

The Curious Undular Bore

Stuart Pearson¹ and Marion Tissier¹

¹Delft University of Technology

November 22, 2023

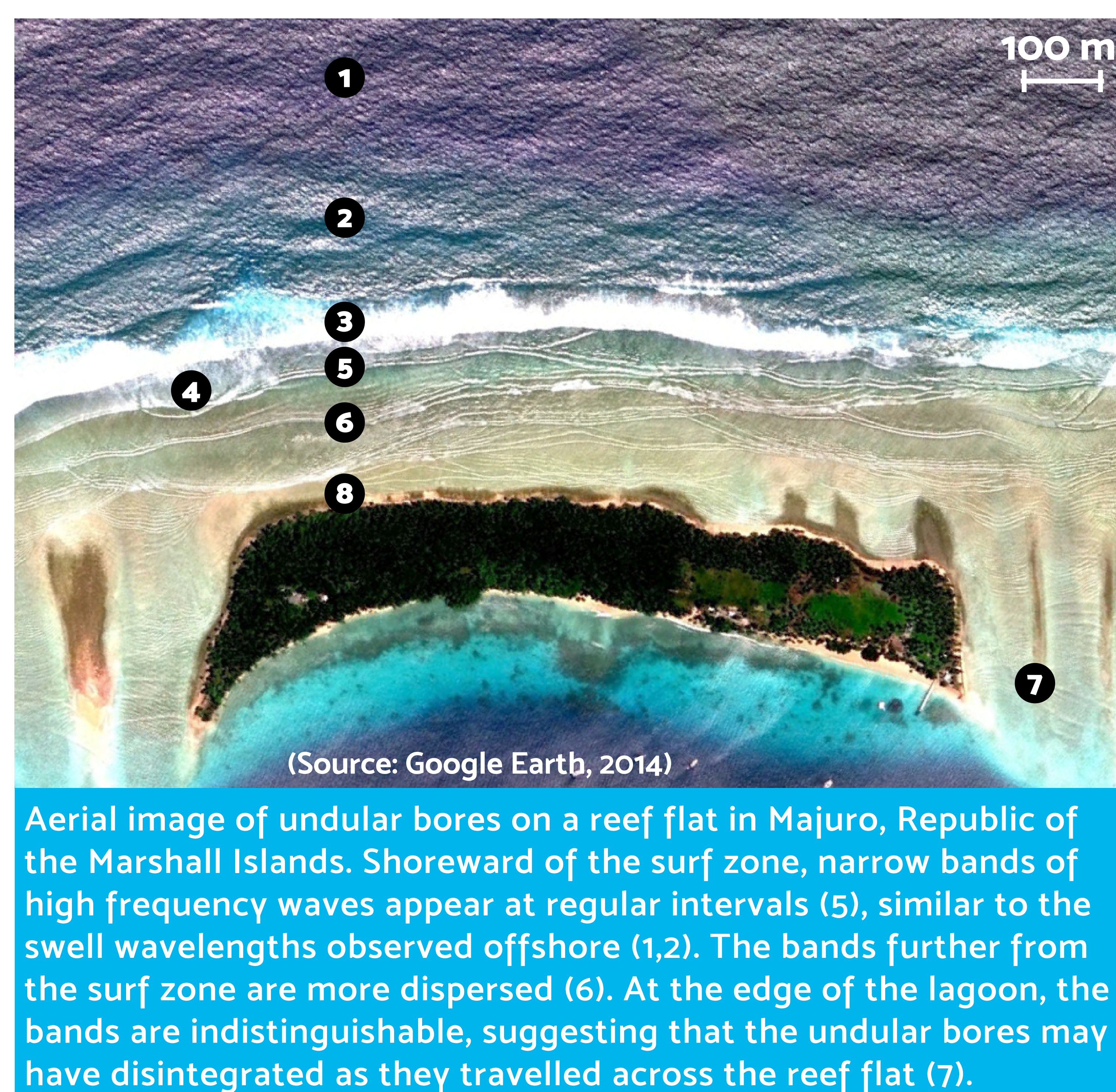
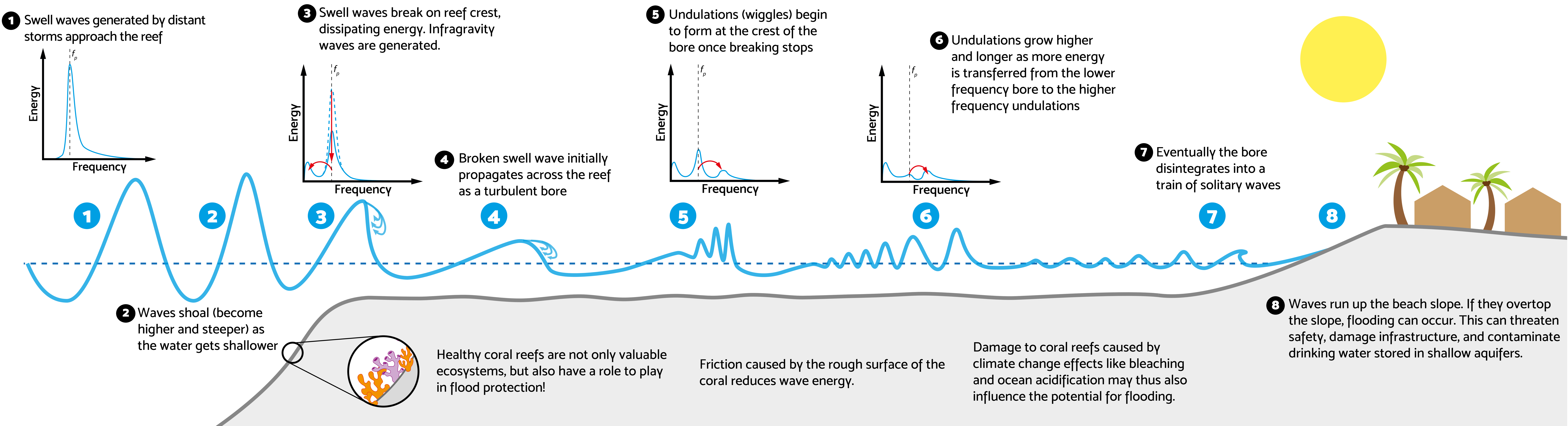
Abstract

The curious undular bore// Propagates onward to shore// The energy flies// From low freqs to high// Until the wavefront is no more

The Curious Undular Bore

Stuart G. Pearson^{1,2}, Marion Tissier¹

¹Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, Netherlands
²Department of Applied Morphodynamics, Unit of Marine and Coastal Systems, Deltares, Delft, Netherlands



The curious undular bore
 Propagates onward to shore
 The energy flies
 From low freqs to high
 Until the wavefront is no more

So What?

- Low-lying tropical islands with coral reef-lined coasts are highly vulnerable to the combined effects of sea level rise and wave-induced flooding (Storlazzi, 2018)
- To accurately predict wave-driven flooding, we need to understand how waves transform as they move across reefs and run up on beaches
- Undular bores are ubiquitous in field observations (Gallagher, 1972) and in numerical models of fringing coral reefs (Pearson, 2016), but their role in reef hydrodynamics has received limited attention
- Undulations increase the height of the wave front and modify the frequency distribution of the wave energy, which is likely to affect runup on the shore (and hence flooding)

What Next?

- Recent laboratory experiments and analysis (Dekkers, 2018; Tissier et al., 2018) suggest that infragravity waves can also transform into undular bores, but further investigation using field measurements is necessary
- These experiments will be extended to analyze the influence of large roughness elements (as typically found on coral reefs) on nonlinear wave transformation

References

- Dekkers, J. (2018). Experimental Study on Undular Bore Development Over a Fringing Reef. MSc Thesis. Delft University of Technology: Delft, the Netherlands. [\[Link\]](#)
- Gallagher, B. (1972). 'Some qualitative aspects of nonlinear wave radiation in a surf zone'. Geophysical Fluid Dynamics 3(1), 347-354. [\[Link\]](#)
- Pearson, S.G. (2016). Predicting Wave-Induced Flooding on Low-Lying Tropical Islands Using a Bayesian Network. MSc Thesis. Delft University of Technology: Delft, the Netherlands. [\[Link\]](#)
- Peregrine, D. H. (1966). 'Calculations of the development of an undular bore'. Journal of Fluid Mechanics 25, 321.
- Storlazzi, C. D., Geringer, S. B., van Dongeren, A., Cheriton, O. M., Swarzenski, P. W., Quataert, E., & McCall, R. (2018). Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding. Science Advances, 4(4). [\[Link\]](#)
- Tissier, M.F.S., Dekkers, J., Reniers, A.J.H.M., Pearson, S.G., van Dongeren, A.R. (2018). Undular Bore Development Over a Laboratory Fringing Reef [Oral Presentation]. 36th International Conference on Coastal Engineering 2018, Baltimore, MD, July 30-August 3, 2018. [\[Link\]](#)

