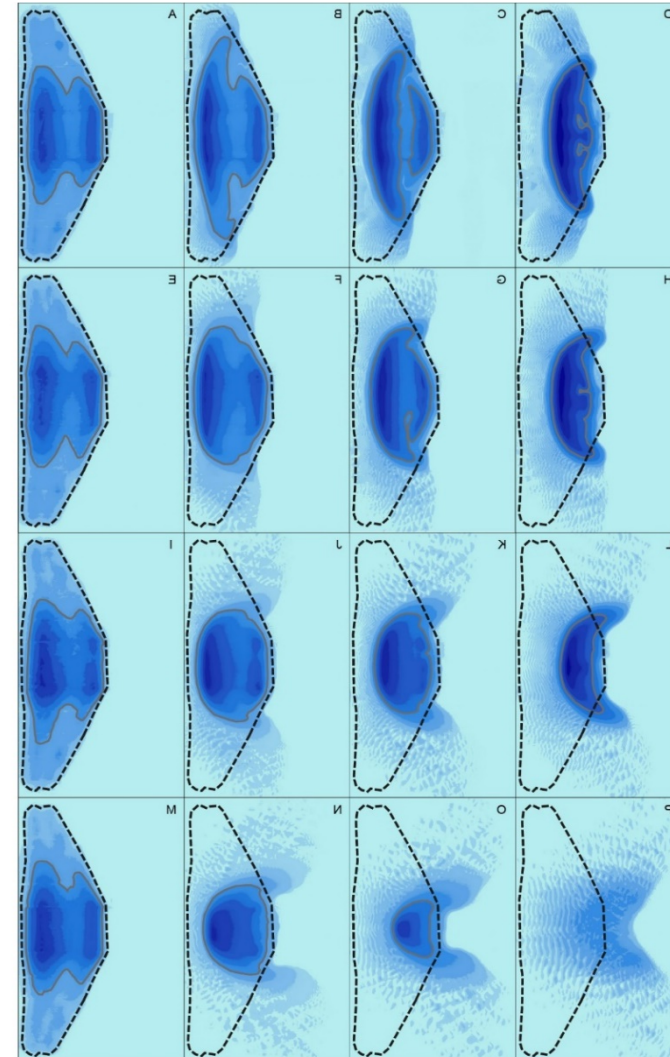
Modelling impact of sea-level rise on atoll island using 1:50 laboratory experiment (wave flume) shows islands can build vertically



Modelling impact of sea-level rise on atoll island using 1:50 laboratory experiment (wave basin) shows islands can build vertically

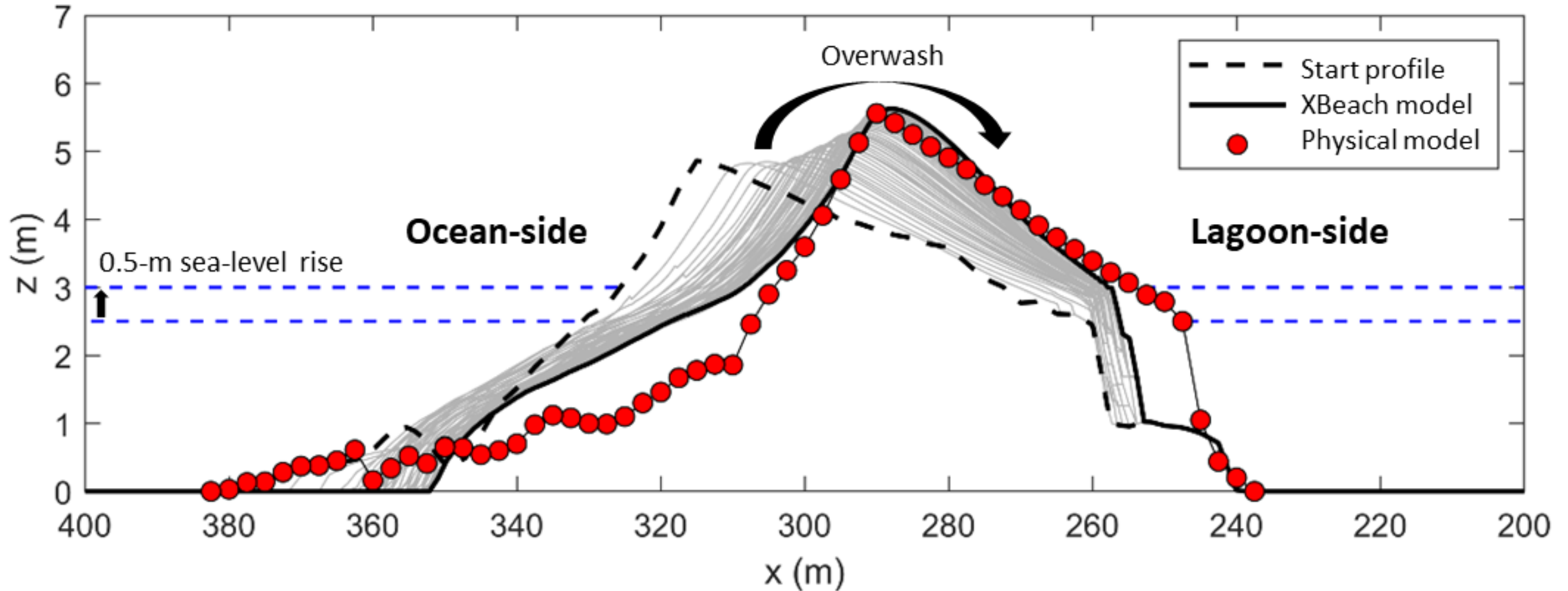


Sea-level rise to from 0 to 1 m

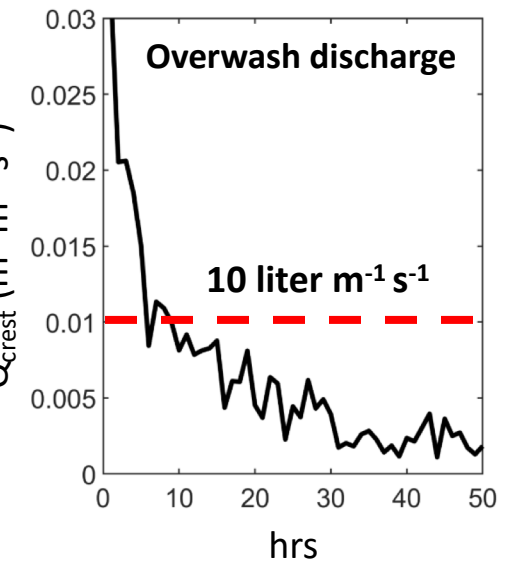
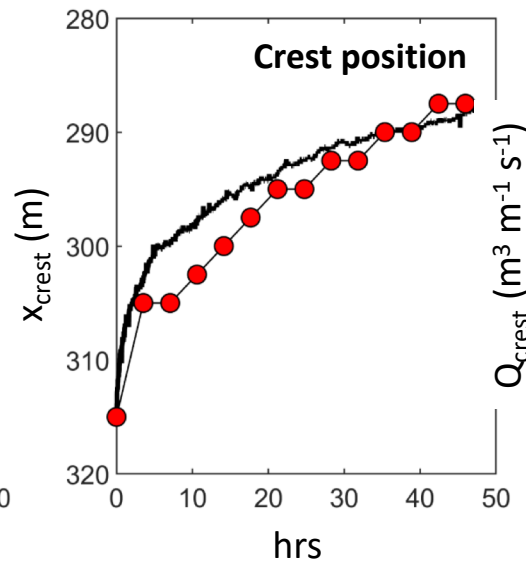
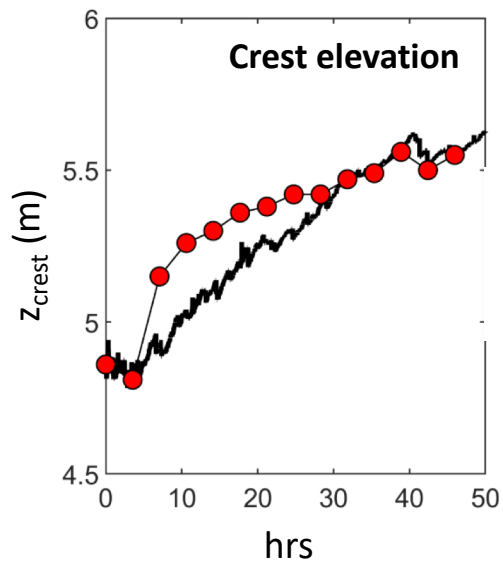
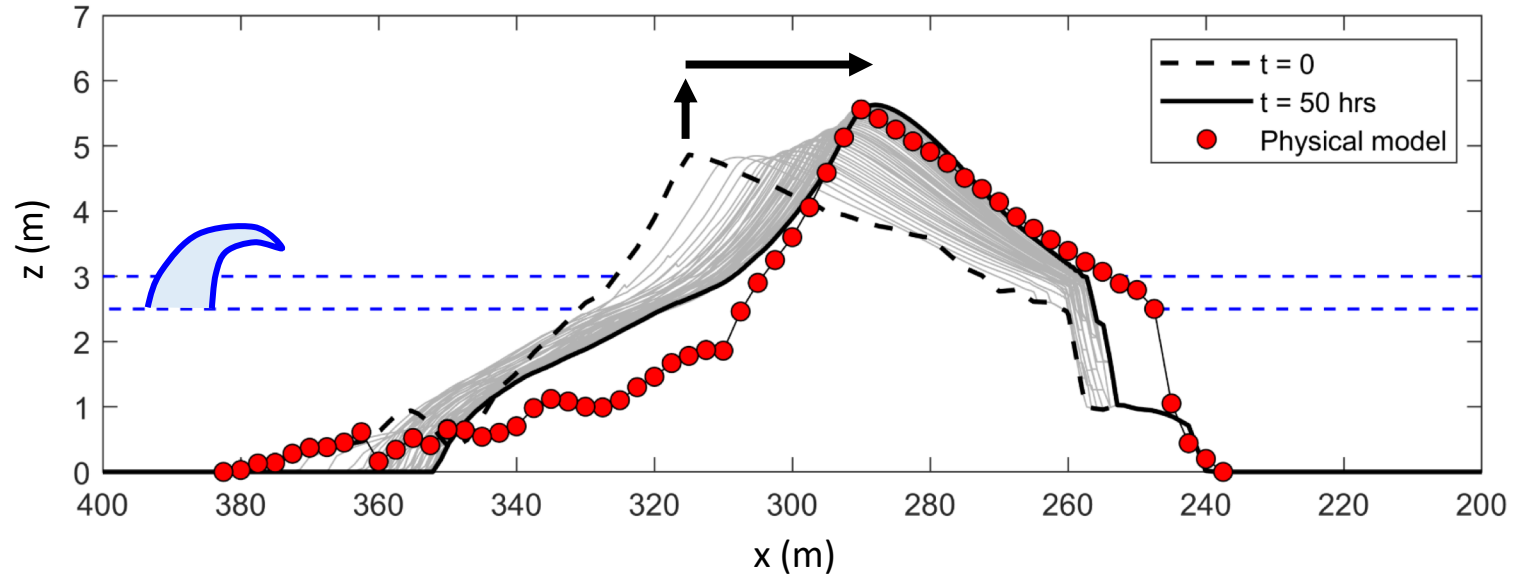


Increasing wave height from 2 to 5 m

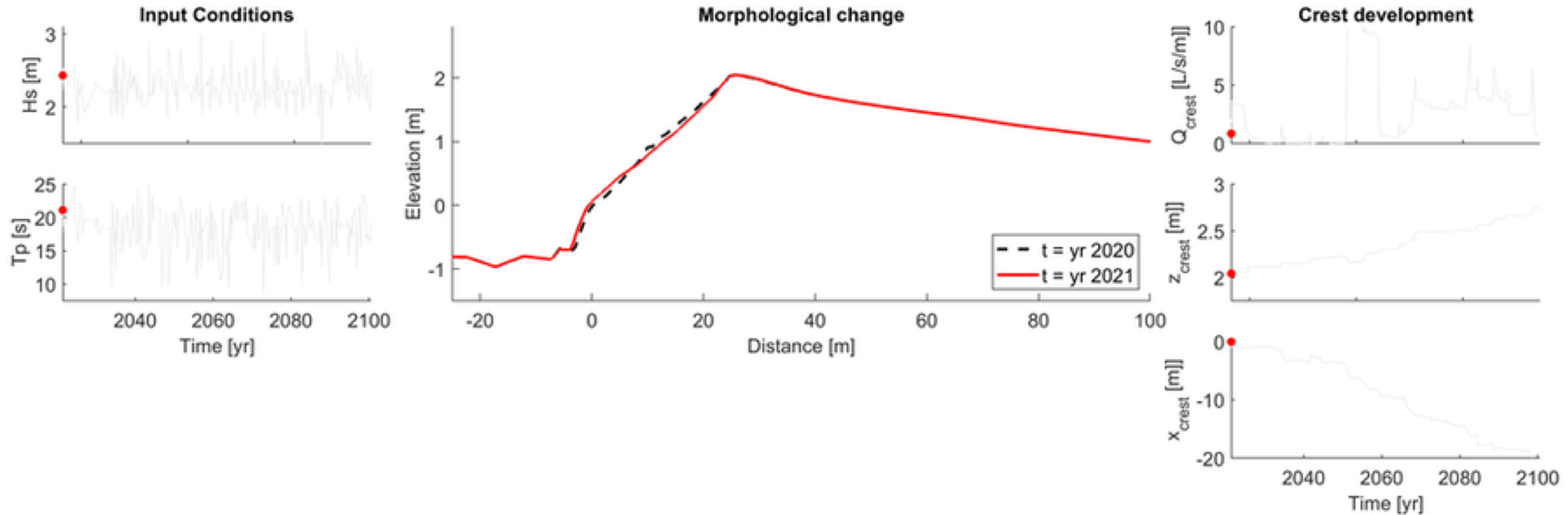
Process-based numerical model (XBeach) can reproduce the raising of the island elevation by overwash



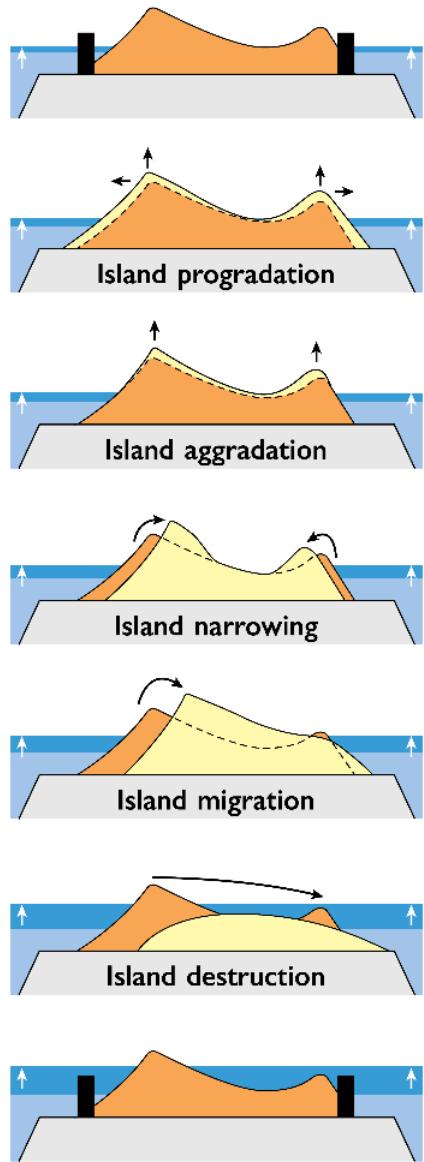
Process-based numerical model (XBeach) can reproduce the raising of the island elevation by overwash



XBeach modelling over 80 years with complete extreme wave and water level time series



Adaptation







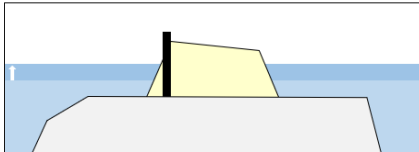
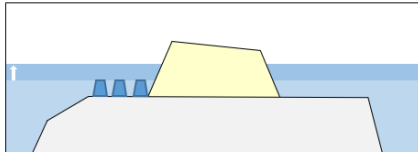
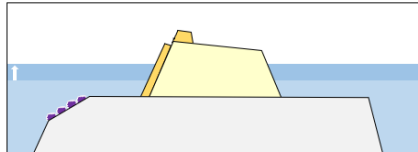
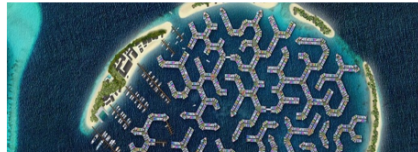
ALTERNATIVE ADAPTATION STRATEGIES

COASTAL DEFENCES

RELOCATION

- Initial morphology
- Altered morphology
- Reef platform
- Increment of sea-level rise
- Major direction of morphological adjustment

Building coastal defences and relocation are not the only adaptation options; acknowledging that the island responds morphologically opens up alternative adaptation strategies

Grey/hard	Hybrid	Green/soft	Other
<ul style="list-style-type: none"> Seawall Dike Land reclamation Groynes 	<ul style="list-style-type: none"> Artificial reef construction Seawall / revetment with transplants 	<ul style="list-style-type: none"> Coral reef restoration Beach nourishment Berm Top Barrier Raising island 	<ul style="list-style-type: none"> Relocation Elevate / flood proofing Floating houses Early warning system
			
			

Prevent flooding and island adjustment

Limit flooding but allows island adjustment; requires societal adaptation



Take-home message

- Forecasts of climate change impacts on atoll islands based solely on hydrodynamics represent the most pessimistic outcome
- Morphodynamic modelling should be used to predict future island habitability to help inform managing the impact of climate change

