Natural Hazards
and Earth System
Sciences

Discussions

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Interactive comment on "Hydrologic sensitivity of flood runoff and inundation: 2011 Thailand floods in the Chao Phraya River basin" *by* T. Sayama et al.

Anonymous Referee #2

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General Comments:

The authors present in their simulation-based paper an interesting diagnostic to quantify the characteristics (in terms of sensitivity to rainfall) of the flood hazard for the Chao Phraya River basin in Thailand.

The topic presented is generally of interest to the readership of the journal and follows a logical structure.

Together with the comments mentioned below, I recommend to thoroughly revise the manuscript, as there are several instances in the paper that require further clarification and discussion from the authors. Therefore, I suggest reconsidering the paper after major revisions.

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Specific Comments:

Section Abstract:

1) P7028L13: The authors highlight that 'the presented approach is effective for large river basins', but it remains unclear what exactly is 'effective'. Is it an effective simulation or it the approach of evaluating the hydrological sensitivity effective? Please clarify.

Section Introduction:

2) P7028L23-24: Please specify how the interpretation of the additional 200mm rainfall can 'affect the understanding' of the flood characteristics.

3) P7029L22-27: Please rewrite the section, as it is not clear what the authors are aiming to convey.

4) P7029L22: The study of Sankarasubramanian et.al. 2001 is cited. However, the main conclusions of that study are not taken into account or even addressed in the discussion sections. Based on their results, Sankarasubramanian et.al. concluded that 'Both model choice and model calibration play an important role in determining the sensitivity of simulated streamflow. . . . Therefore it is difficult, if not impossible, to estimate the sensitivity of streamflow to climate using a single watershed model'. Based on their conclusion, I recommend to add at least a section showing/discussion the influence of the manual model calibration (i.e. parameters choice)

5) P7030 L9: 'They are generally difficult to define. . .' Who is 'they'? Please specify.

Section Methods:

6a) Please add a section describing the general hydro-climatology of the Chao Phraya River basin (i.e. climate influenced by monsoon (how does that influence the climate), at what time in the year are the wet and dry seasons. . .) and of the 2011 event. I.e. how did that year differ from the average year (e.g. sequence of unusual events)? In

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the introduction, it is only mentioned that Oldenborgh et al. (2012) concluded that the year was 'not very unusual'...

6b) Additionally, to better inform the reader about the study area, add a information on the coverage of urban areas in the study region.

7) P 7031L6: Fig 1 should be Fig 2 and P 7032L9: Fig 2 should be Fig 1

8) P7033L6&7: Specify meaning of the variables of equation (2) and (3).

9) P7033L13: '...empirical equations cannot represent well...' Represent what? Please specify.

10) P7033L17: Are these 400 stations roughly equally spread within the basin or sparsely for some region. Add one sentence on station coverage and the possible effect on the simulation.

11) P7034L17: 'G-A model' does this refer to the Green-Ampt equation mentioned before? If so, please add abbreviation in parentheses (P7033L28)

12) P7034L19: Here the threshold of 0.5 m water depth is described for the first time to define the area as being inundated by the flood. Please provide a thorough discussion why that threshold has been chosen and what the authors take is on how a different threshold would influence the ultimate outcome of this study (i.e. flood inundation elasticity).

13) Table 1 is not mentioned in the text, please add. Additionally, specify if the land cover classes 'forested area and cultivated area' correspond to the regions 'Mountains and Plains' mentioned in Table 1. If so, please homogenise naming convention. Also explain what the parameters mentioned in the table correspond to (in words).

Section Model simulation results:

14) P7036L1: Figure 3 dos not only show the discharge at C2 but also two other locations, change text accordingly.

15) P7036L6: the calibration focuses on 'naturalised C2 monthly discharges'. Please specify what model parameters were adjusted in the manual process (i.e. only the parameters for the two land classes (mentioned in Table 1) or other parameters as well?).

16a) P7036L11: two metrics are mentioned in the text however, the appendix only shows the NSE (the Figures show R2 but without any mention in the text). (Also, add a reference to the NSE) Here I would ask the authors not to only rely on a 'relative error measures' such as the NSE only, but also to include an volumetric error measure (e.g. 'mean error'), as the water volumes are also important for quantifying the flood inundation extend simulations. Please add information on this as well.

16b) Additionally, clarify if calibration was performed by focussing on the model performance measure only.

17) From Section 3.1., it is not clear if the model was ONLY calibrated to the discharge at C2 and the parameter settings were then used for the entire basin or if the sub-basins at the gauging stations and dams were calibrated later. Please explain in the text and not only in the caption of Table 2.

18) P7036L16: If calibration is only done for C2 (if I understood the section 3.1 correctly) I would not use the heading 'Calibration' for the other stations in Table 2 as there are practically 'Validated ' for the entire period and do not require a split into calibration and validation period. If all sub-basins were 'actually calibrated' 'I would suggest to apply a similar approach as presented in Table 3 and add the averages at the bottom of Table 2 as well.

19a) P7053: Figure 3: Please specify if observed flow for C2 is the real observed discharge or if this is the naturalised one. It is also suggested to change the line type of the 'simulated' discharge to 'dashed' or 'dotted', so that the reader can better evaluate the underlying observed discharge. Maybe also consider to add the 'underperforming' Y17, so the reader can better understand the degree of the poor performance men-

tioned in the text. Additionally, I suggest adding the following points to the caption of Figure 3: - which stations are above and below the dams - does the performance measures refer to calibration or validation periods. - Mention again the periods used for calibration/validation

19b) P7036L11-20 Briefly discuss the differences in the way how monthly peak discharges are being captured for the different locations shown in Figure 3.

20) P7036L24-P7037L3: Add discussion on the reliability/quality of the remote sensed data in evaluation flood extend. Also, add a sentence if the observed flood extents between the year 2011 and the other years are expected to differ due to the different data sources mentioned in the text.

21) P7054: Figure 4, Please increase size of the figure as currently a spatial comparison is hardly possible. Additionally, add location of C2 (for reference) and legend with colour scale explaining the colour codes used in the Figure. Add to Figure caption a note on the different data sources of the remotely sensed data.

22) P7037L7 & Appendix: Innundation is evaluated using ANE and FIT. a) I'm not convinced if FIT is the best performance measure to use here. As it only evaluates the 'matching' pixels between observed and simulated inundated areas with respect to the 'lumped' areas that are flooded independently of referring to simulated or observed areas. This does not allow evaluating in detail, the goodness of the model performance in terms of pixel overlap. Instead, I advise using two measures that, while similar to the FIT measure already used, enable a clear evaluation of: I) how much of the observed extent is captured by the simulation ((IAobs âĹl' IAsim) / IAobs). II) how much of the simulation extent actually captures the observation ((IAobs âĹl' IAsim) / IAsim).

22b) Additionally, instead of using the 'absolute normalised error' I would use the 'normalised error' as this allows directly inferring from the values in the table if there is an under or overestimation (although from Figure 4 it can be seen that it is an undersestimation).

23a) P7037L15-24: Using the new model evaluation measures outlined above, a better evaluation of the simulation performance will be possible, as especially with regard to weather the simulated cells actually match the observations. Then a more detailed discussion on the differences between large and average floods can be made. Additionally avoid terms like 'some underestimation' and rather quantify amount. 24) Explain in text if only the depicted simulations 2005-2011 were used to evaluate the performance or if the entire series was used. If so, maybe a time series showing the obtained model performance indices or some other sort of summary of the simulation performance might be appropriate.

25) P7037L25-29: Please but this section in context with the results obtained above. So what do the mentioned points mean for the simulations? Please clarify and expand.

Section Sensitivity of flood runoff and inundation

26a) P7038L5: Figure 5 does not show days of the year but rather the daily values? Additionally, it appears that not only rainfall is a cumulative water balance component but also ET and runoff. Please clarify in the text. Why is there only little difference between wet & dry season in the ET?

26b) The grey lines in Figure 5 are barely visible, please increase line width. I might be interesting to add the two other major floods with different colours as well, so that comparisons between the events become possible (This also applies to Figure 7 and 8 in which labels with years could be used for the extreme points). Specify in the figure caption the period used to calculate the average and if the simulated water balance includes the dams.

27) P7038L11-16: provide a more in depth discussion of all the water balance components shown in Figure 5 with particular reference to the 2011 event (e.g. exceptionally high rainfall in mid-March, or flood inundation started a month earlier compared to an average year...) Additionally, substitute the word 'trend' (P7038L12) with the appropriate description.

28) P7038L17-20: Remind reader in one sentence as previously explained why this analysis is done (put into context). Please also clarify if the months of cumulative rainfall are counted from the start of the year or counted from the peak inundation backwards. Is the full period (1960-2011) used or only the 'post dam building' period. Clarify in text and caption

29) P7056: Figure 6, can you use colours to indicate the points (years) that belong to the three largest inundation volumes. Additionally add explanation that this is cumulative rainfall.

30a) P7056 and P7057: According to the description, the relationship shown for Figure 6 (6months) and Figure 7 for the variable of inundation volume should be the same. However, when examined closely, they are depicted differently. In Figure 6 (6 months) the line intersects zero inundation at a rainfall of 800mm, whereas in Figure 7, the red line intersects approximately at 900mm! Please explain why the two figures are different!

30b) P7057: Figure 7: Please add the R2 to the different established relationships (This also apply to Figure 8)

31) P7038L21: are the relationships established at the time of peak inundation? Please specify.

32a) P7038L24: The modelled ET and the established linear relationship with P seem odd. Please further discuss, why the model is producing such an outcome

32b) P7038L25-26: remove the vague expression 'some correlation' from your discussion and rather quantify the type relationship observed. Additionally, all the relationships established in Figure 7 (also Figure 6 and 8) are linear, however here briefly a 'plateauing ' i.e. a levelling of the relationship is mentioned, however without further discussion. I strongly suggest adding a discussion for which precipitation ranges the authors consider the established linear relationships as being valid, particularly with the

focus on extreme rainfalls (as they are of specific importance for elasticity analyses).

33) P7039L1: Change order of 'flood runoff and inundation volumes' to 'inundation volumes and flood runoff' to correspond to the order of the components as presented in the text.

34) P7039L2: 'that' is unclear. Rewrite

35) P7039L2: how is the 6 month rainfall of 'normal years' being determined? Average of 52 values?

36) P7039L9: Table 4 is missing

37) P7039L17: Why 2 additional months months for discharge? Add section explaining this choice.

38) P7039L18-19: I don't see why for dF the analysis is also shown in the Figure. This does not yield any additional valuable information. If the authors decide to keep the Figure as is, swap the description of figure 8b to 8c).

39a) P7058: Figure 8: I would suggest reducing Figure 8 to showing only the inundation in panel a) without dam and b) with dam for the 6 month precipitation and c) and d) for the discharge only for the 8 months,

39b) Please indicate if the same years (number of years) have been used for both panels (without and with dam). If different time number of years have been used (in Figure 8 it looks as if the 'with dam' panel has less data points). I recommend using the use the same years, to ensure that the differences in results (different relationships) obtained are actually due to the effects of the dams and not due to the presence/absence of years.

40) P7039L27-P7040L9: Please move this section to earlier in the paper when the elasticity index is introduced and discussed. Here only a shorter section on the index characteristics is required.

41) P7040L9: 'the results suggest. . .' Please indicate to which panel this statement is referring.

Section summary and Limitations:

42a) P7041L2-14: In this section please always specify the base period used (i.e. 6 vs. 8 months) for rainfall and inundation or runoff and if dams were considered or not. Also add a note if there is a big difference between 6 and 8 month rainfall. If there is a big difference then Figure 9 has to be adjusted to accommodate the differences in rainfall for 8 and 8 months.

42b) P7059 Figure 9: please specify in the figure caption if dams were considered.

43) P7041L18-28: Reorder the order of the terms used, either in equation 5 or change the order of the terms described in this section to have the same order as the original equation.

44a) P7042L2: Please clarify what a 'historic regression based approach' means.

44b) P7042L10 and L13: 'six months' were only used for inundation; please add the 8 months for runoff.

45) P7042L13& 14: Please specify how the other factors mentioned in the text might influence the flood simulations and particularly the estimation of the elasticity.

46) P7042L16-18: Please expand on how the 'flood hazard' of the study region can be 'quantitatively understood' by this study, as this is not clearly articulated.

47) In the 'limitation section' an in depth discussion (advantages/caveats) is needed on the use of linear relationships between rainfall and the other components of the water balance equation. Particularly with a focus on extreme rainfalls (low and high) and the possibilities of non linearities with regard to the estimation of the elasticity indices and the quantification of the flood hazard.

Section Conclusions:

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48) P7043L7-10: Here an interesting point is raised that had not been mentioned before. I would suggest to introduce the issue of the dam management being made responsible for the flood damage in the abstract or at least mention it in the introduction. So far, in the introduction (P7029L3-4) only the possible effects of the conversion of the agricultural land into other uses has been elaborated.

49) P 7043L17-25: I caution to bring the current study in relation with climate change impact analyses and simply extrapolate the linear relationships established. Particularly, with the expected non-linear response of the hydrological systems including the monsoon.

50) In the introduction the possible effect of conversion of agricultural land are being presented as cause of the extreme flooding in 2011. However, in the study it appears as if the model parametrisation had been kept constant. Could the authors please comment on how this assumption influences the estimation of the elasticity indices. This is of particular importance as the authors highlight that their elasticity indices can be used for quantifying the flood hazard.

Typographical corrections needed: P7029 L16: correct 'rainall' to 'rainfall' P7030 L2: correct 'elasiticiy' to 'elasticity' P7030 L3: 'knwoledge' to 'knowledge' P7030 L6: 'luck' to 'lack' P7030 L14: 'interact each other' to ' interact with each other" P7036 L3: 'parmeters' to 'parameters' P7036 L11: 'metrices' to 'metrics' P7036 L13: 'faily' to 'fairly' P7036 L14: 'valiation' to 'validation' P7037 L27: 'floodplauns' to 'floodplains' P7040 L14: 'consiering' to 'considering' P7040 L15: 'resoivoirs' to 'reservoirs' P7042 L23: 'sensitivites' to 'sensitivities'