We appreciate this reviewer's thoughtful comments, which have assisted us in improving the manuscript. In what follows, we respond (in non-bold text) to reviewer's comments (shown in bold text). New or revised manuscript text is italicized. We found it simplest to revise the manuscript at the same time that we prepared our response to reviewer comments. Thus, the line numbers refer to the submitted version unless otherwise noted and indicate where new text has been inserted. Note that all revised Figures referred to throughout the response can be found at the end of this document.

Here, we provide a brief summary of the major changes we have made in response to Reviewer 1: We now more carefully control for the effects of dune aspect ratio and beach width in our analyses. We also clarify our goals and approach with respect to these points throughout the manuscript. To accomplish this, we have reframed our presentation, restructuring the results section and reorganizing the discussion section to highlight that 1) We isolate the effects of dune aspect ratio on dune erosion through analysis of our toes-aligned simulations (in which beach width is held constant). These scenarios allow us to also examine the effects of storm duration and storm surge level on dune erosion as a function of dune aspect ratio. 2) We then isolate the effects of beach width on dune erosion by subtracting the effect of dune aspect ratio on dune erosion as determined from the corresponding toes-aligned simulations, and 3) Our fenced-aligned simulations then provide additional insights into how dune erosion is influenced by emplacement of sand fences as a function of storm duration and surge level. We also propose to change our title from "The influence of dune aspect ratio, beach width and storm characteristics on dune erosion for managed and unmanaged beaches" to- "The relative influence of dune aspect ratio and beach width on dune erosion as a function of storm duration and surge level." Consistent with this revised and more clarifying approach, we adjusted the figures and their presentation in the following way:

- Figure 7 now only shows results from the toes-aligned simulations (instead of all four configurations). There are now three columns (one for each surge scenario), and the top row shows the volume loss, the middle row shows dune toe migration, and the bottom row shows the wave energy reaching the dune (these are new metrics provided in response to comments from Reviewer 2). We include equivalent figures (Figures 8, 9, 11) for the crests-aligned, heels-aligned, and fenced simulations but with the influence of beach width removed by subtracting the toes-aligned results. We have removed original figures 8 and 9.
- A new figure (Figure 10) now shows the volume loss for the crests- and heels-aligned simulations minus the volume loss from the equivalent toes-aligned simulations. These data were plotted versus the initial beach widths of the crests- and heels-aligned simulations to demonstrate the volume loss that was prevented as a function of the varying beach width for these simulations.

Below we respond to specific points in the review although we note the key changes to the manuscript to address the review have been summarized above.

The manuscript under discussion here has as major purpose to analyse dune erosion as a function of dune aspect ratio (i.e., dune height versus dune width) for storms of varying intensity and duration by simulating hydrodynamic processes, sediment trans-

port, and morphologic change. For that, the authors create a series of synthetic dunes to run a series of sensitivity analysis.

The manuscript is well organized, easy to read and clearly presents its objectives. However, I am afraid that the outcomes from the author's experiments do not actually support their conclusions, and more important, are not the best to address the original objective. The conclusions reached by the authors overlap very well grounded facts, namely the importance of the beach width as a major control of dune erosion, stated by several earlier works; e.g. review works (Davidson, Hesp and Miot da Silva, 2020) and works based on field observations (e.g. Burroughst and Tebbens, 2008; Charbonneauet al., 2017; Claudino-sales et al., 2008; Crapoulet et al., 2017; Galiforni Silva et al.,2019; Héquette et al., 2019; Itzkin et al., 2020; Keijsers et al., 2014; Pye and Blott,2016), making it difficult to understand what is the actual contribution of the manuscript tother than calling our attention to the fact that dunes may erode over time (usually not by a single storm), reducing their capacity to prevent overwash and inundation, depending not only on their elevation but also on their width.

We appreciate that the reviewer found the manuscript well organized, easy to ready and to clearly present its objectives—thank you for this positive feedback. We note that the major changes made to the manuscript and summarized on page one of this response improve the connection between objectives stated in the paper, the experiments and the results. In the comment directly above, the reviewer provides several citations to papers that discuss the role of beach width in dune erosion. However, in our reading of these papers while they suggest or state the importance of beach width, they do not quantitatively demonstrate its importance. Not only does our work show that beach width plays a role in dune erosion, it also demonstrates the relative roles of dune morphology (height and width, quantified as the aspect ratio) and beach width in determining how a dune will erode under various storm conditions. Storm impact studies focus on the role of dune morphology (typically just height) but here we quantitatively show, through the use of numerous XBeach simulations, that dune morphology is secondary to beach morphology in predicting storm-induced dune erosion.

Regarding the concern that we are demonstrating something that has already been shown, in the review paper by Davidson et al. (2020)—the most recent of the papers cited by the reviewer— beach width is mentioned as a factor that regulates foredune scarping, and the paper concludes with a statement that calls for just the type of study we have conducted stating that "Further research is required to determine the relative importance of some of the controls on the degree of scarping detailed here, and future investigations on what constitutes the most vulnerable beaches and dune systems, and why, is required" (Davidson et al., 2020) . The paper by Davidson et al. (2020) also states "observations and tests that record the difference in the magnitude or degree of scarping occurring on reflective versus intermediate versus dissipative beaches under the same storm and offshore swell conditions would be very useful". In our revised manuscript wee determine, after incorporating the suggestions from the reviewers, the relative importance of the various controls (TWL, dune height/width, beach width/slope, and storm duration) on dune erosion. Further, while we do not explicitly reference reflective/intermediate/dissipative beaches, we do simulate erosion across a wide spectrum of beach morphologies using "the same storm and offshore swell conditions." Thus, our paper specifically contributes to the further research that Davidson et al. (2020) call for.

The reviewer also suggests that the main message of the paper is that that "dunes may erode over time (usually not by a single storm), reducing their capacity to prevent overwash and inundation, depending not only on their elevation but also on their width." We think this is an oversimplified statement of our study. In response, we have reviewed the text carefully and made changes that we believe helps better communicate our findings to the reader (revised manuscript lines 77-86 and 437-439 respectively):

"The main goal of the work presented here is to assess how dunes erode during a single storm, as a function of dune aspect ratio (i.e., the combined measure of height and width), beach width, and management efforts that led to the formation of an artificial dune (i.e., sand fences). While previous studies of storm impacts on dunes have primarily focused on dune height (e.g., Long et al., 2014; Sallenger, 2000; Stockdon et al., 2007), recent studies suggest that the dune width may also be a key predictor for how much dune erosion will be experienced (Leaman et al., 2020)*. Additionally, although beach width has been posited as a strong predictor of dune erosion (e.g., Burroughs and Tebbens, 2008; Claudino-Sales et al., 2008; Itzkin et al., 2020; Silva et al., 2018) quantifying and understanding the relative role of beach width in dune erosion processes requires further investigation* (Davidson et al., 2020)*."*

"In this study we analyzed how coastal foredunes erode during a storm as a function of their aspect ratio (height and width), beach width, and the presence of management interventions (i.e., sand fencing and beach nourishment)."

I believe that it would make more sense to me to call our attention to the fact that the shape of the dune, not only the aspect ratio as that might be a bit limiting indicator as the shape of a dune can vary very much, turning it very important to consider indicators that inform about the volume, in addition of course, to the elevation, as that is the key parameter that determines the impact regime, the impact can shift to overwash or inundation if a particular height is maintained over a certain width of the dune, but this is not informed by the aspect ratio. So, I would say that additional information other than only the aspect ratio would be needed to actually understand if a particular dune can cope with the impact of one or several storms if the shoreline is retreating (or if the dune is being eroded) the aspect ratio of the dune may also change, as they are all but very irregular features.

We agree that there are many different metrics which can be used to describe the shape of the dune beyond the aspect ratio such as the dune face slope, dune height, or dune width. When we constructed the set of synthetic dune shapes, we set all the dunes to a similar volume so as to compare volume loss among the dunes as a consequence of their shape. To control for volume, we had to adjust both the height and width of the synthetic dunes (as described in the methods section of the manuscript). The aspect ratio metric takes into account both the height and the width of the dune and thus it describes the shape of the dunes we used due to the manner in which the synthetic profiles were constructed. Additionally, as a consequence of the manner in which we constructed the synthetic profiles, the dune face slope is directly related to the aspect ratio of the dunes and so all the results presented as a function of aspect ratio could be interpreted the same way as a function of the dune face slope given that these two parameters are not independent of each other in this study. To address this concern, we have added the following table into the methods section as a complement to Figure 2 detailing shape parameters we use to more fully describe the dune shapes used in this study:

	Aspect Ratio (-)	Volume (m3/m)	Dune Height (m)	Dune Width (m)	Dune Slope (m/m)
1.6X	0.25	52.75	5.68	49	0.15
1.4X	0.2	50.64	4.95	50	0.13
1.2X	0.15	51.76	4.29	53	0.12
1.0X	0.11	53.27	3.69	56	0.1
0.8X	0.07	53.45	2.9	60	0.08
0.6X	0.04	53.25	2.18	67	0.06
0.4X	0.02	53.29	1.47	82	0.04

For clarification we have also modified the caption for Figure 2 to highlight that the "#.#X" values refer to the percent increase (decrease) in dune height (width) relative to the base profile (1.0X) as described in the methods section of the manuscript to maintain a constant initial volume. We have also added the following lines to the section on synthetic dune profiles to address the limitations of these shapes (revised manuscript lines 132-134):

"We modify the dunes to have a similar volume to more easily compare volume loss across different aspect ratios. For completeness in describing the dune shapes, the initial dune shape parameters (i.e., steepness, height, width) can be found in Table 1."

In this line, the authors state that the amount of dune erosion or the vulnerability of coastal dunes does not only depend on dune height but also on its width, as dunes can also erode by collision regimes, and thus, an aspect ratio that includes both dimensions should be used instead of only the elevation. In addition, they also state that dune erosion might be influenced by this aspect ratio. In general, I do agree with the hypothesis stated by the authors, however, I cannot fully agree with the approach used to support their statements and reinforce my concern regarding the originality of the contribution from this work. My main concern is linked to the experiments chosen by the authors, namely to the synthetic dunes used and the way the authors have decided to create the four different configurations, which ended up having dunes with different morphologies (symmetric, non-symmetrical and with changing front dune slopes) and different distances to the shoreline that cannot be easily compared. In fact, the results suggest other factors might be more important than the dune aspect; namely the beach width, which determines the level of impact of the storm over the dune

We appreciate the reviewer's concern that the role of the beach width is critical in understanding how dunes erode during a storm and we have revised the paper (in the ways described on page one of this review) to clarify and strengthen this point. In addition to the changes made, we have kept the numerous instances in which we did refer to the importance of beach width in the original submitted version of the manuscript.

I will try to synthesize my concerns focusing on some statements from the abstract of the manuscript and mainly linked to the results of the experiments or simulations.

The authors state in the abstract that "low aspect ratio (low and wide) dunes lose less volume than high aspect ratio (tall and narrow) dunes during longer storms, especially if they are fronted by a narrow beach". Regarding the first part of the sentence and looking at Figure 7, where the results from the simulations are presented, it is not so obvious this affirmation as low aspect ratio dunes only erode less when using the fixed dune toe configuration (narrowing the size of the beach).

In response to comments from Reviewer 2 (described below), we ran new simulations with improved parameterizations for simulating erosion with XBeach (after Palmsten & Holman, 2012; Palmsten & Splinter, 2016; Splinter & Palmsten, 2012) to better replicate scarping and prevent XBeach from overestimating erosion (see response to Reviewer 2 comments for details). As such, our results are now more physically grounded and they also demonstrate a clearer distinction between how high aspect ratio dunes erode versus low aspect ratio dunes. Our updated Figure 7 (as described on page one in this response) shows a 10-40m^3/m difference in volume loss between high and low aspect ratio dunes, depending upon storm conditions. We have added text to the manuscript to better explain and quantify this revised result (Lines 213-233 in the revised manuscript):

"Simulations with the dune toes aligned have profiles that all share the same beach width (and slope) for the different dune aspect ratios included in this study, thus decoupling aspect ratio from beach morphology. Simulations with the dune toes aligned showed that there was greater erosion for the high-aspect ratio dunes compared to the low-aspect ratio dunes (Figure 7A, B, C). The increased erosion was especially pronounced during low intensity storms where there was a ~10 m^3/m (~19%) difference in volume loss between the high and low-aspect ratio dunes. For the most intense storms, the difference in volume loss between the high and low-aspect ratio dunes was ≤10 m^3/m (~19%). As expected, increasing the duration of the storms led to an increase in the amount of overall erosion experienced, especially for high-aspect ratio dunes. While none of the dunes were completely inundated in our simulations, the dunes (all aspect ratios) lost a significant amount of sediment (>30m^3/m, >60%).

*Although the tall/narrow dunes lose the greatest amount of sediment compared to the low/wide dunes, the dune toe experience less erosion regardless of the storm scenario. While the dune toe for the low/wide dune retreated up to 10m during the longest and most intense storms (Figure 7F), the dune toe for the tall/narrow dunes never retreated more than ~5m (Figure 7D**)** and actually moved seaward by up to ~12m (Figure 7F). For a given storm duration and intensity, the dunes of different aspect ratios are impacted by a comparable amount of wave energy (Figure 7G, H, I) and the beach morphology is the same for all simulations, so the style of erosion is purely being regulated by the morphology of the dune. High aspect ratio dunes are closer to the angle of repose such that they avalanche with sediment piling up at the dune toe. In contrast, low aspect ratio dunes lose more volume than the high aspect ratio dunes but the sediment is lost to the surf zone. For example, during a shorter (+10 hours) storm with low surge, dunes with an aspect ratio of 0.1 and 0.2 both lost equal amounts (~5m^3/m) of sediment (Figure 7A) and were impacted by an equal amount (~500Nm/m^2) of wave energy (Figure 7G)* *during the storm. However, the sediment for the lower aspect ratio dune experienced dune toe erosion while the higher aspect ratio dune experienced dune toe progradation."*

The higher aspect ratios in this case are related to dunes with very steep seaward slopes resembling scarped dunes. As the authors state, and following Hesp 1988, these dunes can be more un-stable and have greater probabilities of crest collapse, is all the sediment from the col-lapsed dune removed by the waves? Having in mind the main principles of dune/beach erosion, the amount of volume eroded should not be very different or dependent on the dune shape, but on the volume of sand that needs to be eroded as it is a response to adjust the beach profile to more energetic waves.

We agree that wave energy impacting the dune plays a critical role in describing how the dunes erode and also that sediment may be deposited at the dune toe or transported towards the surf zone depending upon the mode of erosion. In our simulations we are able to quantify the cumulative energy impacting the dune in each simulation. We have also quantified the change in dune toe position following comments from Reviewer 2 (a metric which relates to where sediment is deposited during the storm). We have added a description of these new metrics in the methods section (Lines 99-109, new text in *italics*):

"To track changes in dune and beach morphology throughout our simulations, the following morphometrics are calculated at every model time step: dune aspect ratio, dune volume, overwash volume, beach width, *dune toe erosion, and wave energy reaching the toe of the dune*. The dune aspect ratio was calculated as the height of the natural dune from D_{high} to D_{low} divided by the width of the dune from D_{heel} to D_{low} (Figure 1). The dune volume is calculated by integrating over the portion of the profile contained within the original cross-shore location of the dune (D_{low} to D_{heel}) in the first-time step and above the D_{low} elevation (0.59 m, NAVD88). The overwash volume is similarly calculated as the change in volume of the profile landward of the initial D_{heel} position. Beach width is calculated as the cross-shore distance between MHW and D_{low} at every time step. Given that pre-storm D_{low} was held constant across all simulations, the beach slope is inversely proportional to the beach width in our simulations (i.e., beach slope decreases as beach width increases). *Dune toe erosion was measured as the final minus initial position of the dune toe. Wave energy is counted as the cumulative amount of wave energy at the dune toe throughout the simulation."*

We have also included new metrics throughout the results section and in the new figures described above. From this analysis we find that, for a given storm condition (surge and duration), there is little difference in the energy impacting the low versus high aspect ratio dunes (when the toes are aligned) however the high aspect ratio dunes have a seaward shift in the dune toe position (sediment piling up at the base of the dune following scarping) while low aspect ratio dunes had a negative shift in dune toe position (sediment being carried offshore). This result would suggest that differences in volume loss are related to the dune aspect ratio as every other factor was controlled for in the toes-aligned simulations and there was minimal difference in the wave energy impacting the dunes. We have incorporated these findings into the results section for toes-aligned dunes, which can also be found on page **6** of this response.

Further, this comment by the reviewer is grounded in the assumption that the beach achieves an equilibrium profile during the course of the storms. Given that an equilibrium profile is not necessarily reached during the course of a storm, this would affect the volume of sediment lost and may be regulated by the aspect ratio. To explain this we have added the following sentences to the discussion section (revised manuscript lines 362-367):

"Additionally, the dune aspect ratio may determine the rate by which the profile achieves equilibrium during a storm. If equilibrium is achieved than volume loss would be equal for both the low and high aspect ratio dunes. However, given that erosion is a time dependent process and is also dependent upon the levels of wave energy during the storm. It is possible that when the dune is scarped (a process which is more associated with the high aspect ratio dunes in our simulations) more sand is moved into the surf zone which will help the profile achieve equilibrium more quickly compared to a low profile dune where there is less sand moving into the surf zone."

It is not so obvious from these results that low ratio dunes erode less, as the authors change the shape of the dunes and their distance to the shore, and therefore, they cannot be easily compared any-more.

The distance to the shore only varies between the different profiles in the crests-aligned and heels-aligned configurations. For these simulations, the beach width increases with the dune aspect ratio such that higher aspect ratio dunes are fronted by wider beaches (note that this is more pronounced in the heels-aligned setup as seen in Figures 2B and 2C). Because we only compare results within each configuration (i.e., Section 3.3.1 compares results from the toes-aligned simulations), and the dune and beach morphology are consistent across runs within each configuration, we believe the within configuration comparisons are valid. We only compare results *across* configurations to evaluate the effectiveness of the fenced dune in mitigating erosion (Section 3.2). However, with the changes to the structure of the paper described above we have made sure to more effectively and clearly distinguish the erosion attributable to the dune aspect ratioand the erosion attributable to differences in beach morphology.

In this regard, I would imagine that a more synthetic dune would help and allow direct comparisons. By a more synthetic dune I imagine something that preserves the slopes (shape) changing the ratio (even though not so realistic, a cube would make it easier). In fact, when looking again at figure 7, the lower ratio dunes are eroding more for all cases but the toe fixed one, which is due to a change in the seaward slope of the dune and not merely to a change in the ratio, as those have very very gentle slopes that do not make easy to identify which is the actual location of the dune toe (or transition to the beach). So, from what is shown here, high ratio dunes are not "specially" losing more volume of sand when the beach is narrow as the authors state, but "only" when the beach is narrow, otherwise they almost don't lose sand.

We agree with the reviewer's comment that different dune face slopes may lead to variability in how the dunes erode. We also made this point in the discussion section (lines 377-

379) where we pointed out that the higher aspect ratio dunes have dune face slopes that are closer to the angle of repose and thus may more readily experience avalanching/scarping.

The latter results from the fact that the other configurations (fixed crest and heel) present wider beaches and so, they may enter the collision regime later, or not at all. The authors also suggest that this affirmation mostly applies to longer storms. However, from figure 7f, j, g, k, we see that the erosion increases over time also for low aspect dunes if the configuration of the dune is different, so, again, the problem of comparing dunes with different shapes and distance to the shore does not help interpreting the outcomes of this work, and to assess the role of the ratio.

We agree that the results within the crests and heels-aligned configurations need to factor in the role of dune aspect ratio and beach width, which is why we have restructured this analysis to more clearly present erosion as a function of dune aspect ratio (Section 3.1 and Figure 7) and beach width (Section 3.3 and Figure 8). Additionally, we have added the following statements to clarify this distinction by explaining a) that the toes-aligned simulations control for beach width and thus we can attribute differences in erosion to differences in dune morphology and b) that by subtracting out the erosion from toes-aligned simulations from the crests- and heels-aligned simulations (as described above) we are able to isolate the effect of varying beach width between the dunes in these simulations. These additions are on Lines 209-214, 219-221, 264-268 in the revised manuscript, and shown in order below:

- *"Additionally, the four different dune configurations presented in our analysis (i.e., toes-aligned crest-aligned, heels-aligned, and fenced) allow us to isolate the amount of erosion attributable to the dune morphology (aspect ratio) and the amount of erosion attributable to the beach morphology (width and slope) by establishing a baseline level of dune erosion in the toes-aligned simulations before introducing variations in the beach width in the crests- and heels-aligned simulations and management interventions in the fenced simulations"*
- *"Simulations with the dune toes aligned have profiles that all share the same beach width (and slope) for all of the different dune aspect ratios included in this study; Because of this we are able to isolate the effect of dune aspect ratio on dune erosion from these results because the only difference between the simulations was the dune morphology."*
- *"To isolate the effect of beach width we subtract the amount of erosion from the dunes in the toes-aligned simulations (which control for beach width) from the amount of erosion in the crests- and heels-aligned simulations."*

Also in the abstract, the authors affirm: "During more intense storms, low aspect ratio dunes experience greater erosion as they are more easily overtopped". I see again a problem when comparing dunes with different shapes and distances to the shoreline. The affirmation sounds totally logic to me as the amount of volume needed to erode depends on the magnitude of the storm, and as stated by previous authors: "one of the most significant factors affecting the magnitude of spatial and temporal change to a foredune during an

erosion event is the height of the mean water level during the storm(Davidson, Hesp and Miot da Silva, 2020 and references therein)", and in fact this is the main factor that the authors assess when changing the magnitude of the event, the water level. However, when looking again at figure 7 (namely 7i), high and low aspect ratios share maximum volume loses, and in fact the main difference with fig.7e, is the fact that a higher water level reaches the low aspect ratio dune crest more easily than low water levels. Conversely, low aspect ratio dunes for the configurations other than the fixed toe one, are more vulnerable because their toe is closer to the shoreline when compared to the high aspect dunes, which are far from the shore in the crest and heel fixed configurations, which in turn makes it difficult to compare volumes of erosion

The changes described in our responses above better isolate the effect of varying beach width in our simulations. Specific to this comment, a new figure (Figure 10) now shows the difference in volume loss between the crests- and heels-aligned simulations and their equivalent toes-aligned simulations as a function of beach width. This shows a strong relationship between the amount of volume loss and the increase in beach width relative to the toes-aligned simulations. For example, we now show that for heels-aligned simulations with a ~68m wide beach there was a 15-30m^3/m decrease in volume loss (greater decrease in volume loss for longer storms) compared to the equivalent toes-aligned simulations which had an equally narrow beach for all dune shapes. In addition to the new figure, we have added an explanation for this relationship in lines 261-264 in the revised manuscript:

"Combining results from all simulations (Figure 10), we observe a proportional relationship between pre-storm beach width and volume loss (relative to the equivalent toes-aligned simulation). We also find that the erosion mitigated by wider beaches is even greater under longer and stronger storms (Figure 10)."

Still in the abstract, the authors state that in managed scenarios (by managed dunes, they refer to those sites where a fenced dune is constructed seaward of the existing natural dune) a fenced dune effectively prevents the natural dune behind from experiencing volume loss. Again, this is what should be expected as having a fenced dune implies in their case that the shoreline is again seaward and distant from the toe of the natural dune, resembling a wide backshore. Yet, the authors mention that the volume loss can be reduced up to 50%, which is a number that depends on their experiments, as if they have built a larger fenced dune it would be greater, also if instead of using the toe fixed they had used the crest or heel fixed configurations, that % would increase. So, again, it is not clear the point/contribution of the authors as these are well grounded ideas/facts usually used for the managers to design the actions to take

While our simulations show a reduction in volume loss of up to 50% with the new XBeach parameterization between the fenced and toes-aligned simulations, we fully expect the modeled volume loss to vary based on both the parameters used with XBeach and the configuration of the synthetic profiles. We have added this point in an explanation clarifying that the specific amount of volume loss related to how our dunes eroded are a function of XBeach parameterization but that we expect the trends and relationships identified in this work to hold true in all instances given that any of these changes related to model setup would be applied uniformly to all simulations and would thus impact them all equally (Lines 209-211):

"We note that while the specific amount of volume loss relating to dune erosion and wave energy are a function of model setup, the setup is applied uniformly to all simulations such that the trends will remain constant regardless of how the dune shapes are formulated and how the model parameters are set."

Regarding the shoreline positioning in the fenced dune simulation, the shoreline is in the same location as it is in the toes-aligned simulations; The only difference is that part of the beach has been turned into the fenced dune. While this scenario may not be entirely realistic, it allows us to directly quantify the role that the fenced dune plays in mitigating dune erosion by allowing for a comparison between the fenced and toes-aligned simulation as the only difference between the two is the presence of the fenced dune. If the fenced dune were placed in the crests-aligned or heels-aligned simulations, the issue of the varying beach widths would still be present as the distance from the shoreline to the toe of the fenced dune would vary between the different dune profiles. While the role of sand fences on dune growth has been studied before (e.g., Anthony et al., 2007; Charbonneau & Wnek, 2016; Itzkin et al., 2020; Mendelssohn et al., 1991), a quantitative assessment of how much natural dune erosion is prevented during a storm by the presence of a fenced dune has, to our knowledge, not been previously addressed. To explain why we have configured the fenced simulations in this manner we have added the following sentence to the results section (revised manuscript lines 284-287):

"We performed a suite of simulations using the same dune profiles as the dune toes-aligned scenarios but with a portion of the beach replaced by a fenced dune (Figure 1D). The placement of the fence on the beach allows us to compare with the non-fenced simulations without changing the beach width. By comparing the results from these simulations with those from the toes-aligned simulations (Figure 10) we are able to quantify the effectiveness of artificial dunes (formed via the emplacement of sand fences) under varying storm scenarios."

We have also modified the following sentences in the discussion section (revised manuscript lines 393-394 and 416-420 respectively):

"The key dynamic in this case (regardless of actual storm duration), was that the fenced dune was sufficiently high to protect the natural dune until the peak of the storm had passed. The foredune behind a fenced dune is not impacted until the fenced dune is eroded away, making the aspect ratio of the foredune secondary to the morphology of the fenced dune in providing protection to back-barrier environments *(a taller fenced dune would offer even greater protection)."*

"The strong inverse relationship between beach width and dune erosion (Figures 9 and 10) suggests that regardless of the aspect ratio of a foredune, widening the beach can be sufficient for preventing overwash during most storms and will be a more effective strategy for increasing coastal protection than re-building the dune or installing sand fences; *although pairing sand fences with a wide beach via nourishment would offer the greatest overall reduction in natural dune volume loss."*

In this line, the authors also state: "a wide beach offers the greatest protection from erosion in all circumstances regardless of dune morphology or storm characteristics". This is again, the expected result, so, are the authors trying to convince the readers that XBeach can simulate erosion? And yet, this is again something that many examples in the literature have demonstrated. Finally, and yet in the abstract, the authors end saying: "in maintaining wide beaches and dunes, the protection offered in the short-term must be considered against long-term detrimental effects of potentially limiting overwash fluxes, which are critical to maintaining island elevation as sea level rises". This idea is developed at the end of the discussion section. From what I understand, a nourished beach, if using the adequate sediments, could provide the needed sediments for the dune to cope with sea-level rise as that is the regular mode dunes grow vertically. The authors claim that maintaining large beaches would prevent rollover and thus, the natural adaptation of the barrier to sea-level rise. Here, I cannot agree with the authors because barriers, if sediment input is enough (so they maintain their beach, even if artificially) can adapt by adapting the vertical elevation of the dune feed from the abundant sediments of the beach, and not only through rollover, right? I see more the problem of being able of maintaining large beaches with the adequate sand and in terms of costs. In this context, if sea level rises, so will the nourished beach berm and thus the dune, unless winds are not efficient anymore, which seems not to be the case in the future. Therefore, I would recommend the authors to better explain what the actual message is that they try to highlight here and to state what is their opinion about the possible coupled adaptation of the dune in that context.

At the end of the discussion section (Lines 477-485) we point out that the limited overwash flux in managed locations can have long-term implications for barrier island survival under sea level rise. Barrier island rollover under SLR and how it may be modulated by development is a process that is well-studied (see citations in the paper). Our work ties into this process because we show that wide beaches and higher aspect ratio dunes will be more resistant to erosion and therefore less frequently overwashed. Rollover is the cumulative effect of numerous overwash instances and previous studies show that reduction in overwash volumes can hasten island drowning (e.g., Magliocca et al., 2011; Rogers et al., 2015). If dunes (or structures) reduce the volume of overwash from reaching the island interior and back-barrier, island elevation decreases, and nourishment on the front side will not prevent drowning from the bay side. Further, while it is true that continuous nourishment can promote resilience to barrier drowning (i.e., Masselink and Lazarus, 2019), this is not a realistic long-term solution. Resource limitations, pointed out on line 500 and by the reviewer, will not allow for continuous nourishment indefinitely. We have revised the wording on these points at the end of the discussion to clarify (revised manuscript lines 421-430):

"*It is important to recognize that although management initiatives such as widening beaches and building dunes with particular aspect ratios can be effective at mitigating erosion, these actions may have effects that are undesirable in the long-term. For example, overwash facilitates barrier rollover—a process that is necessary if islands are to maintain subaerial exposure as sea level rises (e.g., Leatherman, 1979; Moore et al., 2010; Lorenzo-Trueba & Ashton, 2014; Rogers et al., 2015). Thus, constructing dune and beach systems that reduce the amount of overwash that would otherwise naturally occur may inhibit rollover, thereby* *increasing the likelihood of eventual barrier drowning (e.g., Magliocca et al., 2011; Rogers et al., 2015). This lack of overwash is a concern even in the presence of expected ongoing beach nourishment because overwash-induced increases in island interior, and back-barrier elevations are necessary to prevent drowning from the backside and because it is not feasible to continue beach nourishment indefinitely along all developed barriers."*

More specific comments: Regarding the introduction, I would expect here that the authors present the main factors controlling the magnitude of dune erosion by storms, as this will be the main point of discussion, also considering the scales of change, from a single storm to a series of storms or the time-scale of relevance for managing would be interesting. In relation to the methods, they mention that the effect of the configuration of the beach, namely the beach slope, will be also assessed, however, this is not thereafter clearly evaluated. In line 281, I would add here the importance of the width of the dune to the impact of storm groups also.

We see the confusion here, perhaps introduced by our objectives which state that the third question we will address is "How does the morphology of the beach (i.e., width and slope) affect volumetric dune erosion independent of dune aspect ratio?" As we explain in the methods section (2.1, Lines 94-96), because the dune toe elevation is the same (0.59m) for all the dunes considered, the beach width and beach slope (calculated between MHW and the dune toe) are directly proportional to one another. For this reason, we only consider beach width in our analyses because additional analyses on the beach slope would be redundant. We address this concern by modifying the statement of our third objective (Lines 93-94) as follows (new text italicized): "How does the morphology of the beach (i.e., *width/slope*) affect volumetric dune erosion independent of dune aspect ratio?" We have also added a statement to the methods (Lines 106-108) explaining that beach slope and beach width are directly related in these simulations to further clarify this issues.

Additionally, we have included the following sentences to the introduction to clarify that the focus here is on a single storm and the specific metrics we analyze in the paper which can be found on page **3** in this review and lines 77-86 in the revised manuscript

We have also modified the following sentence in the discussion section to address the effects of multiple storms on the dunes as described in our comments on page 11-12 of this response.

The following figures can be found in the revised version of the manuscript referred to in the responses to the reviewers. Note that figure numbers refer to their placement in the manuscript.

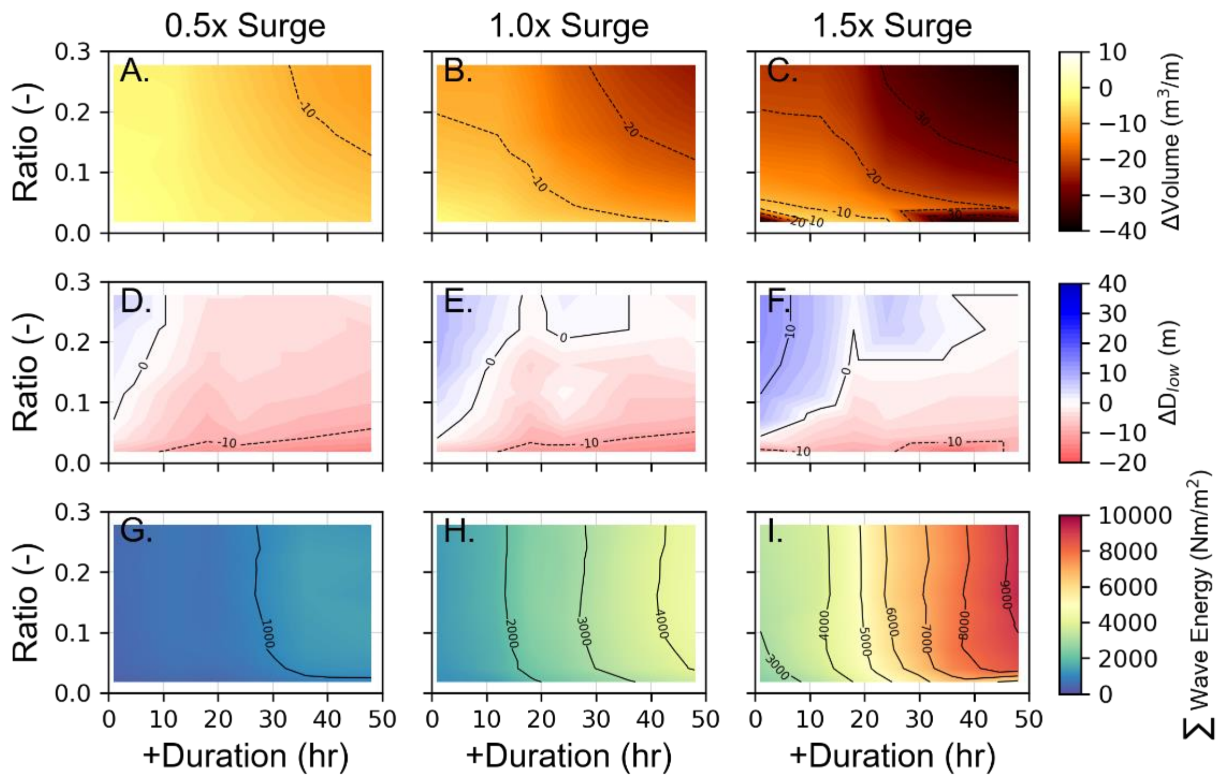

Figure 7: Dune aspect ratio versus storm duration for simulations with toes-aligned (controls for beach width/slope and initial dune volume). Each column represents a different storm surge level (increasing left to right). The top row (A, B, C) shows the change in dune volume, the middle row (D, E, F) shows the change in dune toe position (negative values indicate landward erosion), and the bottom row (G, H, I) shows the cumulative wave energy impacting the dune.

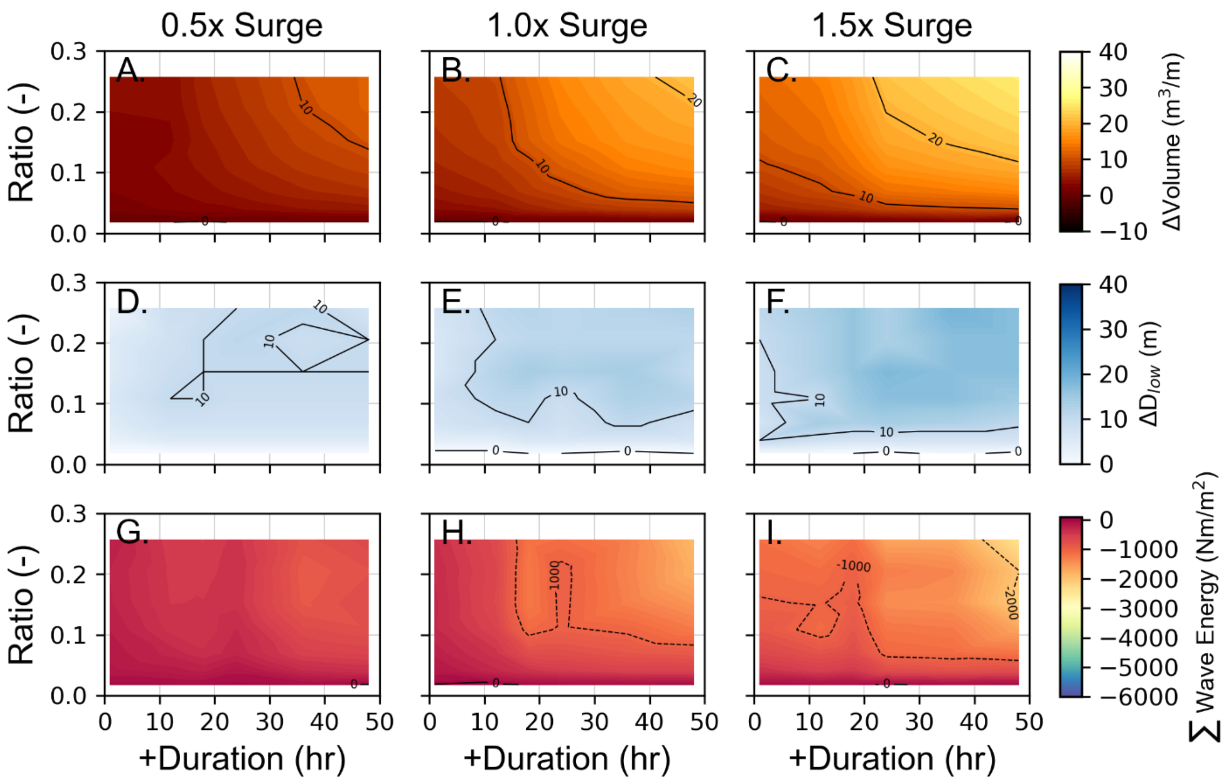

Figure 8: Dune aspect ratio versus storm duration for simulations with crests-aligned. The values from the equivalent simulations with the dune toes aligned have been subtracted from the crests-aligned simulations to highlight the influence from the varying beach widths in the crests-aligned simulations. Each column represents a different storm surge level (increasing left to right). These values represent a comparison relative to the toes aligned simulation (where beach width is controlled for) such that the top row (A, B, C) shows the amount of volume loss prevented by the wider beach in these simulations, the middle row (D, E, F) shows the additional dune toe progradation induced by the wider beach width, and the bottom row (G, H, I) shows the reduction in wave energy reaching the dune due to the wider (and thus lower sloping) beach.

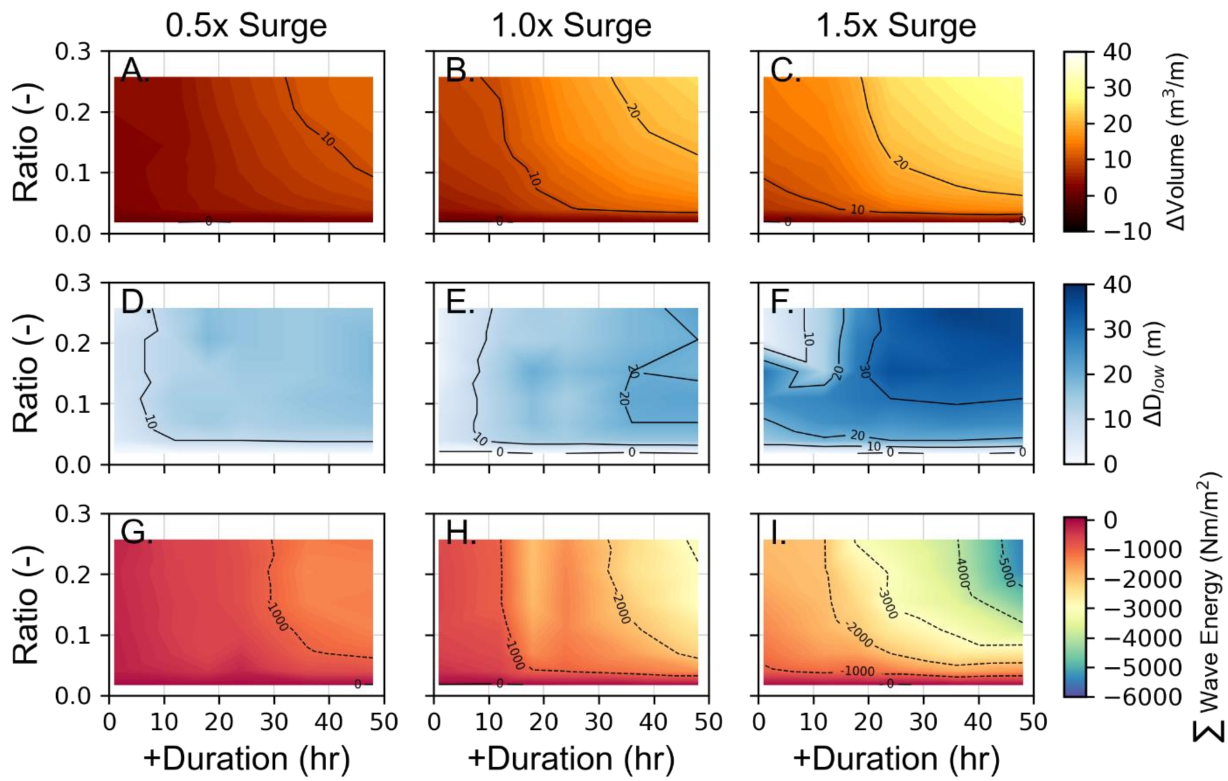

Figure 9: Dune aspect ratio versus storm duration for simulations with heels-aligned. The values from the equivalent simulations with the dune toes-aligned have been subtracted from the heels-aligned simulations in order to highlight the influence from the varying beach widths in the heels-aligned simulations. Each column represents a different storm surge level (increasing left to right). These values represent a comparison relative to the toes-aligned simulation (where beach width is controlled for) such that the top row (A, B, C) shows the amount of volume loss prevented by the wider beach in these simulations, the middle row (D, E, F) shows the increase in dune toe progradation induced by the wider beach width, and the bottom row (G, H, I) shows the reduction in wave energy reaching the dune due to the wider (and thus lower sloping) beach.

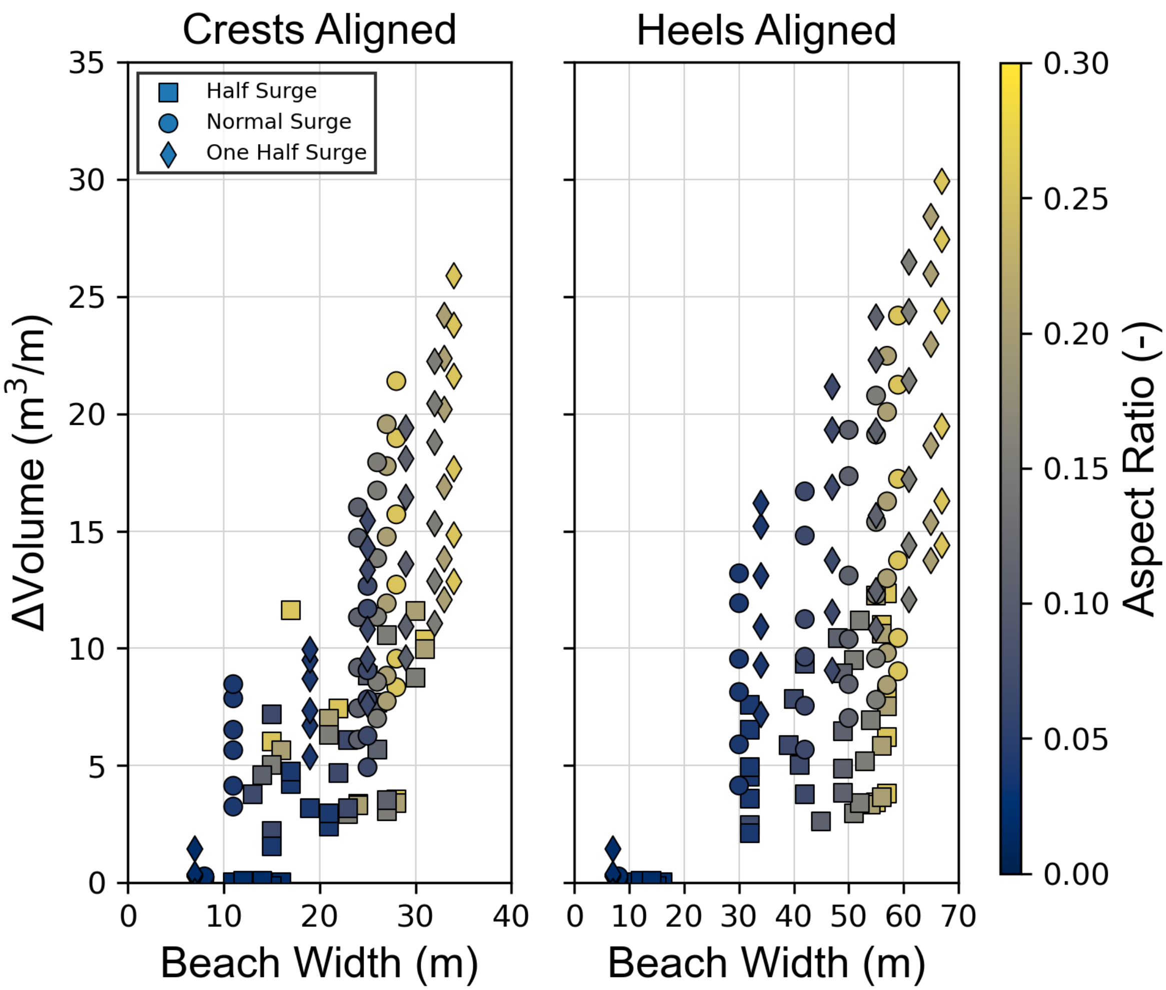

Figure 10. Volume loss from the crests-aligned and heels-aligned simulations minus volume loss from the equivalent toes-aligned scenarios versus the initial beach width for the crests- and heels-aligned simulations. The color corresponds to the dune aspect ratio and the shape corresponds to the surge level.

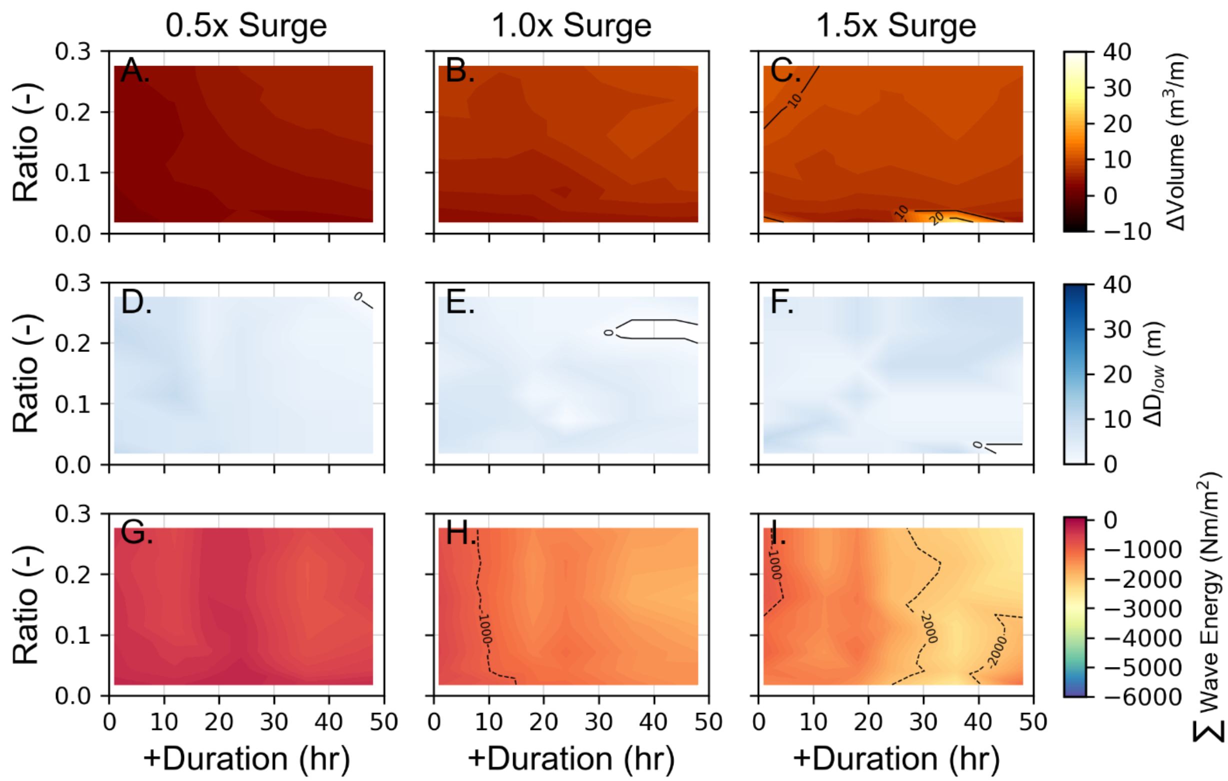

Figure 11: Dune aspect ratio versus storm duration for simulations with sand fences. The values from the equivalent simulations with the dune toes aligned have been subtracted from the fenced simulations in order to highlight the influence from the presence of the fenced dune seaward of the natural dune. Each column represents a different storm surge level (increasing left to right). These values represent a comparison relative to the toes-aligned simulation (where beach width is controlled for and there isn't a fenced dune) such that the top row (A, B, C) shows the amount of volume loss prevented by the fenced dune in these simulations, the middle row (D, E, F) shows the increase in dune toe progradation induced by the fenced dune, and the bottom row (G, H, I) shows the reduction in wave energy reaching the dune due to the fenced dune.