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Biogeosciences Discussions

Interactive comment on "Exploring the contributions of vegetation and dune size to early dune building using unmanned aerial vehicle (UAV)-imaging" *by* Marinka E. B. van Puijenbroek et al.

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Thank you for your comments and the helpful feedback, which will help us improve both clarity and impact of the MS. Below we provide a point-by-point response to the comments, including their consequences for the MS.

Reviewer comments are indicated with open bullet points, whereas our response is indicated with a dash.

Kind regards, also on behalf of all co-authors

Marinka van Puijenbroek

This is an interesting topic , sadly very poorly written.

o Line 55- there are multiple papers outlining how incipient or embryo dunes develop in multiple countries so this is patently wrong – remove or rephrase.

- We agree that there are many paper that describe the formation of incipient foredunes or embryo dunes. However there are not so many papers that quantify the factors that determine the speed of early dune development. We will adapt the sentence to reflect this.

o Lines 57 to 63- actually Hesp stated that incipient foredunes are initiated in several ways and by nebkha and shadow dune formation is only ONE way. If the authors are going to review how incipient foredunes are formed they need to state all the other ways too – e.g. by aeolian deposition in continuous alongshore canopies of vegetation as well as discrete nebkha. And it's: incipient foredunes" NOT incipient dunes" - the latter describes any type of dune. . .

- In our study site dune formation is initiated by the establishment of vegetation and the formation of a nebkha and shadow dune. Since the formation of an incipient foredune by sand deposition within the continuous alongshore vegetation did not occur in our study site, we would rather not add this process to our introduction. We will clarify throughout our MS that we are studying nebkha dunes.

o Lines 79-80 these refs are very recent – the more comprehensive reviews of e.g. effect of veg density and distribution are in hesp papers – 1983, 1988 for example so cite these and Arens papers.

- We only cited the more recent papers to limit word counts. We will add some additional older references including Hesp from 1983 and 1988 as well as the papers by Arens, to give a more comprehensive overview.

o Lines 91-92. You need to explain better WHY u think greater dune size should mean

greater accretion/deposition. Is it because u think if a dune is big then it obviously has a greater sediment supply than a small dune? BUT what about age? How has this been taken into account? A dune might be small because its young/in early development stage, a big one because it's been sitting there for 200 years or gets regular scarping, scarp fill, crest growth due to that. . . Also is it because a larger vegetation patch would produce a larger nebkha and therefore would be able to collect more sand? There are multiple answers here and you must discuss there and later in the discussion/conclusions the impacts of these on your results.

- We changed our hypotheses to clarify our expectations:

We expected that nebka dune growth would be a function of vegetation density, initial dune size, and shelter, with the function being modulated by season and degree of shelter. We hypothesised that:

1) Nebkha dunes with high vegetation density grow fastest irrespective of season or shelter

2) In summer, growth of nebkha dunes is linearly related to initial dune size with small dunes growing at the same rate than big dunes. Exposed dunes grow faster than sheltered dunes because of higher sand supply.

3) In winter dune growth is no longer linearly related to initial dunes size, as small dunes are more susceptible to storm erosion than big dunes. Exposed dunes grow slower than sheltered dunes because of higher storm erosion.

- The dunes in our study are quite young, most of the nebkha dunes (ca. 95%) have developed within 5 years. Age is important as it will affect the size of the nebkha dunes, however age is difficult to measure. Furthermore, in coastal systems the dune size can also decrease by sea water inundation during large storms, this erosion will weaken the correlation between age and nebkha dune size. At the study site section we mention the age of our nebkha dunes.

- The area of the vegetation patch can indeed have a large effect on the sand deposition and thereby nebkha dune growth. We therefore did some additional analysis to test the effect of vegetation area on nebkha dune growth. In our study site the vegetation area was correlated to the dune size. We checked whether the vegetation area is a better predictor for nebkha dune growth than dune size, however this was not the case. Especially for the dunes seaward of the foredune, vegetation area only explained 36% of the variation, whereas dune size explains 90% of the variation. We will include these results and discuss this in the discussion.

o Lines 92-93: WHY? Because of snow cover, more wave energy and erosion, wet sand WHAT? Please explain.

- We think that exposed dunes grow faster in summer, because there is no storm erosion and therefore more net sand deposition, the sheltered dunes will grow slower because they have less sand supply. In winter storms result in sand erosion, potentially leading to negative growth for the exposed dunes. The sheltered dunes are protected from the storm and will still have a positive growth and therefore have an increased growth in winter. To clarify our expectation we will change the hypotheses, see above new version.

o Lines 101-102: WHAT 3 types of dunes? You haven't said before this that there are 3 types. In line 100 u say dunes are formed by 1, 2 or a mixture. . . is that what u mean by saying 3 TYPES of dunes? In which case they are NOT types.(im convinced even by this stage you do not understand how dunes are classified. . .) they are ALL incipient foredunes formed in diff species or mixtures of species. REWRITE. Elucidate please!

- We will change the sentence to reflect that these are all nebkha dunes, with different species composition. We will check the manuscript to clarify that we are always talking about nebkha dunes and that the different dunes consist of different plant species.

o It is NOT obvious until one gets into the methods section that you are mostly, or

entirely talking about incipient foredunes and mostly nebkha and shadow dunes. You need to state this clearly at the start of the paper and also in the abstract.

- We indeed study nebkha dunes only. We will change the text accordingly.

o Lines 275-276: dune height - WHY? Because these are older since they are more landward? Explain 289-290: obviously because they formed earlier and are older and have had a greater time to collect sand. How about stating these kinds of associations when u state your results?

- The sheltered dunes are not much older than the exposed dunes, five years at most. Nevertheless, we agree that the height differences between sheltered and exposed dunes cannot be contributed to their position only, but can be a function of their slightly older age too. We added this explanation to the MS.

o Also u are omitting the important papers on flow and sedimentation in patches or vegetation – classic study of diff patch density by Qian et al; Liu papers, Bouma paper on flow in veg patches underwater etc. – these all provide excellent explanations of how density controls nebkha development and need to be reviewed and cited.

Bouma, T.J., van Duren, L.A., Temmerman, S., Claverie, T., Blanco-Garcia, A., Ysebaert, T., Herman, P.M.J., 2007. Spatial flow and sedimentation patterns within patches of epibenthic structures: Combining field, flume and modelling experiments. Continental Shelf Research 27, 1020–1045.

Dong.,Z., Wanyin, L., Guangqiang, Q., Ping, L., 2008.Wind tunnel simulations of the three-dimensional airflow patterns around shrubs. Journal of Geophysical Research 113: F202016, doi: 10.1029/2007JF000880

- We thank you for calling attention to these nice papers; we will incorporate them into our MS, making our discussion stronger.

o Lines 337-340: it's strange and weird that you state dune vol is related to dune volume! Of course it is as it's the same thing. . . . Rewrite to explain better what you

are correlating here.

- We meant that the absolute change in dune volume was related to the initial dune volume, we will rewrite this sentence to make it more clear.

o Line 358: YOU MEAN: "The aim of this study was to explore the contributions of vegetation and dune size to NEBKHA dune development" - add this word otherwise its totally confusing and non-obvious what u are talking about; i.e. ANY dune development??!

- We changed this to nebkha dune development.

o Line 359 – now your aim is ONLY about degree of shelter? What about the other aims stated at the start of the paper??

- The main aim of our study is to explore the contributions of vegetation and dune size to nebkha dune development. Our secondary aim is to understand how the contribution of vegetation and dune size is modified by the degree of shelter. We will change the sentence to better reflect this.

o Lines 368-369: because you have failed to adequately review the literature you are stating untruths here. One of the great papers to fully show how seasons control foredune growth is the one by Davidson-Arnott (ref in Hesp 2002 paper maybe). Check his book which has the model in it I think. At any case remove the statement that this is the first to relate foredune growth to seasonal change.

- You are entirely correct that we are not the first paper to show how seasons control vegetated dune growth. Davidson-Arnott and Law (1990) show that the amount of sand deposition at a foredune depends on the season, where in winter more sand is deposited than in summer. Montreuil et al. (2013) showed that embryo dunes show a seasonal cycle of summer growth and winter erosion. As far as we know, we are the first paper to show that the effect of vegetation and dune size on nebkha dune development differs between a winter and summer. We will change the sentence to

clarify this.

o Lines 390-393: the referencing of the transverse dune lit here doesn't compute. Shadow dunes and/or nebkha do not at all have the same flow dynamics as transverse dunes. You need to rethink this entire idea and writing. Shadow dunes for example are controlled by paired horizontal flow vortices and max slope angle (hesp 1981). Nebkha vol and height is largely controlled by veg density and nebkha age and rate of plant growth.

- You are correct that it is not correct to compare nebkha dunes with transverse dunes. We therefore removed the sentence.

- The sentence will be replaced by the following sentence: The linear relationship between initial dune volume and dune volume change found for the nebkha dunes in our study indicates that different dune sizes have similar effect on the wind flow pattern per unit of area, which indicates scale invariance (Hallet, 1990). Scale invariance has been used for modelling nebkha and foredune development (Baas, 2002; Durán Vinent and Moore, 2013), but has not yet been validated for nebkha dunes to our knowledge.

o Lines 415-416- and less storm surge, wet high tide beach, etc on the sheltered side??

- We compared the dune growth of sheltered nebkha dunes between summer and winter. In winter the sheltered dunes had a slightly higher growth compared to summer. This higher growth rate cannot be caused by less storm surge, since these nebkha dunes were not affected by storm surge in summer and winter. Therefore, the higher growth rate is probably caused by higher sand deposition in winter. Although, at a wet high tide beach less transport is also possible, we expect that the higher wind speed in winter are a more likely explanation for the higher dune growth for sheltered dunes in winter. We will change the sentence to clarify our result, to the following: Interestingly, the sheltered dunes had a slightly higher dune growth in winter compared to summer. This increase in dune growth for sheltered dunes can perhaps be explained by more frequent and/or intensive aeolian transport events during winter resulting into higher

sand supply to the sheltered dunes.

o Line 418 and subsequent lines: You are NOT describing "veg characteristics" here. BE specific – u are at least first describing the effect of veg species differences or combinations of species, NOT density, distribution, height etc. So be specific – rewrite. OK I see that you discuss these other factors next BUT would be better to still rewrite the first part to make it clear you are first just talking about species differences. Lines 448-449: there are several studies showing that ammophila does trap more sand generally compared to other species due to its high density clump-like nature so cite some of these.

- You are correct that we first discuss the difference in dune growth formed by different plant species. To make the title better reflect the section we will rename the title to vegetation. Furthermore, we will be more specific in the subsequent lines on our results.

- We added a reference that reported that A. arenaria can trap more sand compared to other dune building species.

o lines 514-515: I don't see anywhere a decent explanation of why this is the case. You need to better explain this conclusion.

- Thank you for calling attention to this. Indeed, we only looked at the difference in dune growth for dunes with different species composition. We will change the sentence to the following: Species composition does not affect dune growth over summer, but does affect dune growth during winter, particularly at exposed sites.

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