Editor

Earth Surface Dynamics

December 22, 2020

Dear Editor,

We would like to thank you for your handling and response to our submission. Please find enclosed the revised manuscript for *Earth Surface Dynamics*, entitled "*Different coastal marsh sites reflect similar topographic conditions for bare patches and vegetation recovery*" [Paper #esurf-2020-56], and detailed list of our responses to the comments of the reviewer. We highly appreciated the comments made by the reviewer, as they enabled us to greatly improve the manuscript.

Below we give a step-by-step response to the comments. The original comments of the reviewer are copied below and shown in black. Our step-by-step replies are inserted and shown in blue. The line numbers that are mentioned refer to the line numbers in the revised manuscript with tracked changes.

Thank you very much for your continued consideration of this manuscript.

Looking forward to your reply.

Yours sincerely,

On behalf of all co-authors,

Chen Wang

"Different coastal marsh sites reflect similar topographic conditions for bare patches and vegetation recovery" [Paper #esurf-2020-56]

Chen Wang, Lennert Schepers, Matthew L. Kirwan, Enrica Belluco, Andrea D'Alpaos, Qiao Wang, Shoujing Yin, and Stijn Temmerman

List of response to the comments

Suggestions for revision or reasons for rejection (will be published if the paper is accepted for final publication)
The manuscript presents an interesting study of the occurrence of bare patches in three contrasting saltmarshes and aims to elucidate how topographic settings determine marsh destruction or revegetation. The introduction and methodology are very clear and the manuscript is generally well-written. However, I have some concerns about the mechanisms proposed in the discussion and the generalizations illustrated in figure 8. I moreover suggest to go through the text to correct some minor unclear formulations and corrections.

1) Main comments:

The manuscript claims that revegetation was studied for three sites but actually only one site showed revegetation. The other two sites were not investigated since there didn't occur revegetation as partly shown by previous studies. I suggest to rephrase more carefully in the abstract line 25 and the discussion line 345 that this is not a finding particular to this work but only a confirmation of previous studies.
This was adapted as suggested, by adding the following text (underlined here):
Line 26: "In line with previous studies, revegetation…."
Line 358-360: "No vegetation recovery was observed in the two sites with smaller tidal range and sediment input (Venice lagoon, Blackwater marshes), which is in line with previous studies in these two areas, showing progressive marsh die-off over longer (century) time scales (e.g. Schepers et al., 2017; Carniello et al., 2009)."

The authors conclude that larger patches cause larger connecting channels but this is not clear from the findings. Alternatively, larger channels could also promote larger bare patches. I suggest to either rephrase the statement in the abstract line 21 and discussion line 358 or carry out an additional analysis tracking connected bare patch size and channel width through time to investigate what occurs first and determine which determines the other.
This was adapted as suggested, by adding the following text (underlined here):
Line 371-374: "First, concerning the positive relationship between bare patch size and connecting channel width, we are not certain about the direction of causal relationship (either larger bare patches causing wider connecting channels, or vice versa), but we may formulate certain hypotheses. This relationship may be due to…."
Line 21: "and that there is a positive relationship between the width of the connecting channels

and the size of the bare patches, in each of the three marsh sites."

➔ The latter formulation does not suggest the direction of causal relationship.

The discussion about the wave-induced resuspension is only valid for large microtidal marshes, such as Blackwater. I suggest to explore more on alternative hypotheses on tidal channel hydrodynamics (suggested references are in the detailed comments).
We followed this suggestion. The same suggestion comes back in the more detailed comments below, and there we explain how we adapted it in the manuscript.

Figure 8 generalizes the two findings from Blackwater and Saeftinghe in one figure, which should be separated: wave resuspension within bare patches and revegetation do not co-occur in the presented systems and therefore should be illustrated separately. I suggest to simplify the schematic model showing bed elevation and likelyhood that a certain feature occurs and possibly link to tidal range. Since it is not clear what is the main driver of bare patch formation (waves, SLR, SSC) I would refrain from generalizing the findings in a figure such as presented.
As the reviewer founds this figure confusing, and as it is only an attempt to present a conceptual, summarizing sketch, and as such it is not essential for the paper, we decided to leave this figure out.

2) Detailed comments:
3.1: I am missing a definition of how you define the difference between channel and connected bare patch/the boundary at which you define it as patch or channel?
An explanation was added:
Line 164-167: "The edge between a connected bare patch and the connecting channel was visually defined as where the channel planform shape (i.e. linearly shaped) in upstream (landward) direction widens into a bare patch (i.e. non-linear, more irregular shape), as shown in Figs. 1-3."

Line 165- 167: 'Field surveys only include selected 165 locations, but with greater vertical accuracy, especially for vegetated areas where LIDAR partially reflects on the vegetation canopy, and open water where LIDAR reflects on the water surface.'
It is not clear what this sentences means – do you mean accuracy is enhanced for the classes vegetated and open water?
We rewrote this sentence, so that it is clear what we mean:
L 170-173: "Field surveys only include selected locations, but field surveys of soil surface elevation had greater vertical accuracy than LIDAR surveys (see below), especially for vegetated areas where LIDAR partially reflects on the vegetation canopy, and open water where LIDAR reflects on the water surface."

Line 227: Please add a reference for the Mann-Whitney U test
Reference was added to: R Core Team, 2016. A Language and Environment for Statistical Computing. R, Vienna, Austria.

Line 233: Please add a reference after 'growth'

Reference was added to: Balke, T., Stock, M., Jensen, K., Bouma, T. J., and Kleyer, M., 2016, A global analysis of the seaward salt marsh extent: The importance of tidal range: Water Resources Research, v. 52, no. 5, p. 3775-3786.

5.1.1

You refer in this paragraph to the peak of the distribution but I am not certain how to interpret this value. Please explain in one sentence on what the distribution and the peak show.

This is explained:

Line 284-285: "The peaks of the elevation distribution (i.e. the mode of the elevation distribution)…"

Line 277-278: Please rephrase the sentence, to me it is not clear what this means - between all comparisons of two of the 3 variables?

This was reformulated as suggested:

Line 282-284: "The differences in elevation between the vegetated marshes, connected and unconnected bare patches were statistically significant between all comparisons of two of the three variables (p < 0.001 based on the Mann-Whitney test)."

5.1.3

I do not understand this paragraph from the figure. Where do I see the difference between connected and unconnected bare patches in Fig. 6? Where are the values (% of area) visible in the figure?

This is now explained in the text below the figure:

"Bare patches with connecting channel widths < 0.5 m are defined as unconnected bare patches in the text (see methods). The patch number proportion (%) is calculated as the number of bare patches in each class of bare patch size relative to the total number of bare patches for each category of channel width."

Line 347 key point (3): Please be careful with the phrasing: This last point does not emerge from the presented results but was already described in previous publications (as you mentioned in line 220 Schepers et al, 2017). Only the second sentence was shown in this work.

This was adapted in response to a previous similar remark by the reviewer above:

Line 358-360: "No vegetation recovery was observed in the two sites with smaller tidal range and sediment input (Venice lagoon, Blackwater marshes), which is in line with previous studies in these two areas, showing progressive marsh die-off over longer (century) time scales (e.g. Schepers et al. 2017; Carniello et al. 2009)."

Line 336: What about the unconnected patches?

This was added:

Line 343-345: "Permanent bare areas are always connected to channels, and tend to be associated with wide channels, while unconnected bare patches always rapidly revegetated (i.e. within 4 to 6 years after their first appearance) (Fig. 7c)."

Line 350: 'high connectivity': Do you refer here to the width of the connecting channel in fig.7c?

Yes indeed. This is explained now explicitly:
Line 361-362: "…by wider channels connecting the bare patches to the channel network."

6.1

I think that the discussion focuses too much on the resuspension by waves but does not explore other optional hypotheses. For example, the time lag between incoming and outgoing tide can result in ebb-dominance in marshes and therefore lead to net sediment export through the channels (e.g. https://www.jstor.org/stable/25736162 or https://doi.org/10.1029/2019WR025942). I think this is a more elegant explanation for sediment export from the marsh and can explain the difference between Saeftinghe and Blackwater. This can furthermore be related to vegetation species, which are mentioned in the text but neglected in the discussion.

Moreover, I suggest to mention that waves are only relevant in microtidal marshes and negligible in the case of Saeftinghe, hence a possible explanation for the difference between the systems (see e.g. https://doi.org/10.1016/j.geomorph.2018.03.025).

We thank the reviewer for these useful suggestions, and included them in a reworked section of the discussion:

Line 379-390: Secondly, our finding that unconnected bare patches occur most frequently on higher elevations than connected bare patches, may be interpreted by a number of potential hypotheses. We expect that connected bare patches experience higher incoming and outgoing flood and ebb flow velocities as they are directly connected to the channels, while unconnected bare patches are surrounded by marsh vegetation, which is expected to obstruct and reduce flood and ebb flow velocities. Furthermore, the time-lag between incoming and outgoing tides can result in ebb-dominance in marshes (e.g. Friedrichs & Perry, 2001) and therefore may contribute to net sediment export from bare patches that are connected to the channel network. As such, stronger tidal currents, ebb-dominance and net sediment export may result in lower surface elevation of connected bare patches as compared to unconnected bare patches, where the surrounding vegetation may reduce flow velocities and facilitate the deposition of suspended sediments supplied during overmarsh tides. Such effects of tidal currents may be most pronounced in the study site with largest tidal range (Scheldt estuary), while additional effects of wind-waves on sediment transport have been reported to be important in the sites with intermediate and small tidal range (Venice lagoon, Blackwater marshes) (e.g. Stevenson et al. 1985; Fagherazzi et al. 2006).

I think that autocompaction and organic accretion by different vegetation species are also important phenomena to be mentioned.
Sorry, this suggestion is vague. It is not clear to us how this can contribute specifically to the discussion in 6.1.

Line 444-450: Please be more specific what you mean here. I am not sure what can be concluded from the above paragraph, what is the most likely explanation for large bare areas: SLR, tidal range or sediment supply? Or all these reasons?
This is further specified:
Line 474: "It is probably a combination of all these factors that may explain why…"

3) Figures:
Fig. 3:
Please add in the caption if the small study area is the only data considered in the paper - if yes, it is not clear to me why the blue patches are excluded but the yellow ones are considered.
Suggestion added in the figure caption:
"Data presented in this paper are for all bare patches in the small study area (both unconnected ones (in pink) and connected ones (in yellow)). In order to obtain a higher number of observations of connected bare patches, we also included connected bare patches in the larger study area (in yellow) but excluded unconnected bare patches (in blue)."

Fig.4 :
Please mention in figure caption again why there is no lidar data for bare patches at Blackwater and no field data for Saeftinghe
Suggestion added in the figure caption:
"Field data were added to LIDAR data for San Felice and Blackwater, because bare patches were partly covered there by water, which obstructs LIDAR sensing of the soil surface beneath the water surface; while in Saeftinghe all bare patches were drained at low tides and LIDAR is not obstructed here by water cover."

Fig. 6:
I got confused if both connected and unconnected patches were included. Only later I saw that the first class is unconnected channels. I think it would enhance clarity to add that in the figure by text but especially in the caption. Also, I miss the percentages mentioned in the text, maybe it is possible to highlight them.
Suggestion added in the figure caption:
"Bare patches with connecting channel widths < 0.5 m are defined as unconnected bare patches in the text (see methods). The patch number proportion (%) is calculated as the number of bare patches in each class of bare patch size relative to the total number of bare patches for each category of channel width."

Fig. 7:
Panel c is not clear to me: Why is 40% of pixels rapidly revegetated with a channel with of 0? I guess the two left data points are unconnected bare patches? I suggest to make that clear, maybe a scatter plot is more representative than a line plot since it is a limited amount of data and maybe separate connected/unconnected patches by a vertical line.
This is more clearly explained in the figure caption:
"The proportion (%) in panel (c) is calculated as the number of pixels in each class of channel width relative to the total number of pixels that are permanently bare patches (blue line) or rapidly revegated bare patches (red dashed line)."

4) Textual comments:

a) Some of the wording I am not familiar with, such as the terms 'overwash tide' and 'tidal frame'. Overwash is usually referred to as waves and I was not sure what the difference between tidal

range and tidal frame was.

We didn't use the term "overwash tide" but "overmarsh tide", these are high tides that submerge the complete marsh surface. This is explained now:

Line 130-131: "overmarsh tides (i.e. high tides that submerge the complete marsh surface)"

b) The use of the word 'connectivity' is arbitrary: do you mean connected/not connected or degree of connectivity through channel width? This should be defined in the introduction and possibly adjusted throughout the manuscript.

There were 6 places in the text where the word 'connectivity' was used. It was defined where it was used the first time as: "connectivity is defined here as the width of connecting channels"

c) You mix the use of the word 'feature' and 'category' for the different classes vegetated, bar patches etc. (e.g. fig.4 caption) . Please be consistent.

It was changed and the word 'category' was consistently used throughout the paper.

d) I suggest to revisit the punctuation in the manuscript, specifically the use of commas.

We revisit the punctuation as suggested.

4.1) Detailed comments:

All below suggestions were adapted:

Title: occurs = 'occur'

Line 19: 'distance from'

Line 151: 'tidal range' = 'tidal amplitude'

Line 212: 'method as for Saeftignhe' 'field elevation survey': remove 'elevation'

Line 231: 'the LIDAR data'

Line 364: 'on higher'= 'at higher'

Line 405: 'feedback'= 'feed back'

Line 406: 'remove second 'may' before 'contribute'

Line 478: 'indicative' is used twice in a row; 'recover from'

Caption figure 4: 'exact numbers' = 'total numbers'