RC 1

Dear Editor and Associate Editor,

the paper describes a large-scale experiment on vegetation effects on the evolution of a tidal network. The experiments were carried out in the Metronome at the Utrecht University. Vegetation seeds were sown by dispersing them or manually creating some patches during the evolution of the system. The experiments were then compared to control experiments where no vegetation was used. Pictures of the tidal system were taken at different stages of the experiments to monitor vegetation growth and the channel geometric properties (with and without vegetation). In the experiments, vegetation favoured the development of a denser and more efficient network.

The issue is timely and of broad interest, particularly in view of the current great concern about the fate of coastal environments threatened as they are by climate change. The paper is well-written and well-conceived, but it would benefit from some minor clarifications and corrections. Thus, I recommend publication with minor revisions as the manuscript meets the kind of broad interest commanded by the readership of your Journal.

Please read below my comments (italics refer to the text of the manuscript).

Questions

- What was the duration of each experiment (days) and what would it correspond to in a real tidal system (years)?

Reply: Every tidal cycle takes 40 seconds. The control experiments took five (control 1) and ten days (control 2) to run. The vegetated experiments took longer to run as we had to wait four days between sowing events for seeds to germinate and grow sprouts. They both took around one month and a half (50 days) to run. We will clarify this in the paper.

It is difficult to say how many years it would correspond to in a real tidal system as we are not working with a classic scale model. If we base our timescale on the tides, we can assume that 5000 tidal cycles relate to about seven years in real-time (i.e., for a semi-diurnal tidal regime, one tidal cycle takes ca. 12 h and 25 min, that makes ca. 705 tidal cycles per year). However, the morphodynamics simulated over 5000 tidal cycles do not necessarily scale to the morphodynamics observed over seven years in natural intertidal systems due to uncertainties in scaling sediment transport capacity by tidal flows in the experiment versus natural systems. Furthermore, there is uncertainty on the scaling of the morphodynamic time scale and the time scale of vegetation development in the experiment. Nonetheless, our vegetated experiments ended up with low vegetation covers (especially in the hydrochorous experiment) instead of fully covered mature marshes, which qualitatively matches with the relatively slow rates of plant colonization that can be observed after ca. seven years in real intertidal systems. So, in conclusion, the time scales of morphodynamic and vegetation development qualitatively match. We will explain this in the paper.

- How did you ensure that the morphodynamic equilibrium was reached? Did you use a local or global criterion? The average difference between two successive DSM was computed and, if the difference was smaller than a certain threshold, the morphodynamic equilibrium was reached? Did the vegetation encroachment increase the speed at which the system reached the morphodynamic equilibrium? Could this trend be in line with previous field investigations in tidal environments?

Reply: We ensured that the morphodynamic equilibrium was reached by quantification of global system properties such as volume and channel migration (e.g., Figs 9 & 10 and supplementary Fig 6). In these graphs, we can see that around 5000 tidal cycles the rate of change of these system properties stabilizes, indicating that we have reached a "morphodynamic equilibrium". The presence of vegetation did not affect the speed with which the systems reach a morphodynamic equilibrium. Based on our timescale, we can argue that this trend is not in line with previous field investigations (morphodynamic equilibrium is usually reached after multiple decades or even a century). It seems that the morphodynamics is developing ahead of the tidal timescale.

- What are the limitations of using this vegetation species for large-scale experiments on the morphodynamic evolution of a tidal network? Vegetation has many functions in a tidal environment, for example it increases friction and favours deposition by sediment trapping and organic production. Are all these functions potentially reproduced (or reproducible) in the experiments? Or is there a function that is more dominant than the others in the experiments?

Reply:

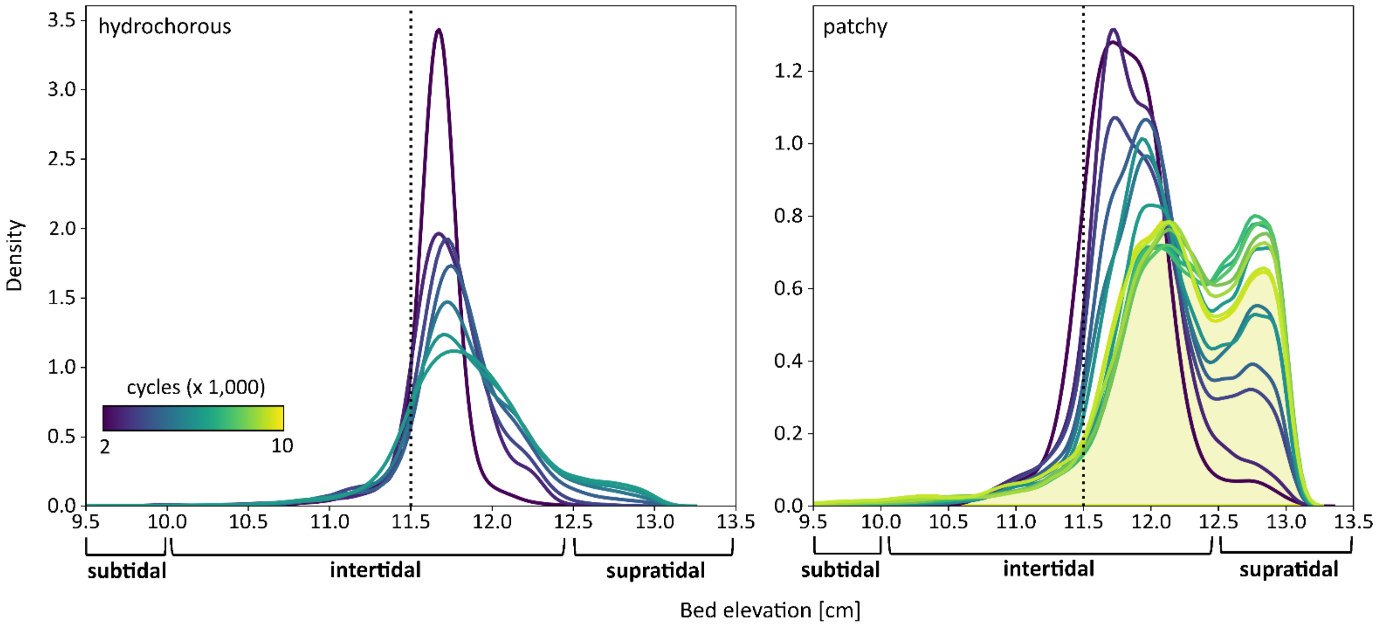
Previous research by Lokhorst et al. (2019) showed that this plant species could reproduce multiple functions, such as increased friction, flow retardation, and bank stabilization. Similar findings were found in Metronome experiments on estuaries using this species (Kleinhans et al., 2022; Weisscher et al., 2022).

In our experiments on saltmarsh systems, increased friction is the dominant function as this plant occurs in a high density. We did not observe sediment trapping to the same extent as in nature and in the experiments by Weisscher et al., where suspended sediment with lower density was added. However, some sediment was trapped in some locations containing dense vegetation patches, as seen in the picture below.

One of the limitations of using this species is that the seeds do not disperse over the whole tidal basin when they are spread hydrochorously. They only end up in areas close to channels. This might be one of the reasons why vegetation cover remained low during the hydrochorous experiment. Furthermore, using this species could be a disadvantage if you want to simulate plant establishment in higher locations. Different plant species that are transported in suspension could be used for this purpose (e.g., *Veronica beccabunga*). We will discuss this in the improved paper.

- Does the vegetation grow in a specific elevation range related to the tidal range? Does the vegetation biomass peak at a specific elevation?

Reply: The vegetation mainly grew in intertidal and supratidal areas of the tidal basin. This corresponds to around 11 – 13 cm in bed elevation (the initial bed elevation was 11.5 cm). If we plot the density of bed height containing vegetation, a noticeable peak can be found around 11.5 to 12 cm and 13 cm (see figure below). The black dotted lines represent the initial bed level. We will provide this additional information in the supplementary materials of the revised manuscript.



This figure shows the density of bed elevation pixels containing vegetation. We can observe a peak around 11.5 – 12 cm in both experiments and an extra peak around 13 cm in the patchy experiment. The dotted line indicates the initial sand bed level of the experiments. The estimated tidal ranges (subtidal, intertidal and supratidal) are specified as well.

Figures

Figures 4-11 and their labels look a bit blurred on my pdf file. This could be due to the pdf file compression but, anyway, please make sure that the overall resolution of each picture is high enough (usually 300 dpi).

Reply: Indeed this is due to compression and we will solve this in the revised manuscript.

Figure 1. On the top left, the panel labelling seems starting with "b)" and it gets a bit confusing when I look at the inset on the top right. I would replace label "b)" on the top left with "a)" and delete the labels in the inset on the top right leaving only the black square.

Reply: This will be changed.

Figure 2. Could you add photographs where you see the channel network and the vegetation on the floodplains? I am thinking of photographs like those in Figure 5 in Weisscher et al., 2022. It helps to better visualise the experimental setup.

Reply: Thank you for your suggestion, we will add a figure with photographs.

Figures 3, 4, Sup_f01, Sup_f02, Sup_f03, Sup_f04, Sup_f05. Tick values on some vertical axes are missing.

Reply: The tick values were removed on purpose in the y-axis, apart from the most bottom subplot to simplify the figure and remove 'unnecessary' text. However, we can change this.

Figure Sup_f05. In the panel referring to hydrochorus vegetation at 3071 cycles, the sea basin is represented with a darker blue. I think it is only a plotting issue, but it could be worth checking it out.

Reply: This is not a plotting issue, but a consequence of external disturbance changing the position of the laser-camera system. Basic corrections were applied to correct this, however, some inaccuracies can still be seen in the sea basin. We will add this information to the figure caption.

Figure 5. This is a very nice picture. It seems that you have a figure composed of only a single column. Is it done on purpose? If you stretch the horizontal axis as in Figure 8, does it get too distorted? Moreover, tick values on some vertical axes are missing. If you use panel labelling, you can refer to specific panels when describing the figure in Lines 256-269.

Reply: We chose to plot the figure in this format to avoid making it too distorted/too big, as we do not consider it a highlight in the paper. It is an example of all experiments' erosion and sedimentation maps. Since we could not discern big differences between the experiments, we show only one plot. The tick values were removed to simplify the plot, but they can be added again.

References

Lines 606, 625. "/a -n/a" appears in the references Temmerman et al. (2005) and Vandenbruwaene et al. (2011). Is that right?

Reply: We corrected this and have added the page numbers in these references.

Lined comments

- Line 146. "Based on Lokhorst et al. (2019), experience in the Weisscher et al. (2022) experiments and pilot experiments not reported here". Is there a reference (paper or conference abstract) for the "pilot experiments not reported here" (are the pilot experiments mentioned in line 173?)? I would simplify the sentence as "Based on previous experiments (Lokhorst et al., 2019; Wesscher et al., 2022;, ...), a single plant species was ..."

  Reply: We will discuss the 12 pilot experiments briefly in the manuscript. These have not been published and are also not so interesting, but they demonstrate that our experiments in the paper are not accidental hit-miss cases, and that the equilibrium dimensions can become larger or smaller depending on the imposed conditions and are therefore truly equilibria in our paper.

- Line 149. "alfalfa". Plant species were written in italics in the manuscript. Please write alfalfa in italics.

  Reply: Alfalfa is not the Latin name of the plant species (*Medicago sativo*) and is therefore not written in italics.

- Line 150. "it does not establish in unsuitable locations". Do you mean "grow"?

  Reply: We specifically use the verb "establish" as we focus on the seedlings' establishment phase and uprooted seedlings that can settle in other locations via the tidal flow. Plant growth was not observed in these experiments as the absence of nutrients prevents further plant development as seen in Lokhorst et al. (2019).

- Line 196. "... with a resolution of 4000 of 6000 pixels ...". Is it 4K or 6K?

  Reply: This is a typo, we meant to write 4000 by 6000 pixels.

- Lines 198-199. “The images were calibrated for internal and external parameters (i.e., lens correction, geometric rectification) before they were stitched.”. Which calibration method did you use for correcting lens distortion? Checkerboard method by Zhang (1998) or another one? Could you add the reference for the method?
  Zhang, Z. (1998). A flexible new technique for camera calibration. Technical Report MSRTR-98-71 Microsoft.

  Reply: The lens distortion was corrected in the standard Matlab toolbox. A pinhole camera model was applied for calibration, which uses calibration techniques involving the checkerboard method. Afterwards the “undistortImage” function was used to correct the images for lens distortion. This can be added in the methods description of the revised manuscript.

- Was the geometric rectification carried out using python built-in functions in OpenCV? If so, please add a reference of the python package (e.g., Bradsky, 2000).
  Bradski, G. (2000). The OpenCV Library. Dr. Dobb’s Journal of Software Tools, 120; 122-125.

  Reply: The geometric rectification was carried out in Matlab by applying a projective transformation using the “fitgeotrans” function based on a correspondence between fixed (coordinates in real world) and moving points (corresponding points in images captured by the cameras). This can be added in the methods description of the revised manuscript.

- Line 206. “Basic corrections were applied.”. Please give a brief description of the basic corrections applied.

  Reply: The basic corrections applied are the following: a correction value was retrieved by calculating the median of the differences between two DSMs (one ‘undisturbed’ DSM and one DSM after the position of the laser-camera system changed). This value was then added to the elevation data. This can be added in the methods description of the revised manuscript.

- Line 259. By introducing panel labelling, you could refer to specific panels in figure 5 when describing evolution phases.

  Reply: We will follow this suggestion, and additionally we will add text next to the plots (similar to figure 4) to describe the developmental phases.

Minor typographic/grammatical corrections were made as indicated. Suggestion about the plots will be implemented.