Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2020-79-RC2, 2020

Earth Surface Dynamics Discussions

Interactive comment on "The Influence of Dune Aspect Ratio, Beach Width and Storm Characteristics on Dune Erosion for Managed and Unmanaged Beaches" *by* Michael Itzkin et al.

Anonymous Referee #2

Received and published: 18 December 2020

The Influence of Dune Aspect Ratio, Beach Width and Storm Characteristics on Dune Erosion for Managed and Unmanaged Beaches By: Michael Itzkin et al.

Submitted to Earth Surface Dynamics

Overview: This paper presents new XBeach modelling to examine the impacts of dune aspect ratio and beach width on the modelled erosion volumes for a set of different storms (including varying duration and surge levels). The three main objectives of the paper were: (1) How does storm duration affect volumetric dune erosion as a function of foredune aspect ratio? (2) How do variations in storm TWL affect volumetric dune erosion as a function of foredune aspect ratio? (3) How does the morphology of the

beach (i.e., width and slope) affect volumetric dune erosion independent of foredune aspect ratio.

Overall, I found the paper well written and quite succinct. From a point of view on was there a substantial increase in our fundamental understanding into dune erosion, I was less convinced. Not much in the paper surprised me or told me something I didn't know, but more reaffirmed my understanding/observations/past work. That's not to say that more couldn't be presented to improve the paper and provide further understanding that I think is unique to modelling work as you have high resolution results that you can interrogate more than you have presented here. By presenting more and digging more into the results I think you could better answer your three objectives above.

For example: Your dune profiles were very different and in XBeach, erosion occurs if a cell is determined to have been 'wet' so since your higher aspect ratio dunes had more sand closer to the dune toe, they would expect to have more erosion volumes by the nature of the model and not necessarily by a physical meaning. XBeach dune erosion is purely ad-hoc. If a cell is wet, it compares it to your wet slope and erodes it if it's above this critical value. Realignment can also take place if dryslp is exceeded. None of this is really based on physics of dune erosion. Dunes hold much larger scarps under active erosion (See Palmsten and Holman paper for examples but many others as well including work by Erikson and Hanson -> dune notching paper , Larson Erikson and Hanson (2004) and all the work on dune impact models (Overton et al) all show this). The sand is typically (from my experience using XBeach) also immediately moved offshore (to keep the wetslp low) so the feedback mechanisms we'd see in real erosion are not there where slumped sand protects the dune toe. The model has limitations and I can accept those but I think you need to acknowledge them a bit more here and realize what we can (and cannot) learn from these results.

Consider the very different dune aspect ratios you are considering and the distribution of sand in the cross-shore, it would be good to see dune toe recession presented as well as you refer to volumes (which I also think are needed) but when you align toe,

heal, center, and with each of the aspect ratios you change the distribution of the volume in the dune. So small events will erode a lot when the toe is aligned because there is a lot of sand up close, but dx (dune toe erosion) might be similar and this is a key variable of interest to engineers/managers. The model is a grid so you are 'eating away' at the dune 1 grid point at a time as a function of the predicted TWL. Default dry slopes in XBeach are also quite flat compared to what would be capable in active dune erosion (see for example lab studies of Palmsten and Holman 2012, https://www.sciencedirect.com/science/article/pii/S0378383911001633; Palmsten and Holman 2011, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011JC007083; Palmsten and Splinter 2016, https://www.sciencedirect.com/science/article/pii/S0378383916(- this latter one explicitly looked at XBeach and my memory is that to match the lab data they used dryslp almost 4x the default value to allow for near vertical scarping)

Can you also answer your objectives in terms of dune toe recession (as well as volume) to get a deeper understanding/picture of how dune aspect ratio effects overall erosion. One would expect that perhaps that higher aspect ratios might also have less dune toe recession as more sand is dumped onto the beach and may offer protection.

I would also like to see plots of beach width change over the storm. This is something you say is quite important to your results – wider beaches offer more protection. Something that other researchers have also shown to be quite important (eg. Plant and Stockdon, 2012. Probabilistic prediction of barrier-island response to hurricanes https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011JF002326; Beuzen et al. 2019. Controls of Variability in Berm and Dune Storm Erosion https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019JF005184) Beach width (or safe corridor width) is also a key parameter that engineers/managers are wanting. How does your beach width over a storm impact on the erosion – does it need to be completely removed or only a certain percent for the dunes are vulnerable.

I think if you could present your results looking at multiple parameters (volume, dune to retreat, beach width change, dune impact hours) then the reader would get a

much richer understanding of the impacts these changes to dune aspect ratio/beach width/storm duration had on the study. Volumes themselves only tell a small part of the story.

Other Scientific Aspects to be considered: L35: "Considering that wave runup is most likely to impact the dune face (i.e., collision; Sallenger, 2000)âĂŤwhich is more likely to affect the width of the dune rather than the heightâĂŤis the most temporally common impact regime during a storm (Brodie et al., 2019; Stockdon et al., 2007), the width of the dune is an important predictor of how much erosion a dune might experience during a storm." I find this sentence really hard to read. Consider revising. As well, width won't be a predictor so much of the amount of erosion I would think, but of the erosive vulnerability of the dune itself. This paper might be of interest to you as it looks at both dune characteristics (height/width) and beach width in terms of erosion and flooding risks in storms: Leaman et al. (preprint, under review in Coastal Eng). A Storm Hazard Matrix combining coastal flooding and beach erosion. https://eartharxiv.org/repository/view/1753/

L171: I am a bit concerned about leaving all other XBeach parameters as default as many studies have shown this isn't appropriate outside of the highly dissipative beaches for which the model was originally designed (along the Dutch coast). Leaving all other parameters as default has implications between overwash and collision regime erosion estimates as noted by previous researchers such as Passeri et al. and Simmons et al.. Not accounting for these processes will impact on your results. Why weren't these considered?, even is the cases were limited where overwash did occur? Others have also shown sensitivity of the erosion to parameters. Eg references below (note this isn't a complete list, just ones I could think of off-hand). Passeri et al. The influence of bed friction variability due to land cover on storm-driven barrier island morphodynamics https://www.sciencedirect.com/science/article/pii/S0378383917301114 Simmons et al. Calibrating and assessing uncertainty in coastal numerical models https://www.sciencedirect.com/science/article/pii/S037838391630234#f0030

Splinter and Palmsten. Modeling dune response to an East Coast Low https://www.sciencedirect.com/science/article/pii/S0025322712002034

L183: “or when dunes are located closer to the shoreline (represented by the dune toes-aligned scenarios; Figure 7).” I am a bit confused by this as the effect of beach width would be shown not when the dune toes were aligned (and all beaches had the same beach width) but instead when the dunes were aligned at their crest or heel, which then changes their beach width. Ideally you should be comparing the cases for the same dune aspect ratio at these three positions to determine if effect of beach width. And this is repeated for each of the dune aspect ratios. This would be an interesting thing to see in my opinion (same dune aspect ratio plotted for the 3 positions within your dune toe, heal, crest align) to see how BW effects erosion for the same dune.

Wider beaches offer a big buffer of sand that must be eroded before the wave action can get to the dune and frictional damping of the runup would also occur, lessening the probability of a dune experiencing wave impacts. Looking at dune impact hours could be interesting and provide some good insight here.

L185: “situated farther from the shoreline (dune heels-aligned)” as above, I don’t see how having the dune heels aligned also indicates they are further from the shorelines as each of these cases would have a different beach width.

L241: “Additionally, the sensitivity of the dune to decreases in storm duration was inversely proportional to the beach width such that dunes fronted by wide beaches were noticeably less sensitive to increases in storm duration than dunes fronted by narrow beaches (Figure 9).” – It would be great to see figures that show beach width change over the storm.

Specific Minor Editorial Comments: L75: ‘aspect ratio’ is repeated twice

L91: replace ‘Dtoe’ with ‘Dlow’ to match figure 1 and to remove confusion as I believe

that Dlow=Dtoe.

L95: “Given that Dlow was held constant across all simulations” I think should be “Given that prestorm Dlow was held constant across all simulations”.

L147: remove ‘.’ in ‘approximately.’

Overall, I think the paper could be improved to provide a fuller understanding of the complexities of dune erosion and how dune aspect ratio, beach width and storm duration/intensity impact on the model results. I have provided a number of example references to consider, but I’d like to acknowledge here that these are limited to what I could recall off hand rather than providing a complete list of relevant resources. Please consider these as examples and you might find more suitable ones within these papers as well.

Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2020-79, 2020.