LIFE-CYCLE ANALYSES OF SUBAERIAL BEACH NOURISHMENTS WITH CONCURRENT NEARSHORE PLACEMENT OF DREDGED SEDIMENT

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The practice of placing sediment dredged from navigation channels in the downdrift nearshore is common in the US. These nearshore placements of dredged sediment, or nearshore nourishments, often correspond to a variety of positive nearshore morphology and shoreline stability benefits. They are often able to beneficially use sediment not directly suitable for dry beach placement, which increases the volume available to nourish the full beach profile and keeps sediment in the system that would otherwise be removed. Concentrating dredged sediment placement in nearshore berms may dissipate wave energy farther offshore and reduce the sediment needs of the co-located shoreline. This strategy may be able to extend subaerial beach nourishment lifespan, which typically cost substantially more. Co-located nearshore and subaerial beach nourishments could lead to large cost savings, but the potential to increase subaerial beach fill lifespan has not previously been quantified.

StormSim LCS-Beach (Melby et al. 2021) provides a unique opportunity to incorporate the impacts of nearshore nourishment in beach nourishment life-cycle analyses. StormSim LCS-Beach simulates cross-shore hydrodynamics and morphological change by embedding the one-dimensional cross-shore model CSHORE (Johnson et al. 2012) in Monte Carlo life-cycle simulations. This enables computationally efficient life-cycle predictions that are based on nearshore bathymetry and the cumulative impacts of morphological changes associated with each event in a statistically robust storm selection. In Melby et al. (2021) beach nourishment lifespan along Galveston Island, TX, was determined by simulating the morphological change of representative cross-shore transects during storms until the dune height eroded to half of the initial value. Representative cross-sections were eroded and rebuilt over 50 years in 30 lifecycle simulations to achieve statistically stable results. This methodology is modified here to include annual additions of dredged sediment into the nearshore (Figure 1). The subaerial beach nourishment lifespans for simulations representing the southern end of Galveston Island are compared with and without nearshore placement. Initial results indicated that only including cross-shore sediment transport may under-represent the benefits that have coincided with many of the real-world examples. Two-dimensional processes are an important element of the morphological changes observed at nearshore nourishments (van Duin et al. 2005), so the methodology was further modified to incorporate a simplified representation of alongshore sediment transport gradients. Waves that break over the nearshore berm generate a zone of reduced alongshore sediment transport in the lee of the placement, potentially trapping updrift sediment.

Results of this study indicate that alongshore transport gradients may be a critical element of the accretion associated with many nearshore placements of sediment. A simplified representation of these alongshore transport gradients may provide a powerful tool for life-cycle analyses where two-dimensional models are not feasible, but both cross-shore and alongshore processes play important roles.

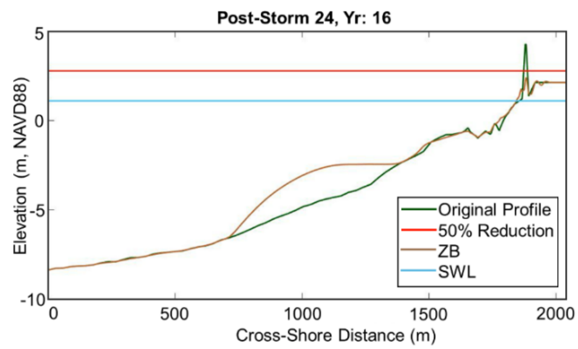

Figure 1 – Example of profile morphology (ZB) after the 16th storm (with still water level SWL), with 2184 m^3/m of sediment added to the nearshore. Dune erosion has exceeded the limit (50% reduction) and the beach will be rebuilt before the next storm.

REFERENCES

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