BERM MIGRATION UNDER SCALED STORM EVENTS

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BACKGROUND

Coastal regions are highly susceptible to erosion because of continuous exposure to waves and human interference. Coastal erosion will escalate due to increasing severity of storms and sea level rise. Consequently, infrastructure and populations near coastal regions will experience increased flooding as natural beach defenses are eroded away. Predicting how geomorphological features such as berms migrate is important to understand erosion processes.

Berms are one of the natural barriers protecting beaches from wave action and are the first intermittently exposed coastal feature to experience hydrodynamic forcing. Berms erode when storm activity mobilizes sediment offshore or carries it onshore through overwash. However, berm response under varied storm conditions requires further study.

Pore water pressure response has been shown to potentially impact beach erosion (Stark, 2022). The infiltration from wave runup followed by exfiltration from rundown destabilize the sediment bed resulting in particle motion. Wave runup increases bed shear stress (Sumer, 2011), and horizontal pressure gradients have been shown to mobilize sediment in the surf zone (e.g. Anderson, 2017). Erosion occurs from numerous physical processes acting together to mobilize the sediment. This study aims to identify these physical processes and berm response for variety of scaled storm sequences.

LARGE SCALE EXPERIMENT

A large-scale study will be conducted in the summer 2022 to simulate storm conditions to quantify the motion and burial of unexploded ordnance (UXO) in the nearshore. The study will take place in the large-scale wave flume at the Institut National de la Recherche Scientifique (INRS) in Quebec City, Canada. In addition to measurements of UXO mobility and burial, the hydrodynamics and morphodynamic changes to the beach profile in response to conditions of varying temporal increases in wave height will be quantified. Measurements will be taken with the use of in situ sensors, subaerial (Lidar) laser scanners, and video imagery (Figure 1).

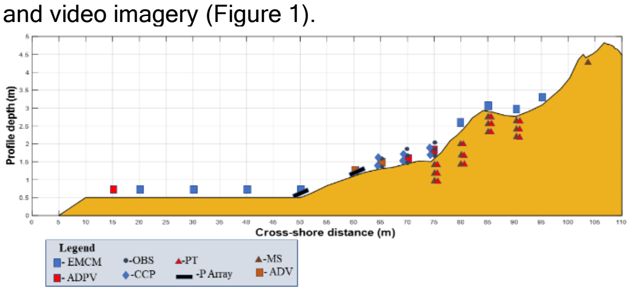

Figure 1 - Cross-shore profile of flume with the location of sensors to be deployed

A coupled berm-dune profile from Mantoloking Beach, New Jersey, USA and wave events from Hurricane Sandy will be scaled for the study to replicate the beach profile and storm conditions, respectively (Figure 2).

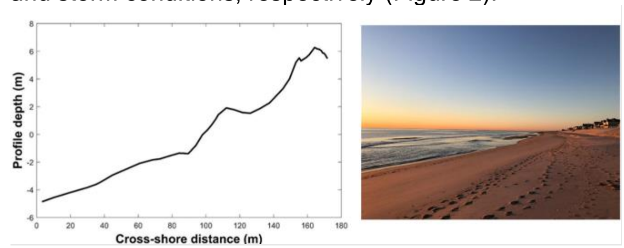

Figure 2 - Pre-storm beach profile from Mantoloking, NJ, USA (left) and picture of the beach (right; https://www.mantoloking.org/).

Total erosion and deposition will be quantified along the profile sonar scanners, subaerial Lidar scanner, and real time kinematic global positioning systems (GPS). Video measurements using Allied Vision Technologies (AVT) imagers will be collected during testing. Wave runup will be calculated from the video measurements. Pore pressure will be quantified using pressure transducers in the bed. Physical forcings will be examined through horizontal and vertical pressure sensor arrays and Acoustic Doppler Profiling Vectrinos (ADPV) along the profile.

EXPECTED RESULTS

Initial XBeach simulations for the large-scale experiment indicate that the berm and dune will erode and create a sand bar under the storm conditions simulated (Figure 3).

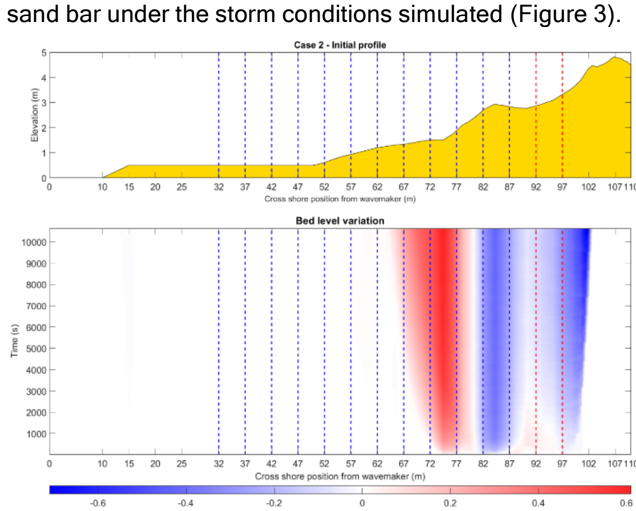

Figure 3 - Net change in bed level for Case 2 with significant

wave height = 1.1 m, wave period = 7.1 s, and water depth = 2.87 m

Sediment erosion as a function of wave runup and physical processes will be analyzed. Wave runup (Figure 4), pressure gradients, and velocity profile will be compared with the locations of sediment erosion and deposition to establish relationship between these processes and sediment transport. The data is expected to provide insights into the factors affecting the migration of berms under extreme forcings.

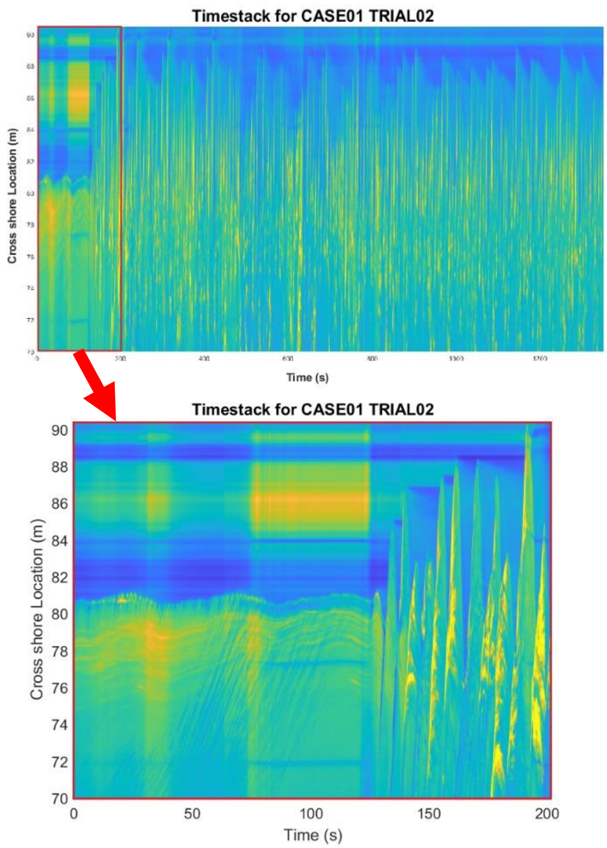

Figure 4 – Timestack of wave runup for one trial (top) and timestack of wave runup for first 200 seconds of the same trial (bottom)

REFERENCES

Anderson, et al. (2017): *Observations of wave-induced pore pressure gradients and bed level response on a surf zone sandbar,* Journal of Geophysical Research, AMERICAN GEOPHYSICAL UNION, vol 122, pg. 5169- 5193.

Stark, et al. (2022): *Vertical pore pressure variations and geotechnical sediment properties at a sandy beach*, Coastal Engineering, ELSEVIER, vol. 172, article 104058

Sumer, et al. (2011): *Flow and sediment transport induced by a plunging solitary wave*, Journal of Geophysical Research, AMERICAN GEOPHYSICAL UNION vol. 116, C01008.