04/20/2022

General comments

The manuscript discusses compound flooding using an analytical model after validating the model with an idealized hydrodynamic model. The authors conducted sensitivity tests and investigated what the important factors for compound flooding are. The methods are appropriate and the results are interesting, but my concern with the manuscript is seemingly lack of novelty. The analytical model has already been developed and the results are mostly in line with the past literature. Some results are new, but they don't look like scientifically novel. Also, an equally concern is lack of "quantitative" analysis. The authors presented the results, but did not seem to quantitatively discuss the results in depth. e.g. comparison between analytical and numerical models in terms of their capabilities and caveats and the relative importance of depth, friction, river discharge, convergence length etc. on the resulting compound surge levels. It should be possible to rank them to discuss further quantitatively what's the most/least important and why. Use of analytical model enables you to do such analysis. Given that, although this manuscript is supposed to discuss the insights of compound flooding, I am not convinced that this manuscript provides the insights. I suggest the authors to include more quantitative analysis of the model results and discussion of the findings.

Also, I strongly recommend the authors to add a table on all model parameters with number as well as a table or glossary for **all variables** with unit you used in the manuscript and be consistent throughout the texts. I was struggling to read this manuscript due to inconsistency of the variables and confusion of their use. In addition, it's better to be more specific about the variables you use in the text such as "waves" as you include multiple waves (primary/secondary surge and tides) or assign unique variables (I recommend the latter). I was having difficulty reading the manuscript because it's not clear to me for example what waves the authors are referring to.

In conclusion, this manuscript will need more work to be published as it is and I suggest the authors to make a major revision.

Specific comments for each section

1. **Introduction**: It is not clear to me as to what's the missing pieces of compound flooding studies, which motivate your study and what's the advantage and limitation of your analytical model over numerical model. This should be addressed in introduction or in method section.
2. **Methodology**: The method section includes the analysis of some model results (section 2.2) as well as the description of the analytical model and validation. Those should be separated so I suggest to move a portion of the section 2.2 to section 3; then, maybe section 3-5 can be combined with the portion.
3. I suggest adding a table including name, unit, and variable of all model parameters (e.g. Bg, B0, dx, domain size, run time, frequency, amplitude, and phase of surges and M2 tide, Cd, depth, etc.). Table 1 includes some, but it is incomplete and should be put near Figure 1.
4. **Results and discussion**: As for section 3-5, I don't understand why you need another model comparison as you already have one. Also, this is a new configuration compared

to the one used in texts, which should be explained prior to the results/discussions (e.g. methodology). The section provides the results which were not presented in section 2-2; however, I am not convinced that the authors need this section as a separate section. Maybe the author can think about combining section 2-3 and 3-5. Just merging 3-5 into 2-3 does not seem to work. In addition, I suggest that the authors should include in-depth analysis of the model results and their comparison with the numerical model and other similar studies to discuss the analytical model.

Line-by-line comments

#	Line #	Sentence	Comments
1	94, 98	Non-stationarity	I am a bit confused about the word, non-stationary (or non-stationarity) as this manuscript does not discuss non-stationarity (changing conditions over time) much. Please clarify.
2	149	A is channel cross-section	A is channel cross-sectional area?
3	145,146,161, 165,173,187, 239,252	Equations 1-8	Each variable should have unit in texts.
4	153	L_e	Have you defined L_e prior to the equation? If not, please define.
5	157	Tidal amplitude to depth ratio	ξ was defined as tidal water level elevation on line 149 so the ratio is not amplitude/depth, but tidal elevation or tidal level/depth.
6	161, 166	Equation 3 and U_R+U_T	Define U_R and U_T. Are they different from u_R and u_T? If not, the authors should use the variables consistently. I suggest the authors to check all variables in the manuscript to make sure that they are consistent.
7	166	$U_{(x)}$	Is upper case U, the maximum value of current and I wonder the same applies to U_R and U_T? Nothing was mentioned in text.
8	169	Figure 1b	h is mean depth and is supposed to be constant. But in Figure 2b, two arrow lengths of h: one at ocean boundary and the other at upstream are not same in length. It's just a schematic illustration, but it's nice to be consistent. Also, is Z at ocean boundary always zero as illustrated in

			Figure 1b? I guess it's very small, but I don't think it's zero. And where is surge level?
9	170	Figure 1 caption	Figure caption should include all parameters in the figure and/or put them in a new table with the note in the caption.
10	173	Equation 5	Isn't u_r supposed to be always negative for the coordinate on Figure 1?
11	183	Landward boundary	The authors mentioned that the landward boundary is extended 100 km to avoid tidal reflection. If so, the landward boundary is where the river discharge was prescribed? What's the size of the domain? It's hard to see that on Figure 1 as there is no scale and no list of parameters and their values.
12	184	Seaward boundary	What's boundary condition at the seaward boundary? Radiation?
13	209	The presence of river discharge u_R	Q is regarded as discharge (u=Q/A on line 151), but u_R is also defined as discharge here. u_R is velocity in m/s and the discharge is in m^3/s. So I am confused. Please clarify.
14	209-210	Stronger ebb currents(u_r+u_T) and weaker flood currents(u_r-u_T)	u_r and u_T are positive landward according to Figure 1, aren't they? If so, flood currents are $-u_r+u_T$ and ebb currents are $-u_r-u_T$. If that's true, the authors should modify the text. Still stronger ebb currents and weaker flood currents, though. Correct me if I am wrong.
15	215	Tidal discharge amplitudes	What are tidal discharge amplitudes?
16	226	Tidal amplitude	ξ was defined as tidal water level elevation (Line 149) and here the authors re-defined ξ as tidal amplitude. Tidal amplitude and tidal elevation are different (only equal when the elevation is the maximum). Better to define it with a different

			character, e.g. A_{tide} as A is used as amplitude in the text.
17	228	River flow velocity	This should need a clarification. Velocity has a unit in m/s and river flow velocity (θ) has no unit as it is normalized. Maybe you can add 'normalized'?
18	228-229	River flow velocity applied at the upstream boundary	How can you apply normalized flow velocity at the upstream boundary? It is supposed to be a unit of velocity (and height). It seems that the authors use river flow velocity (line 228) and river flow ratio (line 231) interchangeably, which also confused me.
19	253	$\overline{H}$ is elevation and $\bar{h}$ is the mean water level	The choice of variables is very confusing. In Figure 1, H is the total depth and h is mean water depth. Here $\overline{H}$ is defined as elevation (of what?) and $\bar{h}$ is mean water level. We often assume $\bar{h}$ is mean of h and same for $\overline{H}$. Suggest to use the variables consistently throughout the texts.
20	255	Considering the first and third terms in Eq (4), ….	There is no third term on the right hand and the left hand sides in Eq (4).
21	257	Section 2-3	This section partially include results and discussion that is less related to the validation, but more to the results. The authors may want to consider moving some paragraphs to the result section.
22	258	Tidal amplitude variation	Delete amplitude?
23	261	Wave amplitudes	I am a bit confused. First, wave amplitude of what? Second, amplitude is supposed to be constant (e.g. A_{pri} and A_{sec} in Eq 6). It seems that the wave amplitudes mentioned here and after this are spatially varying amplitude, not a constant value of amplitude. The authors should clarify this as I am not sure what amplitude the authors are referring to. Maybe

			define a new variable, e.g. A(x) or A(x,t) so that readers are clear about what amplitude the authors are referring to?
24	271	Figure 3 shows the spatial pattern of the dominant tidal constituent amplitude	Again, M2 amplitude is spatially varying M2 amplitude, not D_2 in Table 1? If so, all amplitudes at each grid occurred at the same time stamp? I doubt that all maximum water levels come at the same time at all grid points due to phase lag associated with tidal distortion due to topography and/or friction etc.
25	276	Figure 3	I can see that the difference between numerical model and analytical model is larger between L_*=0.3-1.0 for θ=1, but not for θ=0. Likewise, I can also see that the difference is larger for L_*=1.0-1.5 for θ=0, but not for θ=1. Can you please explain why? Also, the authors should flip x-axis to be consistent with other figures. It confuses readers. Another suggestion: It may be nice to add the extent of L_e and where b(x) is equal to B_c in Figures 3,4,5.
26	272, 287, 364	Figure 3, Figure 4, and Figure 6	Are these figures the model results at what time? Or just maximum value at each point?
27	284	The RMSE between …. Are 0.03, 0.08, 0.09, 0.10.	Why does RMSE become larger as the river flow (θ) increases? Please explain.
28	288	Figure 4	Is the ocean boundary at L_*=0? X-axis is different from the one in Figure 3. Should use the consistent axis range (i.e. from 0 to 1.5. Positive values). Another questions: 1. On (a) with θ=1, water level from analytical model is larger than the numerical model at

			L*=-1.5. but smaller near the ocean boundary with the intersection in the middle (L*~=-0.8), but it looks like the intersection is shifted landward with decrease in θ. 2. The same trend applies to (b) with shifting the intersection as h increases. Please explain why. The answer to this question along with others I asked will clarify why analytical model and numerical model behaves/responds differently.
29	293	Higher mean water levels (Z)	Could this be Higher mean water levels ($\bar{h}$)? I am not sure if I understand the difference between $\bar{h}$ and Z and also $\partial\bar{H}/\partial x$ and $\partial Z/\partial x$(or $\partial Z/\partial L_*$). Both are defined as mean water level and surface slope, respectively.
30	330	Su_{pri} time scale	Su_{pri} period as you use periodic function in eq 6.
31	339	A_*	Boundary is ocean boundary or land boundary?
32	346	Figure 5	Y-axis is not amplitude, but surge level or elevation. Amplitude is supposed to be constant.
33	361	L_*=1.5	There is no L_*=1.5. L_* ranges from -1.5 to 0. Figure 3, 4, 6 and 8 has different x-axis range. Suggest to use consistent x-axis range for the figures.
34	364	Figure 6	Where exactly is L_*=-1.5 in Figure 1? Is it where b(x)=Bc or the location of the land boundary where river flow is prescribed? If the latter, it's strange because the authors mentioned that the channel was extended 100 km (line 156) to allow tides to dissipate due to friction and that's where river

			flow was prescribed. Am I misunderstanding? Also, $\zeta = 1.0\ m$ in the legend. Even if amplitude of primary and secondary surges are combined, the amplitude is not 1.0. Where did $\zeta = 1.0\ m$ come from?
35	358	Wave time scale (T=1/ω)	T is also used for bed stress divided by water density on eq 1. Do not use the same name for different variables. Is this the same as wave period? Also, increase in wave period of what? primary or secondary surges? Maybe a subscript (throughout the texts) could be helpful.
36	358 and 364	Wave amplitude (ζ)…	What wave amplitude is ζ? I guess ζ is constant as in the legend of Figure 6. If yes, the amplitude should be noted as A as in Equation 6.
37	358	Wave time scale	Wave period
38	372	A_*	Use same notation as the one in line 339.
39	394	Figure 7	It is hard to see the contour lines and labels. Use a different color or use a different colormap. A monotonic colormap may help. Also, I am a bit confused with the figures as θ and Ω only have 4 numbers in table 1, but the figure looks like there are more data. Did you use shading color (e.g shading interp on MATLAB)? If so, it is better to use flat (no-shading). Please clarify.
40	426	TWL=T+SS+R	Have you defined all T, SS, and R in the text? The authors used T=1/ω (line 358) and it confuses readers with the same variable name, but defined more than once as a different variable. I am confused with the various definitions

			from the beginning of the manuscript. Please make them clearly defined.
41	435	Figure 9	Why does tidal and surge amplitude decrease as river flow (θ) increases? Is that a distortion of tide and surge due to non-linear processes as river flow increases? Please explain the details. Also on (a) and (e), the contour of 0.75 looks different at 0.3<L$_*$<1.0. Can you add an additional contour e.g. 0.8 or 0.9 to see if the contour on (e) is similar to that on (a)? I think they should be similar as tide, surge, and river look similar between the two depth cases. But if not, what process could cause the difference?
42	455	Estuary boundary	Please define estuary boundary in Figure 1.
43	477	River effects are larger than marine effects	"effect" is a vague word. It is unclear to me as to what you mean by effect. Please define it more precisely.
44	481	A decrease in mean river discharge may also cause a landward migration in the crossover point.	I don't get the point. Can you explain why? If this is indeed true, there should be a way to quantify.
45	484	Long wave amplitudes	Are they total amplitudes (primary/secondary surge and tide)?
46	489	Increases in channel depth, wave time scale, and decreased length scale.	Could this be "increases in channel depths and wave time scale, and decreases in length scale"? I don't understand what "increases in decreased length scale" mean. Also, wave time scale should be wave period What's the relative importance of each parameter on the total water level?
47	497-498	The transition zone may be sensitive to changes in estuary geometry, such as depth…….	This should be discussed further quantitatively and your analytical model allows you to do that.

48	508	Section 3.5	I feel strange to see another model comparison here at the end of the manuscript. The authors compared the analytical model with numerical model on section 2-3 and compared the model again for another idealized model with a different configuration. Though the section provides some new information, I am not convinced that it is necessary to be added as a section. Suggest to remove it or combine it with the validation on section 2-3.
49	512	Idealized numerical modeling of Familkhalili and Thalke (2016)	Is this idealized model different from Delft3D the authors used in this study? If so, please explain what the difference between the two models is and why the authors used a different model. That statement and a brief introduction of the model should be included in the text.
50	512	River kilometer (Rkm) 12.	What is Rkm 12?
51	514	Shipping channel was increased	Shipping channel was deepened.
52	532	Figure 12	Why does the analytical model consistently overestimate A* over the numerical model across all depth settings?