Dear Editor and Reviewers, NHESS,

First of all, we deeply appreciate the editor and reviewers' efforts to evaluate our manuscript, and also must thank them for the fact that they spent their precious time in conducting this reviewing process. The authors wish to express their gratitude for a number of constructive comments and advice given regarding the original manuscript, which much assisted the authors in its revision. Please find below a detailed reply to all reviewers' comments.

Kind Regards,

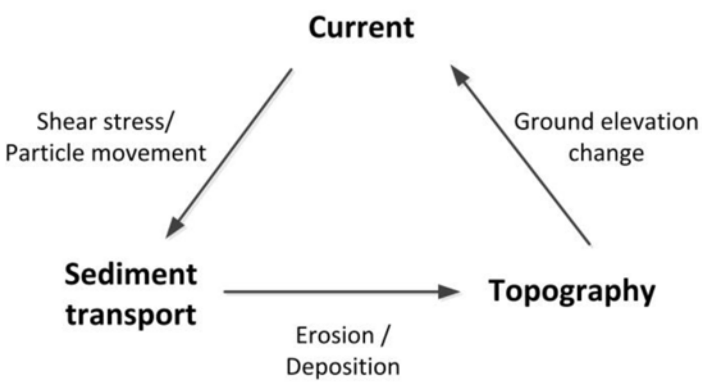
Hiroshi Takagi
Tokyo Institute of Technology

Reply to the comments:
In blue: reviewers' comments
In red: authors' reply

Reviewer #1

General Comments and Remarks

This paper investigates the benefits of mangrove embankments in attenuating the amplitudes of ocean tides through a coupled numerical model that reproduces shallow-water current propagations under the effect of soil consolidation and sea level rise. This phenomenon/process is a typical water-sediment-topography interaction issue can be described as below:

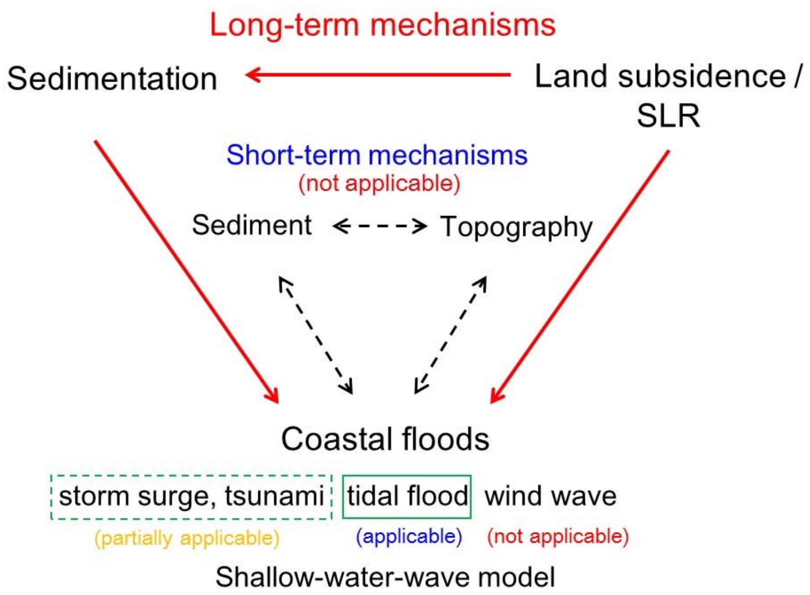


Ocean waves/tides induced onshore/offshore current causes accordingly sediment transport due to the bottom shear stress, then the net balance of sediment flux result in erosion or deposition of movable layer and further cause topographical change. Finally, current is influenced by the renewed topography. Basically, it is a dynamic cycle and is significant in the nearshore area. Thus in my opinion, the method used to investigate this topic should be capable of reflecting the interaction processes aforementioned. However the developed model in this study seems only cover part of the cycle mentioned above, sediment transport due to the shear stress generated by current is not considered. Topographical change calculation only consider soil consolidation (Eq.3 ~ 8), lack of erosion/deposition caused by net sediment flux. The sediment accretion(deposition)/decrement(erosion) should be calculated according to the temporal of vegetation growth ratio not only an assumed average accretion rate 1 cm/year instead. Generally speaking, the topic discussed in this paper is essential and well fit with the scope of this journal. However, the completeness of the coupled model applied in this study, in my opinion is insufficient as well as lack of model verification based on field data (hydrodynamic, topography etc.). In additions, it is suggested to extend more discussion on the sand trapping efficiency and tidal wave energy dissipation due to the existence of mangrove embankments especially in different stages.

We thank the reviewer for the great number of very productive comments and suggestions above, which would enable us to significantly improve our manuscript.

We agree the importance of the dynamic interactions among current, sediment, and topographical changes (here, referred to as short-term mechanisms), as illustrated by the reviewer's diagram. Indeed, we didn't state the contribution of the short-term mechanisms on the morphological changes of the mangrove embankment. Therefore, a brief section "Short-term morphology changes under waves and tidal currents" will be added in the revised manuscript, stating "These appear to be very important mechanisms in determining the topography of the mangrove embankment in the short term. Nevertheless, a beach profile due to this mechanism will be seasonally fluctuating around an equilibrium beach profile if it is monitored over many years. This cross-shore evolution is believed to occur on a somewhat shorter time scale than the planform evolution, and tends to demonstrate a seasonal cycle (i.e. summer waves act like bulldozers that push the offshore sand up across the shoreline, whereas the winter waves rush onto the beach, erode the beach sand, and carry it seawards with the backwash). Because this study aims at investigating the long-term / macroscopic evolution of the embankment, the morphology changes under waves and/or tidal currents were not taken into account in this study; it focused only on the cycles of the long-term mechanisms."

Besides, a conceptualized figure (borrowing the idea of the reviewer's diagram) will be added, as shown below, so that the scope and the applicability of the proposed model could be clearly understood by the readers.



New figure to be inserted in the revised manuscript: Scope and the applicability of the proposed model. Long and short-term mechanisms could both cause morphology changes of a mangrove embankment. However, only the long-term mechanisms were taken into consideration in this study. The shallow-water wave model adopted here can reproduce the propagation of not only tides but also storm surges and tsunamis over the embankment. However, the latter mechanisms may not be always reproduced.

Specific comments:

1. P.3, I suggest to add a paragraph to introduce the study area. For example, climate, shore geomorphology, wave, tidal components, historic disasters etc. That will be helpful for readers to understand the determination of computational conditions for the case study (P.7).

We agree. The section of "Computational Conditions for the Case Study" will be modified by including some more clarifications on the study area.

2. P.4, Ln26-27, "… the water depth used in Equations (1) and (2) is adjusted to the ground subsidence that is calculated by the following Terzaghi one-dimentional consolidation equation…", How to adjust need more descriptions.

We agree. The following paragraph and some more will be added in the revised manuscript:

"The water depth used in the shallow-water wave model will be updated by incorporating the calculated subsidence at the *n*th year. Besides, the SLR and sediment accretion will be taken into account in determining the water depths above the ground surface of the mangrove embankment."

3. P.4, please provide field verification examples or application references of this integrated model.

The shallow-water wave model and the Terzaghi one-dimensional consolidation theory are both very commonly used in scientific communities with the long-history of engineering application. Moreover, the present coupled model do not consider the short-term mechanisms as mentioned earlier. Also, the verification of the model seems to be virtually impossible as it requires the data measured over decades. On the other hand, the verification could be possible for the tidal propagation part if the field observed data could be obtained in a natural or manmade mangrove forest, of which geometry is similar with one assumed in this study. However, such model verifications are outside the scope of the present paper, and should be the target of future work.

4. P.7, 2.5 Computational conditions for the case study:

- What about the sea level rise scenario during simulation period

The clarification on the SLR scenario will be added in the revised manuscript.

- Why boundary condition only consider diurnal tide? What about other tidal components?

In this study, the analysis was performed only for the diurnal tide to simplify the discussion and to test for an unfavourable tidal condition, where the mangrove's effect as a tidal attenuator could be limited. The longer the tidal period, the smaller the tide attenuates. Therefore, the authors believe that investigating the diurnal tide is ideal for observing the fundamental function of the mangrove embankment system. The tidal damping for semi-diurnal tidal components, which are half the periods of the diurnal tides, appears to be more remarkable compared to the diurnal tide, when their amplitudes are the same.

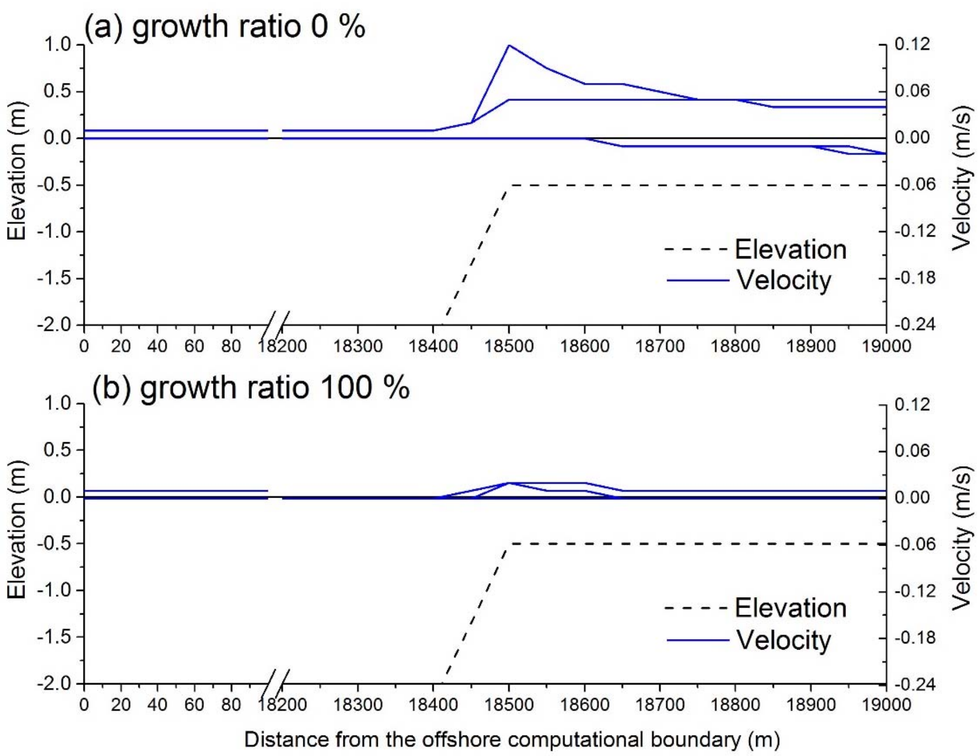
- Bottom roughness linearly increase with time to represent vegetation growing, however the sediment accretion was assumed a constant value 1 cm/year seemed not reasonable. Sediment accretion could be higher in the final stage when the land subsidence become worse.

5. P.9, Ln6, "Suspended sediment trapped by mangroves is highly dependent on the extent to which the plants are fully grown", this means the amount of trapped sediment should be calculated according to the shear stress generated by current.

Thank you for providing this insightful comment. Indeed, it is expected that a fully-grown mangrove could substantially slow down tidal velocity, thereby contributing to accelerated sediment deposit. In this study, however, the rate of sediment accretion was simply assumed to be constant because the uncertainty inherent in the process is too large to provide a reliable estimation over the years. It is also noted that the efficiency of sediment trap with vegetation growth could be canceled by the velocity increase due to the water-depth increase as the land subsides.

6. P.9, Ln18-26, P.10, Ln1-1, P.10, Ln27-30, please provide more current simulation results like velocity, shear stress variation etc.

We agree. The figure dealing with the flow velocity over the mangrove embankment, such as below, will be place and discussed in the revised manuscript.



New figure to be inserted in the revised manuscript: Cross-sectional profiles of flow velocity during one tidal cycle (line was drawn every 6 hours). The water depth of the embankment was assumed 50 cm.