Atoll reef flat excavation pit influence on wave energy

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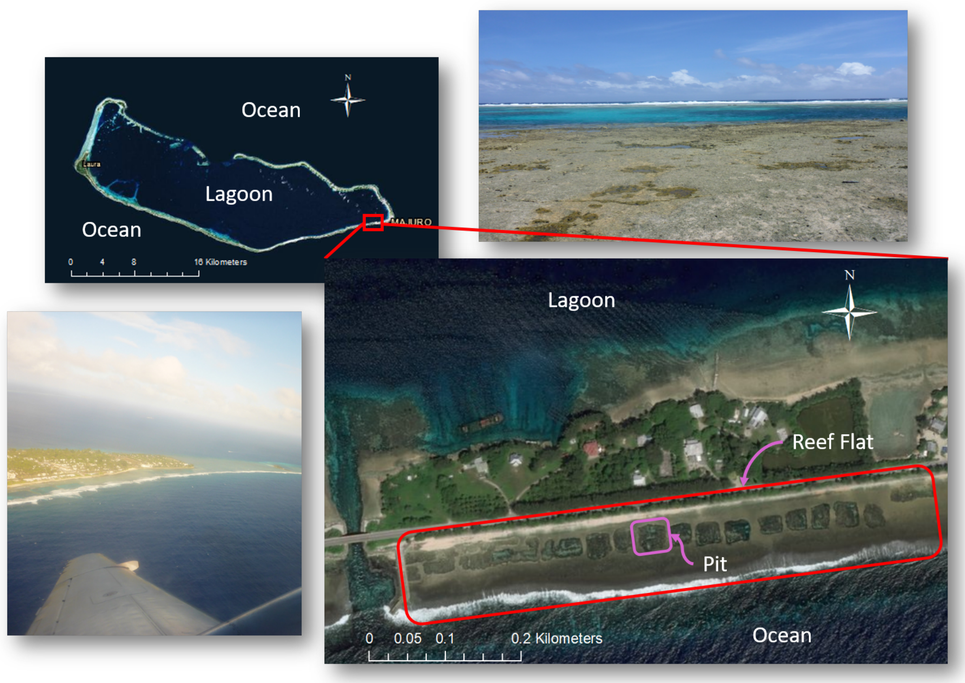
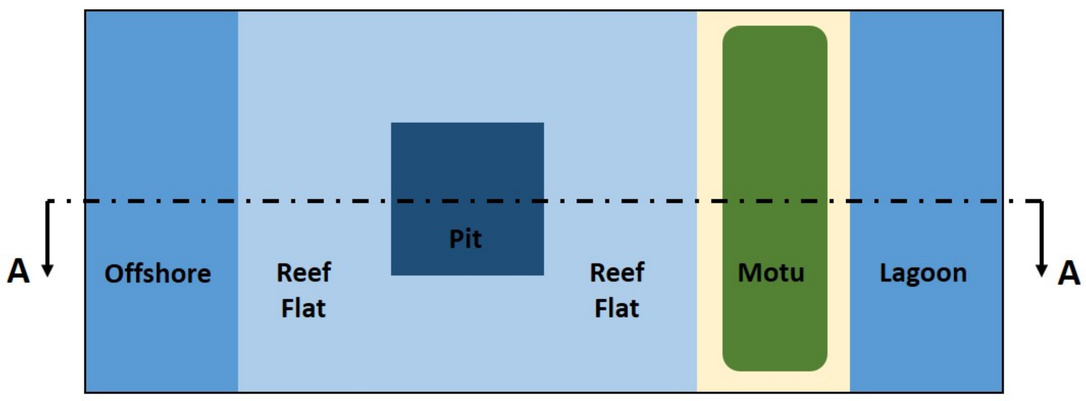
Motivation

The shorelines of atolls are often exposed to high energy wave climates that have the potential to wreak havoc on coastal structures. Luckily, a fringing reef flat serves as a natural defense by attenuating wave energy as the waves propagate over the reef. As human development increases on atolls, there is an increase in reef flat excavation for construction materials.



Methods



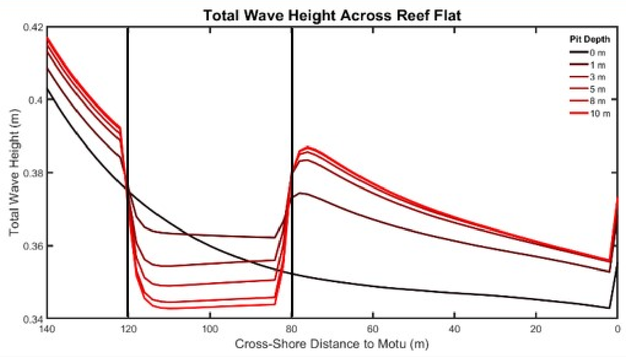
- The open-source numerical hydrodynamic model XBeach was used to assess the changes in wave energy reaching the sub-aerial reef island.
- Excavation pit size (40 m) and the reef flat width (200 m) were based on the average of ten locations in Majuro.

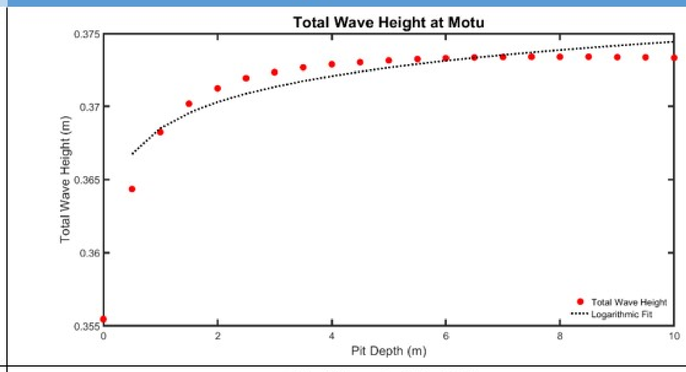
Results

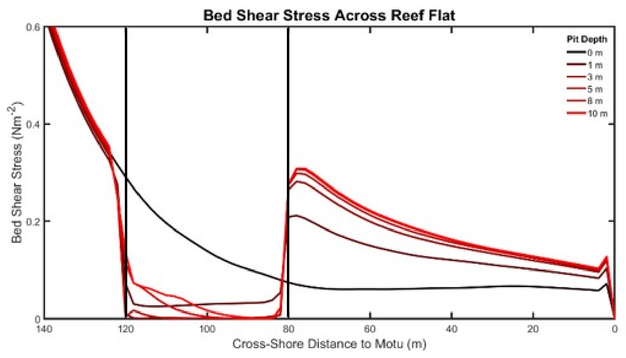
Height Across Reef Flat

Height at Motu

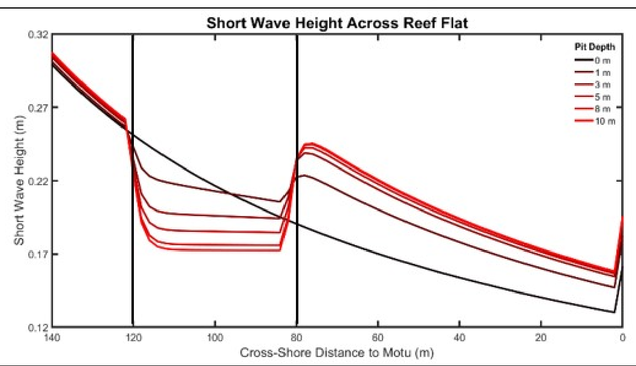
Total Height

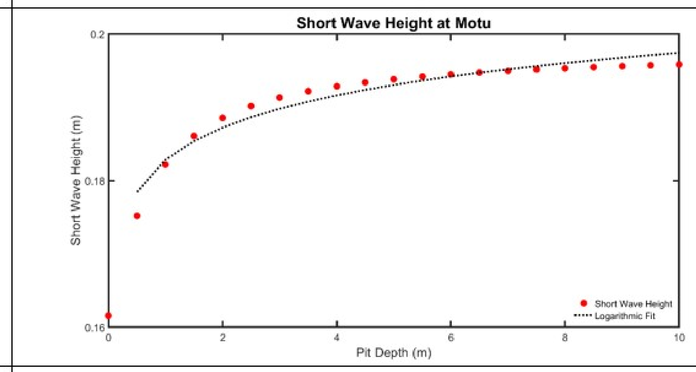




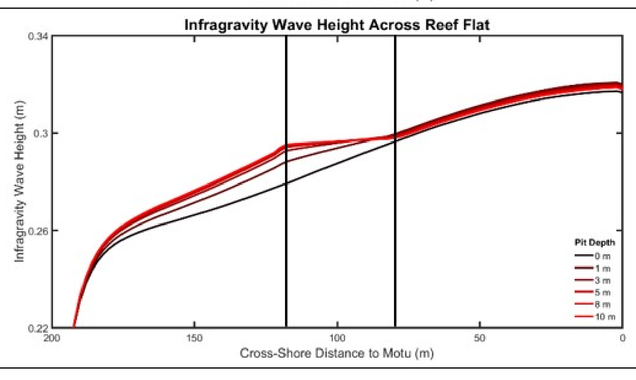


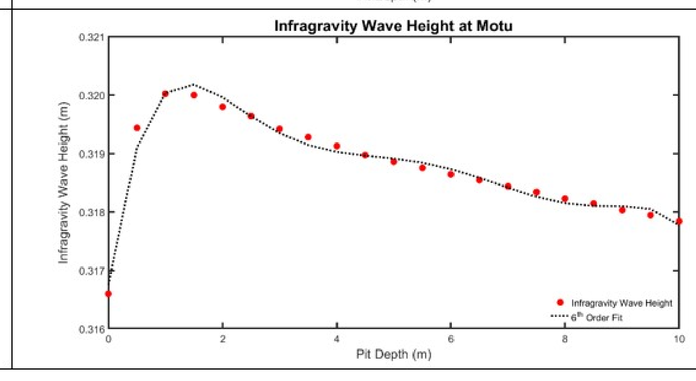
Short Waves





Infragravity Waves





Pit Depth (m)	H (m)	Hstdev (m)
0	0.150	0.020
1	0.172	0.022
2	0.180	0.024
3	0.185	0.024
4	0.188	0.025
5	0.191	0.025
6	0.192	0.026
7	0.194	0.026
8	0.195	0.026
9	0.196	0.026
10	0.196	0.026

Conclusion

- This study analyzes the effects of ocean-side atoll excavation pits on wave height.
- The presence of an excavation pit and its depth both increase the wave height reaching the sub-aerial reef island.
- With larger waves and more energy reaching land, more erosion will likely take place and infrastructure vulnerability will increase.

Future Work

- Run the model with morphodynamics turned on, allowing erosion and deposition to take place.
- Adjust parameters such as the open water wave height and coefficient of friction.
- Test extreme events such as cyclones and tsunamis.

References

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