Referee comments and replies on "Physical controls and a priori estimation of raising land surface elevation across the southwestern Bangladesh delta using Tidal River Management" by Md Feroz Islam et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-300-RC1, 2021

Reviewer #1

Reviewer's comments:

This study aims to quantify the potential effects of Tidal River Management (TRM) in elevating low-lying areas (beels) in southwestern Bangladesh, building upon an existing work by Adnan et. al. (2020). The study addresses the non-linear nature of sediment deposition during TRM, which underpins its main contribution. However, I have a few observations in terms of motivation, clarity, and justification of this study. I would like the authors to address the following comments diligently before the manuscript can be considered for publication.

Authors' response

Authors thanks the reviewer for the suggestions. The reviewer comments (in italic) and point by pint response of the authors' to the comments are presented in the following section.

Reviewer's comment

Line 19-20: "Beels in the western part retain more sediment because of lower average land surface elevation". Does sediment deposition only depend on the existing elevation of the selected beels? Sediment concentrations in adjacent rivers of the select beels vary, which may also cause heterogeneity in the deposition. The authors have also acknowledged this fact in the discussion section.

Authors' response

Authors thanks the reviewers for pointing that out. Sediment deposition and sediment delivery inside the beels depends on numerous factors including the average land level. The line is adjusted as:

"Lower average land surface elevation is one of the reasons for the beels in the western part to retain more sediment."

Reviewer's comment

Line 376-377: "This means that sediment deposition in beels depends mostly on suspended sediment concentrations (SSC) in the feeding river". They should revise the abstract to provide a clear message from their study.

Authors' response

Authors thanks reviewer for the suggestion. The abstract is adjusted to provide more clarity by adding the following sentences:

"Our model results indicate that these five parameters and their interactions are significant for sediment deposition per day (SPD) where SSC and BA have high impact, TR and ID have moderate impact and IW has low impact on sediment deposition."

Reviewer's comment

Line 22-23: "Thus, the length of time of TRM application in cyclic order will need to vary across the delta to counterbalance RSLR". It is not clear what type of variation in the length of time of TRM application that the authors are referring to.

Authors' response

The line is adjusted as:

"Thus, the length of time of TRM application in cyclic order will need to vary across the delta from one to multiple years to counterbalance RSLR"

Reviewer's comment

Line 94-95: "Although their regression model had a coefficient of determination (R2) of 0.88, it remarkably did not include tidal range (TR), suspended sediment concentration (SSC) and surface area of the beel." I think this statement is partially correct. The authors have only referred to the criteria for flood susceptibility modelling in Adnan et. al. (2020), ignoring the indicators used for simulating sediment deposition in 234 beels. Section 2.5.1 in Adnan et. al. (2020) includes the following statements: "To identify suitable TRM sites, five indicators were selected: i) tidal prism; ii) river salinity; iii) flood-prone areas; iv) crop production; and v) size of the 'beel'." So, I would suggest the authors revise the statements written in lines 90 – 95.

Authors' response

Authors' thanks the reviewer for the suggestion and the lines have been adjusted as:

"Adnan *et al.* (2020) used tidal prism, river salinity, flood-prone areas, crop production and size of the beel to identify suitable TRM sites. Although their regression model for flood susceptibility had a coefficient of determination (R2) of 0.88, it remarkably did not include tidal range (TR) and suspended sediment concentration (SSC)."

Reviewer's comment

The contribution of this study needs to be clarified. I feel the authors should clearly write the main argument of their study. They could summarize the key research gaps in the existing relevant literature at the beginning of the last paragraph in the introduction section.

Authors' response

To clarify the research gaps and objective of the study line 99-101 is adjusted as:

"To evaluate how TRM may help to raise the land in polders in southwestern Bangladesh, a quantitative understanding is needed on how different boundary conditions, beel topography and geographical setting determine sediment deposition, and how these vary across the SW Ganges delta. This understanding is currently lacking."

And the objective and the relevance of the study is presented in line 101-104 as:

"In this study we aim to determine the effect of physical controls related to the hydrodynamics of the river and how geo-morphodynamics of beels control the sediment deposition in those beels using TRM. We evaluate the possibility to raise the land surface elevation of the beels in the southwestern region of Bangladesh through sediment deposition using TRM to counterbalance yearly RSLR."

Reviewer's comment

This study used a range of datasets. It would be convenient for readers if the authors provide a summary table (including sources and resolution where applicable) of data used in this study.

Authors' response

The data set used in this study was collected from Islam *et al.* (2020 and 2021) where tables are presented with the source and resolution of the data. Authors have referred the articles in lines 183-184 as:

"For the scenarios, we used the TR and the SSC that occur within the three flow regime regions during the different seasons as defined by Islam *et al*. (2020, 2021)"

Reviewer's comment

Figure 3: How were the spatial boundaries of four sample beels determined? It is not clear in the manuscript.

Authors' response

The boundaries of the beels were selected such that the surface area of the beel met the criteria of the scenarios presented in Table 2.

Reviewer's comment

The policy implications of this study are not clear. In the discussion section, the authors have critically evaluated the effects of the physical controls on sediment depositions across various beels, and their impacts on land elevation. However, it is equally important to provide a clear message to the policymakers by translating the scientific finding into policy measures.

Authors' response

The reviewer has rightly pointed out that this study discusses about physical controls of the sediment deposition inside the beel. Authors have tried to indicate the implications of the findings of the study to the policymakers and requirement of taking socio-economic aspect of TRM into consideration in line 506-509 as:

"Our regression model provides a priori estimation of the potential to raise land surface elevation for the beels in southwestern Bangladesh, which may assist decision makers to prioritize the location of TRM operation, for example as part of the Bangladesh Deltaplan 2100. TRM may be implemented, restricted to monsoon periods, involving a flood rotation scheme of different polders being raised during different years, over a prolonged period of time, to keep up with continuing sea level rise. However, since TRM operation is not only dependent on physical constraints, planning should also give adequate attention to socio-economic aspects to get acceptance by stakeholders affected."

Reviewer's comment

This study quantified TRM's impact on land elevation only from the perspective of physical environment. But historically the success of TRM was interrupted by various social factors such as social unrest, conflict, and issues related to compensation. I understand these are outside of the scope of this study. However, I would like the authors to provide a few statements on potential uncertainties in the results.

Authors' response

The reviewer has rightly pointed out that this study discusses about physical controls of the sediment deposition inside the beel and socio-economic factors are essential for TRM as well. However, the socio-economic aspects were beyond the scope of this study, Authors have tried to indicate the importance of taking socio-economic aspect of TRM into consideration in line 507-509 as:

"However, since TRM operation is not only dependent on physical constraints, planning should also give adequate attention to socio-economic aspects to get acceptance by stakeholders affected."

The error and uncertainty of the hydro-morphodynamic model is explained in line 149-161 as:

"Islam *et al*. (2020) calibrated the 2D hydro-morphodynamic model for Pakhimara Beel by comparing the observed water level, discharge and SSC with simulated ones. Manning's coefficient, shear stress and settling velocity were the primary parameters for calibrating the hydrodynamic and morphodynamic models. Sensitivity analysis of the model was carried out with varying Manning's coefficient from 0.1 s $m^{-1/3}$ to 0.01 s $m^{-1/3}$, shear stress from 0.01 N m^{-2} to 0.1 N m^{-2} and settling velocity from 0.0001 m s^{-1} to 0.001 m s^{-1}. To understand the uncertainty of the model, the coefficient of determination (R^2) and the normalized root mean square error (NRMSE) were calculated by comparing the modelled results with the observed data for the different input variables. Best model performance was obtained using a spatial average value of 0.032 s $m^{-1/3}$ for the Manning's coefficient, shear stress of 0.08 N m^{-2} and settling velocity of 0.0005 m s^{-1}. The related R^2 for water level, discharge and sediment concentration were 0.87, 0.88 and 0.84, respectively. The NRMSE (%) for water level, discharge and sediment concentration were 9.7, 16.6 and 18.3, respectively (Islam *et al*., 2020). Islam *et al*. (2020) also captured the effect of spring and neap tide during different seasons by running simulations for three tidal conditions and time periods of 14 days. For this study, we carried out simulations for a similar period of 14 days and similar parameterizations to capture the full range of tidal cycles for three flow seasons. The resulting sediment deposition in a beel was calculated in tons per day."

The uncertainty of the regression models are described in table 5 and in line 318-330 as:

"NLM1 shows a larger spread and seems to overestimate SPD for low and higher values when compared to the other two regression models. The coefficient of determination (R^2) of the three regression models ranges between 0.61 to 0.84 for the training sets and 0.29 to 0.94 for the

testing sets (Table 6). The averages for the two sets are, however, highly comparable. The predictive skill of the models generally increases with increasing number of variables. NLM1 using only BA and SSC as predictors for SPD, results in relatively moderate average R^2 of 0.61 and 0.71 for the training and testing data sets respectively (Table 6). NLM2 using TR, SSC, ID and BA and NLM3 using TR, SSC, ID, BA and IW produce better results. The mean R^2 for NLM2 are 0.77 and 0.74 for training and testing data sets respectively and the mean R^2 for NLM3 are 0.77 and 0.76 for training and testing data sets respectively (Table 6). Although IW correlates statistically significant with SPD in the ANOVA test (Table 3), it hardly contributes to better prediction of SPD with exponential coefficients of 0.02 - 0.14 (Table 5). The normalized root mean square error (NRMSE) ranged between 0.3 to 0.5 for the training datasets and 0.15 to 0.49 for the testing datasets (Table 6). The mean of NRMSE for NLM1 for the training samples is higher than obtained for NLM2 and NLM3. The mean NRMSE obtained for the testing dataset is almost similar for all three NLMs."

Reviewer #2

Reviewer's comments:

The authors present an interesting and comprehensive investigation of the physical controls of landscape changes in terms of elevation gain using Tidal River Management (TRM). The authors used a two-dimensional (2D) morphodynamic modeling to explore the sediment deposition in the beels during TRM. In addition, non-linear regression models were developed to analyze the relationship with the selected variables. Overall, the paper attempts to explore the physical controls of five variables: 1) river tidal range, 2) river suspended sediment concentration, 3) inundation depth, 4) width of the inlet, and 5) surface area of the beel. Though the method in itself is not novel, the technique is scalable. Exploring the sensitivity of adding additional variables or removing some of the chosen variables would be better.

The research deserves publication and outreach. However, there are many locations where revisions and modifications are needed. Therefore, I compiled a list including recommendations and questions to the authors.

Authors' response

Authors thank the reviewer for the suggestions. The reviewer comments (in italic) and point by point response of the authors' to the comments are presented in the following section.

Reviewer's comments:

Overall:
The manuscript is well written and focused on five major variables. I have concerns that are they enough? The relative elevation difference between riverbeds at the inlet and average height of selected beel, river slope, and others may be important variables. Another concern is that whether the calibrated model for a particular beel is scalable to the entire domain. Maybe authors can explore the viability of TRM supported by dredging and excavation in future work. Also, since the TRM is participatory, please try to incorporate some socialeconomic indicators.

Authors' response

Authors thank the reviewer for the suggestions. As we explained in the method section, we selected those variables that are the primary controls of the sediment trapping within a beel: In the area without tides (river area during monsoon) the inundation depth, and in the lower reaches and during low flow seasons the tidal range determine the volume of water that may enter a beel. The sediment concentration in the river water then linearly determines the sediment load conveyed into the beel. The inlet size and beel size are controls of the actual volumes entering a beel, and the residence time of the water - determining the time for sediment

settling. We expect that additional variables suggested by the reviewer certainly will correlate with the amount of sediment trapping, but we do not expect much added value from these. This is because the presumed effects of suggested additional variables may not be direct controls of sedimentation ("river slope") or are already incorporated by the variables we used, or spatially correlate to these. Specifically addressing suggested variables: “the relative elevation difference between riverbeds at the inlet and average height of selected beel, river slope” We agree that this might be a useful variable, but we did not consider this elevation difference, mainly since it is difficult to determine (particularly "river bed elevation" is hard to determine). Alternatively, we considered “Inundation depth” which is the difference between the water level and average land surface elevation inside the beel. We expect this inundation depth to some extent to correlate to the difference with channel depth (suggested by the reviewer), since a higher channel bottom level will at the same time lead to higher water levels in the feeding river, and hence to a smaller inundation depth of the beel. This Inundation depth at the same time includes the suggested "beel elevation". The variable "river slope" will likely correlate with deposition, but is not a direct control of deposition, as our variables do. Tidal range will directly (negatively) correlate to river slope (increasing tidal range for decreasing river slopes) in this area, so we do not expect that adding river slope will provide better predictions of sedimentation.

We agree that the question if a calibrated model can be used to understand a broad range of sedimentation inside the beels is important, which is the reason why we have studied this. We conclude that our method to produce a priori estimation of sedimentation inside the beel using understanding of morphodynamic changes of one of the beels of southwest Bangladesh due to operation of tidal river management (TRM) is valid. But we also conclude that for more precise estimation, location specific detailed study will be required, see discussion section.

Here we explored physical controls and morphodynamic changes inside the beel; socioeconomic indicators were beyond the scope of this study. We indicate this focus in our introduction, and in our discussion we refer to the socio-economic aspects that need to be considered for full assessment of impacts and feasibility of TRM in practice. The following sentence has been added after line 469:

“Socio-economic aspects such as conflict between the stakeholders, lack of proper compensation, lack of livelihood opportunities, lack of stakeholders’ participation during planning and implementation phase of the TRM, lack of cooperation between stakeholders and government agencies, divergence in common interest, imbalance between expectation and outcome and unequal distribution of benefits of TRM challenged the effective implementation of previous TRM operations (van Minnen, 2013; van Staveren *et al*., 2017; Gain *et al*., 2017; Mutahara *et al*., 2018).”

Authors agree with the reviewer on the suggestion for future study including the effect of dredging or excavation of riverbed. Authors appreciate this suggestion and the following sentences has been added in the discussion after line 469:

"Implementation of several previous TRM operation included excavation of the adjacent river supplying sediments inside the beel (IWM 2017a; 2017b). Water and sediment dynamics of the river are affected by the change in river bathymetry. Therefore, the effect of dredging and exaction of the river should be explored in the future."

Reviewer's comments:

Abstract:

The first three sentences of the abstract are not well connected to the storyline of the paper. Therefore, I recommend the authors team to re-write them, showing the significance of the study.

Authors' response

The lines are adjusted as:

Following the suggestion of the reviewer the Authors have revisited the introduction and have taken a closer look. We have adjusted the lines and concluded that at current state the lines are appropriate and fits the storyline as these state the dangers of relative sea level rise (RSLR) to the delta, TRM being a potential solution and knowledge in the form of determining the potential of TRM. Therefore, we have decided not to alter these sentences. Line 12 to 13 are adjusted as:

"The potential of TRM application in different beels across southwestern Bangladesh has been estimated previously but requires further exploration. Neither the seasonal and spatial variations in physical drivers nor the non-linear character of physical drivers and several sensitive parameters for sediment deposition have been taken into account so far."

Reviewer's comments:

Is it true that the potential of the TRM application is yet to be determined? I could see the paper has cited Adnan et al. (2020), which explored the potential of TRM for 234 beels using different variables. However, it would be better to write in abstract that the potential of TRM remains to be explored, considering several sensitive parameters.

Line 12 – 13: The potential of TRM application in different beels across southwestern Bangladesh, however, still remains to be determined.

Authors' response

Authors thank the reviewer for the

Line 12-13: has been adjusted as:

"The potential of TRM application in different beels across southwestern Bangladesh has been estimated previously but requires further exploration. Neither the seasonal and spatial variations in physical drivers nor the non-linear character of physical drivers and several sensitive parameters for sediment deposition have been taken into account so far."

Reviewer's comments:

Line 24 – 26: I believe the streamflow would be high from the upstream during the monsoon. And also, the sediment transport from the upstream would be substantial. So how effective would it be to operate the TRM during the monsoon season? I assume the TRM process takes full advantage of tidal flow from the sea in bringing the sediment deposited into the selected beel. And for the effective operation of the TRM, minimum upstream flow is recommended. Therefore, how challenging would it be to manage the upstream flow during the monsoon season?

Authors' response

The reviewer has rightly stated that the flow from upstream will be larger during monsoon and tide is one of the governing factors for sediment deposition inside the beel. Islam *et al.* (2021) indicated that seasonal variation of tidal range isn't large for tide dominated flow region, even during monsoon season and most of the polders of Bangladesh are located within the tide dominated flow region. Moreover, higher water level during monsoon and larger water and sediment flow from upstream results in larger sediment volume available in these rivers during monsoon (Islam *et al.*, 2021). This results in largest sediment deposition during monsoon inside the beel for the regions of tide dominated and mixed flow (Islam *et al.*, 2021) where all the polders and the beels of southwest Bangladesh are located. These are in line with the findings of this study.

In the discussion section we have now explained this point, and we added a reference to a paper in which we explored this issue.

Islam, M.F., Middelkoop, H., Schot, P.P., Dekker, S.C. and Griffioen, J., 2021. Spatial and seasonal variability of sediment accumulation potential through controlled flooding of the beels located in the polders of the Ganges-Brahmaputra-Meghna delta of Southwest Bangladesh. *Hydrological Processes*, *35*(4), p.e14119.

Reviewer's comments:

Introduction:
Are five variables enough? Are any variables proposed by Adnan et al. (2020) important to be included, as additional physical controls?

Authors' response

Adnan *et al.* (2020) considered geomorphic variables only, that indeed likely correlate with potential sediment accumulation in beels, but which are no direct controls. We have explored the physical drivers. As explained in the reply to the first reviewer, the variables considered by us take into account geomorphic conditions as well. The variable "Inundation depth" is the difference between the average land elevation and water level, as such it takes geomorphic variables proposed by Adnan *et al.* (2020) into account. Additionally, two of our proposed variables "tidal range" and "suspended sediment concentration" take water and sediment dynamics of the river into account. In the method section we added the following sentences after line 163 to be more precise to define our variables, and also make connections to the geomorphological variables as proposed by Adnan *et al.* (2020):

"We explored five parameters which affect the total sediment deposition inside a beel: river tidal range (TR), river suspended sediment concentration (SSC) are the two physical controls related to hydrodynamics of the river, inundation depth (ID), the width of the inlet (IW) and the surface area of the beel (retention basin, BA) are the three physical controls related to geo-morphodynamics of the beel. We have selected the parameters that are the primary controls of the sediment trapping within a beel. The ID and the TR determine the volume of water and sediment that may enter a beel. The SSC in the river water then linearly determines the sediment load conveyed into the beel. The IW and BA are controls of the actual volumes entering a beel and the residence time of the water, determining the time for sediment settling. We have explored the physical drivers, and the parameters considered take into account geomorphic conditions as well. The variable ID is the difference between the average land elevation and water level, as such it takes geomorphic parameters proposed by Adnan et al. (2020) such as land elevation, topographic slope and curvature of the land into account. Additionally, two of our proposed parameters TR and SSC take water and sediment dynamics of the river into account."

Reviewer's comments:

In terms of inlet width (IW), the initial IW slowly enlarged along with the operation of the TRM, as every day, two tides pass in and out. Also, the surface area of beel (BA) is often not fully used if the BA is large enough with respect to an available tidal prism. Meaning they are interdependent to a large extent. It is generally expected that the higher tidal range and suspended sediment concentration (SSC) lead to higher deposition.

Authors' response

The authors agree with the reviewer for pointing these out. This is demonstrated by our results, and we explain this in our discussion.

Reviewer's comments:

How will be the effect of saline sediment is deposited on the selected beel? Do we need to consider the quantification of salinity?

Authors' response

This issue was reported as part of our broader study by de Bruin (2019): *https://livingpolders.sites.uu.nl/wp-content/uploads/sites/308/2020/08/Final-Thesis-Jeroen-M-de-Bruin-15072019.pdf.*

To understand how the sediments delivered by the tide inside the beels affects the soil fertility and food productivity, we collected samples of new and old sediment deposits from three different locations. The locations were: The beel where TRM was operated in the past (Khukshia Beel), the beel where TRM operation was ongoing (Pakhimara Beel) and an area which received large sediment during a dike breach as a result of cyclone induced storm surge (Polder 32). Sediment samples were also collected from the areas which are protected from tidal flooding. Rice variety preferred by local farmers was cultivated in the collected sediment samples following traditional and local practices. The results indicate that the sediments delivered by tide had similar fertility and food productivity as the old sediment deposits which were not flooded in recent years.

In the discussion section we have added the following sentences after line 470 on this quality issue, and indicate that salinity does not negatively affect the deposited sediment as soil for crop production, with reference to the study of De Bruin (2019). "To understand how the sediments delivered by the tide inside the beels affects the soil fertility and food productivity, De Bruin (2019) collected samples of new and old sediment deposits from three different locations. The locations were: the beel where TRM was operated in the past (Khukshia Beel), the beel where TRM operation was ongoing (Pakhimara Beel) and an area which received much sediment during a dike breach as a result of a cyclone induced storm surge (Polder 32). Sediment samples were also collected from the areas which are protected from tidal flooding. The rice variety preferred by local farmers was cultivated by De Bruin in the collected sediment samples following traditional and local practices. The results indicate that the sediments delivered by tide had similar fertility and food productivity as the old sediment deposits which were not flooded in recent years. Therefore, the sediments delivered by the rivers of southwest Bangladesh is as good as old sediment deposits if not better."

Reviewer's comments:

Methods

Is the modeling approach calibrated for Pakhimara Beel applicable and scalable to entire southwestern Bangladesh?

Authors' response

The objective of this research is to present a method to explore physical controls, provide a priori estimation of sedimentation and explore the potential to counterbalance the yearly relative sea level rise (RSLR) through sediment accumulation in the beels of southwest Bangladesh. The beels located in southwest Bangladesh are within the same, tide dominated, flow region with similar ranges in geomorphological variables. Therefore, the calibrated 2D morphodynamic model and the resulting understanding of morphodynamic changes in Pakhimara Beels was assumed suitable to explore the general potential of the beels of the southwest Bangladesh using the location specific variables. For more precise estimation, location specific detailed study will be required, which is also suggested by the authors in the discussion section.

Reviewer's comments:

The operation and completion of TRM on adjacent beel play an important role in the sedimentation of current ongoing TRM-operated beel. Because the successful operation of one TRM would decrease the river profile considerably. I could see the paper has cited Talchabhadel et al. (2020). How will you consider such a dynamic effect on sedimentation?

Authors' response

Authors agree with the reviewer that operation of TRM on adjacent beels will play an important role on the sediment availability in the river section. Our model takes into account the tidal range (TR) and suspended sediment concentration (SSC) of the river section. In this way we consider any changes in the sediment load potentially to be delivered by the tidal river, for example resulting from operating TRM in multiple beels along the same channel. However, our model explores the potential considering operation of TRM in one beel within a river reach at once. The following lines are added in the discussion section to reflect this:

"Our study also considers operation of TRM in one beel within a river reach at once. More detailed studies will be required to reflect on the changes in sediment availability in the river section during a basin wide operation and shifting of TRM in several beels as suggested by

Talchabhadel *et al*. (2016 and 2020). As our study considers TR and SSC of the river sections, the changes in sediment availability for such TRM operation can be taken into account. Moreover, similar to our study, Talchabhadel *et al*. (2016 and 2020) also explored the shifting of TRM operation considering TRM in one beel at once."

In an ongoing study we investigate the effect of simultaneously opening multiple beels along the same channel on sediment deposition in a beel. This will be reported in a forthcoming paper.

Reviewer's comments:

Results

Are there any calibrations of beel sedimentation and river bed changes on seasonal levels (monsoon and nonmonsoon) with ground-based observations?

Authors' response

Calibration and uncertainty of the 2D morphodynamic model was done in a previous part of the project, and reported in (Islam et al. 2020). This was based on observations of sediment deposition in Beel Pakhimara in the period 2015- 2017, complemented with measured SSC in the river and feeding channel (IWM 2017b). We added this information to our explanation in lines 156 to 158 as, that read:

"The related R^2 for water level, discharge and sediment concentration were 0.87, 0.88 and 0.84, respectively. The NRMSE (%) for water level, discharge and sediment concentration were 9.7, 16.6 and 18.3, respectively."

The uncertainty of estimated sediment deposition using NLMs against sedimentation data presented in previous literatures for different beels are explained in line 332 to 337 as:

"As a separate test, we applied NLM3 to the Bhaina Beel and the Khuksia Beel where TRM was operated previously. Van Minnen (2013) reported that 6.45 million m3 and 8.2 million m3 of sediment were deposited in Bhaina Beel and Khuksia Beel, respectively, after five years of TRM operation. Sediment deposition per day (SPD) estimated with the NLM3 regression models for Bhaina Beel and Khuksia Beel had an average error of about 12-17% relative to the observed value which can be considered as moderate."

Reviewer's comments:

Table 3: I think IW (inlet width) and beel area (BA) will be throughout constant for a particular beel, whereas other varies temporally. How did you analyze the Pearson coefficient? Also, why are tidal range (TR) and Inundation depth (ID) negatively correlated?

Authors' response

Authors agree with the reviewer that the IW and BA will be constant for a beel; the other variables represent time variable dynamics (tide, inundation depth, sediment concentrations), but the variable themselves are constant during the seasonal time periods we considered (tidal range, SSC during flood, inundation depth during maximum inundation). Therefore, we can analyse them with the other 'constant' variables using the Pearson coefficient. We will indicate this in more detail in our methods section.

Inundation depth was introduced as it is a primary control in the upstream reaches during monsoon, when there is no tidal effect. During monsoon the water level in the river is higher resulting in larger inundation depth (ID) and during dry and pre-monsoon seasons water level in the river is lower resulting in lower ID. In contrast, the tidal range (TR) is ~~also~~ higher during the dry and pre-monsoon seasons. During the monsoon season, the flow from upstream rivers dampens the effect of tide, resulting in lower tidal range. Therefore, the correlation between TR and ID is negative. This is explained in line 292 to 295 as:

"The correlation matrix also indicates that TR and ID have a very strong negative correlation (Table 4). Tidal range (TR) is lowest during the monsoon season when water level in the river is highest and TR is high during the dry and the pre-monsoon season when water level in the river is low."

Reviewer's comments:

Discussion

Overall, discussion on the calibrated model on one particular beel to the whole study domain is insufficient. It would be better to highlight some of the results on earlier TRM operated beels like Khuksia, Bhaina, Kedaria, etc.

Authors' response

Authors thank the reviewer for this suggestion. The sediment deposition in the beels where TRM were operated previously has indeed been compared to our model results in line 332 to 337 as:

"As a separate test, we applied NLM3 to the Bhaina Beel and the Khuksia Beel where TRM was operated previously. Van Minnen (2013) reported that 6.45 million m3 and 8.2 million m3 of

sediment were deposited in Bhaina Beel and Khuksia Beel, respectively, after five years of TRM operation. Sediment deposition per day (SPD) estimated with the NLM3 regression models for Bhaina Beel and Khuksia Beel had an average error of about 12-17% relative to the observed value which can be considered as moderate."

Given the modest difference between actual sedimentation and calculated sedimentation for two different beels we consider our model suitable for the objective of this research: which is to present a method to explore physical controls, provide a priori estimation of sedimentation and explore the potential to counterbalance the yearly relative sea level rise (RSLR) through sediment accumulation in the beels of southwest Bangladesh.

Reviewer's comments:

Also, it is not clear to me that the number of inlets in all selected over 200 beels on the whole domain. For instance, the operated East Kapalia had one opening at first and two openings later; the closing of these inlets were also at different times.

Authors' response

The reviewer rightly mentions that the number of beels might be adapted during TRM. We did our spatial exploration assuming a single inlet, such that the results only depend on spatially varying and inadaptable boundary conditions. Nevertheless, using the regression model we can also identify the effect of using two inlets for a specific location. To clarify this, lines 369 to 372 have been adjusted as:

"We explored how sediment deposition per day (SPD) in beels within the southwestern GBM delta of Bangladesh under active operation of Tidal River Management (TRM) with single inlet depends on boundary conditions associated with flow regime of the feeding river and season (tidal range (TR) and suspended sediment concentration (SSC)), and on various beel dimensions (surface area (BA), width of the inlet channel (IW) and inundation depth (ID))."

Reviewer's comments:

Also, 6.4 million in Beel Bhaina and 8.2 million in Khuksia are at different years of operation. I guess Bhaina was operated for four years, whereas Khuksia for about seven years. Similarly, Kedaria was operated without embankment breach but using over 20 vents. In addition, Bhaina had no peripheral embankment for the selected beel area, whereas kedaria and khuksia had

peripheral embankments. Meaning, the earlier deposition data of operated TRMs had different operation policies and infrastructures and different tidal prisms.

Authors' response

The authors are aware of the differences mentioned by the reviewer. However, differences in beel area, and tidal range are accounted for by the regression model, and variations in TRM period are eliminated by determining deposition per year. Clearly specific operation rules might affect actual deposition rates. In spite of uncertainties in effective inlet size (either being a single inlet canal, or a series of vents) our explorative regression model provides a realistic estimate of deposition. We therefore are confident that the model is valid for a-priori estimation of deposition rates in beels across the lower Ganges delta and explore the potential to counterbalance the yearly relative sea level rise (RSLR) through sediment accumulation in the beels of southwest Bangladesh. To prepare operation rules for TRM in a specific beel a location specific detailed study is required. This is also stated in discussion section.

Reviewer's comments:

Under different RCPs, it is not only expected to change the relative sea level rise (RSLR) but also many hydroclimatic parameters will change, like precipitation pattern. How would these affect streamflow, river sedimentation, and overall sediment transport?

Authors' response

Reviewer has rightly pointed out that different RCPs will have different precipitation regies which will impact the upstream flow. Further not only climate scenarios, but also socio-economic scenarios will have different effect, such such as withdrawal of water in the upstream basins will have impact on the sediment availability in the rivers. The following has been added in discussion section after line 418:

"The sediment carried by Ganges, Brahmaputra and Meghna rivers discharges through the Meghna estuary (Anisul and Munsur, 2016). These sediments re-enter the western sea arms where the beels identified by Adnan et al. (2020) are located due to clockwise estuarian circulation (Anisul and Munsur, 2016). Derby *et al*. (2018) indicated that due to anthropogenic and climate change the supply of fluvial sediment to the apex of the GBM delta is likely to increase substantially, by around 50 percent by 2090s. In contrast, Higgins *et al*. (2018) projected that due to anthropogenic changes upstream, both the Ganges and the Brahmaputra rivers will experience reduction in the annual suspended sediment load by 39-75% and 9-25%, respectively. The increase or decrease in sediment supply in the rivers will impact the potential of the beels for sediment deposition in the future. The overall effect is dependent on the future climate and

connected socio-economic scenarios. With our method a priori estimation of sediment deposition and potential of TRM can be achieved for different future scenarios."

Anisul, H., & Munsur, R. (2016). Flow distribution and sediment transport mechanism in the estuarine systems of Ganges-Brahmaputra-Meghna delta. *International Journal of Environmental Science and Development*, *7*(1), 22-30.

Darby, S. E., Nicholls, R. J., Rahman, M. M., Brown, S., & Karim, R. (2018). A sustainable future supply of fluvial sediment for the Ganges-Brahmaputra Delta. *Ecosystem Services for Well-Being in Deltas*, 277-291.

Higgins, S., Overeem, I., Rogers, K., & Kalina, E.: River linking in India: Downstream impacts on water discharge and suspended sediment transport to deltas, Elem Sci Anth, 6(1), doi:10.1525/elementa.269, 2018.

Reviewer's comments:

Conclusion:
Make conclusion concise and focus on reducing the redundant information.

Authors' response

The conclusion section is adjusted accordingly.

Reviewer's comments:

Line 507 -508: It is sudden that the paper talks on socio-economic aspects in conclusion. I could not see sufficient discussion prior in any sections.

Line 509: same as above for rotation scheme

Authors' response

The flood rotation scheme has also been discussed in section 4.4 of discussion. The flood rotation scheme and importance of socio-economic aspects of TRM operation has been added in the discussion. The following has been added to section 4.4 after line 463:

"However, physical constraints as well as socio-economic aspects of TRM operation should be considered to determine an optimum flood rotation scheme for the beels in southwestern Bangladesh."

After line 469:

"Socio-economic aspects such as conflict between the stakeholders, lack of proper compensation, lack of livelihood opportunities, lack of stakeholders' participation during

planning and implementation phase of the TRM, lack of cooperation between stakeholders and government agencies, divergence in common interest, imbalance between expectation and outcome and unequal distribution of benefits of TRM challenged the effective implementation of previous TRM operations (van Minnen, 2013; van Staveren *et al*., 2017; Gain *et al*., 2017; Mutahara *et al*., 2018). Therefore, next to the physical considerations the socio-economic aspects and social acceptability of TRM should get ample attention in order to fully reap the potential of the method we have explored."

Reviewer's comments:

Minor:

Line 34: full form of RCP at first occurrence. [Please check other acronyms thoroughly]

I found acronyms are provided with full form again and again. So it would be good to use them effectively.

Authors' response

Thank you, we have adjusted this accordingly.