Dear Editor Prof. Passalacqua,

Thank you for sending me the manuscript "Dynamics of salt intrusion in the Mekong Delta; [...]", by Eslami et al. for review. I read the paper with great interest. The authors study the salt intrusion into the Mekong delta on hand of measurements and a numerical model. I like in particular that the authors show how bathymetric changes and surges influence the salinity intrusion, as well as how the dynamics in the smaller less connected distributaries differ from those in the more stratified main channels. The study appears by and large correct, but I have several comments worth a thought, and several minor comments that need clarification, and give some advice on how to improve the presentation. I recommend to accept the manuscript for publication, once it has been improved.

Kind regards,

Comments

- The simulations are insightful, and they could potentially contribute to a better general understanding of salinity intrusion, if the analysis, in particular, section 4.2, were given more theoretical depth.

  According to (*Savenije*, 2012), the salinity intrusion length L can be estimated as:

  $$L = a \log \left(1 + \frac{D_0 A_0}{K a Q_f} \right), \tag{1}$$

  Where a is the convergence length, D_0 the dispersion coefficient, A_0 the cross section area at the inlet, K van der Burgh's parameter and Q_f the river discharge.

  - When do the assumptions fail on which the simple relation () is based on, i.e. how far and why is the 3D model really better and how could the simple relation be improved based on this insight?
  - How can the parameters do D_0 and K be (better) estimated? In particular, how do they vary over the spring-neap cycle, during surges and change due to channel deepening through sand mining?

- The manuscript highlights the importance of on-shelf dynamics for the intrusion of salinity, yet the model only reaches about 70 km (c.f. line 144) into the sea, nowhere near the edge of the shelf which is at its closest point more than 250 km away. This has several limitations:

  - The model seems to account for the surge by raising the mean level at the sea boundary only, instead of modelling it directly. It would be interesting to model the surge fully through a larger domain on the shelf and barometric forcing. For the current setup, I am not fully convinced that a simpler 2DV model which only incorporates the river could not perform similarly well, as long as the surge level is applied at the river mouth in a similar fashion.

  - The freshwater plume is very likely cut off and its dynamics not fully captured.
  - Tidal waves will be spuriously reflected at the seaward boundary.

- Bedform dynamics vary the roughness on the seasonal and the spring-neap timescale and sand mining can reduce bedform dimensions and roughness. This might affect salinity intrusion as much as the deepening of the channels. The bed roughness employed in this study is rather crude. Similar ad-hoc approaches are typically taken in analytical and 1D model studies, but they are less justified for complex 3D models. As Delft3D can capture bedform migration and the induced roughness to a certain extent, it would be interesting to see this incorporated into the model.

- Suspended bed material transport introduces stratification and largely influences the turbulence structure. This certainly influences the mixing and hence the salinity intrusion. As sediment transport is a strongly non-linear process, the influence will be complex. As Delft3D-FM was primarily build to model sediment transport, it would be a pity not to apply it in the model.

- The study investigates the effect of bed level changes due to a reduction of sediment supply and sand mining. It is well known that this also causes wide-scale bank erosion and channel widening in the Mekong. How far does this influence the salinity intrusion and is this accounted for in the model?

- The study also investigates the effect of surges. Large surges potentially cause overbank flow. How far does this play a role in the MD and is this accounted for in the model?

- The study proclaims the superiority of 3D over 2D/1D models, yet the analysis and discussion are limited to 2D dynamics, namely the along channel and vertical dimensions. If the dynamics along the third dimension (across-channel) is relevant, then it should be analyzed and discussed, if not, 3D should be better be called 2D-vertical.

- It is redundant to provide both the R^2 and NSE as both have nearly identical definitions and limitations with respect to evaluating the goodness of fit. I suggest stating only the R^2. It would be much more interesting to provide the goodness of fit for the salinity, even if if it will be much poorer compared to the tides. This will give readers get an impression, what goodness of fit they could expect for their own studies.

Minor

22 "the continental shelf is an intrinsic component of the delta"
I disagree since the continental shelf is considerably larger than the Mekong (pro-)-delta, a more precise formulation would be "hydrodynamic processes on the continental shelf influence those in the delta".

24 "The delta's estuarine system is also more sensitive to upstream discharge variations."
Is this Mekong really more sensitive to river discharge variations than other rivers, why?

34 "in absence of [...] measurements [...], any prognostic evaluation of estuarine systems resorts to numerical modelling"
I disagree. In my experience complex 3D models do not perform well without extensive calibration and accurate bathymetric survey, and even when such data is available, simple empirical predictors fit to the observations often outperform complex models. However, I agree, that 3D models can provide insight into general dynamics and serve as a nifty way to interpolate and extrapolate observation in time and space.

99 Is there no better data than Milliman and Farnsworth? The authors seem to have access to an extensive dataset which should make them able to give more insight into the typical wet and dry season discharge. If not, it should be at least specified what the 350-500 indicate, i.e. interquartile ranges, etc.

125 slack tide : I think this means high water slack, please be more concrete.

130 "open source" : This is an overstatement. While the source code of the computational core of Delft3d-FM is indeed open source, the GUI which is necessary to set-up Delft3D-FM models is proprietary.

131 "Shallow Water Equations" : This is imprecise, Delft3D solves the (hydrostatic) Reynolds-Averaged Navier-Stokes Equations for the 3D parts of the model, and the SWE for the 2D and 1D parts.

160 Evaporation ... Is evaporation important for salinity in the Mekong Delta that it needs to be mentioned here? If so, does it mean evaporation from the water surface or the land surface?

228 bi-weekly : Alternating spring tides of different character are typical for deltas with mixed diurnal-semidiurnal tides. The observation, that this seems to strongly influence the salinity intrusion, deserves more attention. Does the difference in intrusion only stem from the difference in the tidal range or is the tidal asymmetry important which determines the shape of the wave?

97 Section 2.1 should be complemented with some basic information about the tides, at least state the mean spring tidal range or similar.

250 "During spring-tide, Stokes transport generates an upstream water level gradient that releases discharge towards the neap tide." :
Not quite. The oscillation of the subtidal water level offset over the spring-neap cycle is caused by higher friction during spring than during neap-tide. While this also causes the flow to oscillate over the spring-neap cycle, this is different from the Stokes transport, i.e. the transport which is caused by the phase difference between tidal velocity and surface elevation.

278 3.6 Salt fluxes : The description of how the salt fluxes are calculated is confuse and imprecise. Mathematical definitions are mixed with their discrete implementations, for the latter, grid, volumes and faces are mixed up. Note that also some form of interpolation is necessary, as fluxes are computed by Delft3d at volume faces, while salinity concentrations are computed at volume (ortho)-centres. I suggest to state only the mathematical definitions, and not to go into detail of the discrete calculation.

324 1.5 m incision : How deep was the channel, i.e. how large was the incision relative to the depth?

435 blocking river discharge : Imprecise, when a surge comes in, it superimposes a landward current, when it leaves, it superimposes a seaward current. The river discharge is not "blocked".

446 mixing parameters : Does this mean the diffusion coefficient? If so, it should be properly defined.

474 "The ocean surge ..., its impact can be twice as large as the surge period itself." : This seems to be rather coincidental because the simulated surge lasted for 10 days. It might better to write, the impact of the surge is felt even three weeks after the surge. Three weeks also seem quite long to me.

490 Data : Please provide at least a slimmed-down version of the model, i.e. the Delft3D-FM input files. Note that "can be provided" upon request for the data is not sufficient. Standard is providing data in a DOI-referenced repository or in the supplementary.

Presentation

Figure 1 Please mark Phnom Penh and the channel connecting to Tonle Sap on the map.

Figure 1 It is hard to make the grid out inset c. Consider to improve or remove it.

Figure 6 It would be insightful if the (weekly filtered) river discharge were plotted alongside the salinity intrusion, similar to the tidal range.

Figure 2 It would be insightful if this plot were accompanied by the modelled HWS and LWS salinity data for the same dates. This will allow for further insight regarding the classical theory of salt intrusion.

Figure 7 This plot is overloaded, g) has 9 lines. I suggest to provide a bar plot that provides average values for each for the fluxes for spring and neap. At least, try to limit the plot to just say the four most relevant fluxes, and combine the remaining fluxes into one residual flux.

Figure 10 This plot is overloaded, try to focus on what is relevant and the message you want to convey.

I would like to see a figure which shows the variability of the intrusion length - discharge relation, in particular in comparison to a simpler method, like the relation by Savenije .

Suggested Textual Improvements (no reply expected)

The text is understandable but needs a lot of minor corrections before being published, in many places, it misses essential articles or uses improper preposition. The text also mixes past and present tense, sometimes in a single sentence (c.f. 159 : Neuman [sic] conditions were ... wind is). In many places, the past tense gives the impression that the presented results were already outdated. I would personally use present tense wherever possible.

24 "upstream discharge variations" → "variations of the river discharge"

33 "is far more vulnerable" → "has become far more vulnerable"

37 VMD : Why not just MD?

80 makes → make

99 500 G $m^3 \rightarrow$ 500 10^9 m^3

101 seven : I count 8 when looking at the map, but this is probably a matter of definition

113 tidal difference → tidal range?

114 in the delta → into the delta

125 hr → h

135 scheme → grid

140 Martyr-koller → Martyr-Koller

156 in simulation year of 2016 → in the simulated year 2016

159 The Neuman conditions → Neumann conditions

175 our field campaign failed to measure → we did not measure

194 At a sea → At the sea

210 in all stations → at all stations

218 is able to represent → represents

219 can develop → reproduces

222 To study SWI → To study the SWI

224 experiences variable SWI → experiences a variable SWI

225 The lower [...] distributary channels follow similar trends of SWI → SWI follows similar trends in the lower distributary channels

236 upstream discharge variations → variations of the river discharge.

244 channel network → channel (When only the Hau channel is further analyzed, then it is not any more a network.)

248 of surge on substantial → of the surge on the substantial

248 Upstream of Dinh An [...] network → Upstream of the Dinh An [...] network

250 in subtidal discharge → in the subtidal discharge

254 subtidal stationary salinity → tidally averaged salinity?

254 increase subtidal salt intrusion → increase the subtidal salt intrusion

265 of 11 other → of the 11 other, or better → in absence of other tidal constituents, since there are infinitely many more

266 show estuarine → show the estuarine

268 Period-1 → First period and second period sound more natural

269 higher discharge → higher river discharge

272 [partially] → partially

273 starts declining → declines?

273 average salinity → tidally averaged salinity?

273 flux in the downstream direction → flux into the downstream direction

275 increasing total → increasing the total

282 over-depth → depth-averaged

284 elevation → surface elevation

288 As the flux calculation is carried out on numerical model results → As the flux is calculated from the numerical model output

290 As velocity → as the velocity

290 constant within a numerical grid → constant on the surfaces of the finite volumes

219 grid cell → finite volume

291 discharge through a grid cell → discharge through a volume surface (Note that for this, the water surface elevation needs to be interpolated from the neighbouring volume centres to the face.)

293 decomposed to eight → decomposed into eight

302 across the cross-section → across the river

305 nearly double in width → nearly twice the width

306 larger by nearly two fold → nearly twice as large

320 have influenced → influence

323 to other → to the other

323 That study → This study

323 that tidal amplitude → that the tidal amplitude

325 this value increases to 3 m → incision is up to 3 m

333 Stokes transport is maximum → Stokes transport is at its maximum

334 is minimized → is minimal

341 that is often → which is often

376 We showed → we show

376 have dominant role in SWI into the VMD → dominate the SWI into the MD

378 process → processes

384 ocean surge → ocean surges

385 influence discharge division → influence the discharge division

389 While discharge variation inversely changes salt intrusion → While river discharge reduces salt intrusion

391 intrusion , → intrusion,

392 how exactly ocean surge → how exactly an ocean surge

435 increasing channel depth → increasing water depth

437 in the delta → into the delta

436 "the continental shelf ... is an intrinsic component of the delta system" Rephrase, processes on the shelf influence the delta, but they are in a geological sense not part of it. The shelf is much larger than the delta.

438 significantly → considerably

444 significantly → considerably

457 has provided → provides

459 could reproduce → reproduces

475 effect on discharge → effect on the river discharge

475 twice longer → twice as long as

Figure 5 a & c panels → a and c, b & d panels → b and d

Figure 5 Apr.-1st → 1 April 2016, Apr.-9th → 9 April 2016

Figure 6 upper → a, lower → b

Figure 8 velocity profile → vertical profile of the streamwise velocity

Figure 8 in time → over time

Figure 8 product of salinity and velocity in a grid cell at a point along the thalweg → product of salinity and flow velocity at the thalweg

Table 3 $Q_s = XXm \rightarrow Q_s = XXm^3 s^{-1}$?

Table 3 k → 10^3

References

Savenije, H. H. G., *Salinity and Tides in Alluvial Estuaries, 2nd completely revised edition*, salinityandtides.com, 2012.