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Hydrology and Earth System Sciences Discussions

Interactive comment on "Joint impact of rainfall and tidal level on flood risk in a coastal city with a complex river network: a case study for Fuzhou city, China" *by* J. J. Lian et al.

Anonymous Referee #3

Received and published: 1 September 2012

RECOMMENDATION

Major revisions before reconsideration for publication.

OVERVIEW

The study investigates the combination of precipitation and downstream tidal level and drainage on flooding for a coastal city in China in two ways. First a hydrodynamic model, set up to simulate the river network, is used to assess the flood severity (percentage of the river network along which flooding occurs) under a range of precipitation intensities and tidal levels and with and without drainage pumping. Second, a statistical

model is set up to describe the probability of a particular precipitation intensity being exceeded at the same time that a particular tidal level is exceeded.

The approach to the topic – hydrological modelling, validation, statistical modelling and a (potentially) succinct resulting message – gives the manuscript a good broad scale structure and suggests potentially interesting reading for the HESS community, in particular given the growing interest in delta regions. On a finer scale, there is a lot of room for improvement in introducing and connecting the various parts and communicating details relevant for understanding the text and figures.

MAJOR POINTS

1) The clarity of the manuscript should be improved in factual precision and flow of reasoning as well as in English grammar. The authors should first thoroughly examine their entire text to refine its meaning where necessary before handing it to a native English speaker for correction.

An example is P7487 L18-22.

* Firstly "joint probability of rainfall and tidal level" is imprecise without mention of exceedance of return periods or some reference. There is presumably always a tidal level, hence taken literally, the "joint probability [that there is] rainfall and tidal level" is currently referring to the percentage of rainy days.

* My initial guess (without inspecting table 2) at what the authors meant to say was "the probability of rainfall exceeding a particular threshold when tidal level is also high is larger than the probability of rainfall exceeding that same threshold regardless of tidal level, even though the chance of observing simultaneous extremes in rainfall and tidal level is very slight." In other words $P(H>h \mid Z>z) > P(H>h)$, implying that there is some positive dependence between the variables.

This is what referee #1 appears to have understood and has attempted an explanation. If this is what the authors mean (although I now doubt it), it would be interesting to

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hear why they think this is the case. I am not an expert in river systems but would guess that heavy precipitation over several days will lead to higher water levels of the receiving body being measured at the same time as heavy precipitation, which raises another point: Has tidal level the same meaning as water level of the receiving body (as measured by a hydrological station) or has the influence of precipitation on water/tide level been removed or is it considered too small? However ...

* ... In their reply to referee #2, the authors rephrase these lines to mean something very different to my guess above by replacing “joint probability” with “union probability”. Expanding the lines 18-20 using the description of union probability they provide lower down in their answer I get: “It is interesting to note that the union probability [that at least one variable exceeds a certain standard] of rainfall and tidal level is always larger than [the probability that one of them exceeds that standard] the exceedance probability of corresponding return period rainfall, even though the encounter probability is very slight”. This is not interesting however, as P(H>h U Z>z) >= P(H>h) must always hold. It seems the revised message is “the smaller the intersection probability, the greater the union probability and the greater the chance that the flood threshold is crossed”. The point now being made is simply that the design of flood defense currently ignores the extra set of days with low rainfall and high tidal level which can lead to flooding. This message however only relates to the chance of flooding and not the severity of the flood which is what in most cases is more important and will tend to be large when both H>h and Z>z. The intersection probability is small but depending on the risk (losses associated with a specific flood severity), could be important. Whether or not severe flooding can be modelled well using precipitation input alone is of interest.

* Note that the reason for my initial misunderstanding of these lines comes from the impact the words “even though” have on the rest of the sentence. They indicate that something unusual happens despite a low encounter probability. However, given the fact that the encounter probability is slight, it is not surprising that the union probability is much larger than the probability that the condition is met for one variable alone e.g

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P(H>h).

* It would help the reader if the points being made in this section could be illustrated schematically so that there is no doubt about what is meant, especially given the difficulties with English. The distinction between discussing the chances of a flood occurring and the severity of flooding when it occurs should be made more obvious.

2) Comments on the uncertainty and significance of the results are lacking. How reliable are the data in table 2? If results of this study are to be useful in flood defense design for the near and far future, how representative is the input data for the current/future climate?

MINOR POINTS

The word “level” is sometimes used without specifying the variable it is describing. I suggest either writing “tidal level” etc explicitly or defining “level” to mean “tidal level” somewhere early in the manuscript, if all levels referred to actually are “tidal levels”.

Abstract: The first sentence could be clearer, especially if it is to serve the purpose of enticing the reader to read on. Avoid the use of the confusing phrase “multi-variable variables”. The given examples of multi-variable variables, “heavy rainfall, high sea level and large waves”, are not variables themselves but rather amplitudes of variables on the high end of their scales, etc. These kinds of oversights are not solely due to difficulties in writing in a second language but to a lack of care with precision in communication – something the authors should be capable of improving.

Specify the range of return periods considered in the abstract.

P7477 L12-14: Check sentence meaning, and “interested” should probably be “interesting” or “useful”.

P7478 L5: “the encounter probability of two variables”: probably “event” or “condition” is meant rather than “variable”.

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P7478: Would be helpful to describe what the concept of a copula is, in addition to the reasons given for using it.

P7479 L4: Units of temperature missing.

P7479 L6: What is meant by “directly throughout”? Providing a definition of a typhoon and nearness criterion as suggested by referee #2 is important for the interpretation of the frequency of typhoon occurrence.

P7480 L2: Where do the precipitation and tidal levels data come from (P7481 L24 is a bit late) and from what period in time? In what format (spatial scale, temporal interval) is the original data and how is it processed for input to the model?

P7480 L3: What should be understood by “hydraulic parameters” and by “sewers information”?

P7481 L3: SWAT and ARCGIS?

P7481 L11: The process of “data collection” for precipitiation and its translation into the flow hydrograph is not described.

P7481 L15: Reasoning Formula Method?

P7482 L7: Describe the design standard rainfall. The range of precipitation and tidal levels covered could also be mentioned. Is it a time series with realistic variability or something else?

P7482 L8-9: What is the reasoning here? Sounds like the exceedance of the critical condition is decided by eye.

P7483 L14-19: h, H, f, F, z, Z appear in these lines but not all are defined. Fh(h) and Fz(z) are not defined whereas fh(h) and fz(z) are mentioned twice.

P7484 L9: Too little information on the input. What is meant specifically by rainstorm data and operation of flood control?

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P7484 L22: The calibration of the coefficients was not described.

P7486 L8-9: These parameters are mentioned too suddenly. Some have been introduced but not all. U and V were dummy variables on page 7483 but now they are mixed with the assigned variable names and subscripts. Best to clearly state what they are at the point they are used or refer to the formula that contains them.

P7486 L22: This equation needs a much better introduction. Writing the steps between eq 3 and eq 6 would help.

P7488 L11: The meaning of this sentence, in particular "changed combination" is unclear.

P7488 L12-14: Could be misread as "better to understand flood risk theory than try to do something about it".

P7494 Table 2: Explain the meaning of the symbols in the table caption.

FIGURES

Some points to address in the figures and captions (taking into account the reply to referee #1):

1) The text in these panels is far too small, especially in the top panel. Enlarge text that is important to see and remove the rest. The same holds for the distance scale on the third panel.

2) What do the small red dots and arrows signify?

3) State what is shown in colour and the units of the values shown on the colorbar. What is the significance of the letters n, p, g, j, b etc?

4) What is meant by a drainage unit of the urban area? Is it a specific district used as an example? If so, which one? Or is it an average unit? The symbols should be defined in the caption or the reader should be referred to the definitions in the text.

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5) Suggest writing in the caption something like “Submerged sections (thick overlay) of the rivers of Fuzhou city during Typhoon Longwang on day-month-year, according to observations”.

6) This is so similar to Fig. 5 that it takes time to spot the differences. It would be far better to show the differences. Perhaps eliminate Fig 6 and make 2 panels in Fig 5 as follows: Keep Fig 5 the same but add a second panel showing the differences between the model and observations, i.e. highlight the sections that are submerged by the model yet not in the observations and also the submerged sections that the model misses (in a different line colour/style). Clearly state what has been plotted in the caption.

7) Where is this hydrograph made? You might want to mark the point location of these hydrographs on one of the spatial plots.

8) Keep aspects of original caption as it is in the manuscript as it focusses the reader. “Isolines of flood severity as a function of 24-h rainfall and tidal level, shown under two conditions: (a) without pumps working; (b) with pumps working.” But add “Severity is measured as the percentage of the total river length that is flooded. The isoline “Start” indicates the conditions at the instant that the flooding threshold is crossed.”

9) Much better would be: “Same as Fig. 8 but plotting flood severity as a function of the return periods of 24-h rainfall and tidal level instead of absolute values.” This tells the reader immediately what the difference between the two plots is. What is the “(a)” unit on each axis? Better to state (years), as (a) can be confused with the panel labelling.

10) “(a)” -> “(years)”. “Comparison of the start isoline (conditions at the instant that the flooding threshold is crossed) from Fig 9, with and without pumping.” Alternatively, eliminate Fig 10 and combine Fig 9a and 9b into the same panel using different line colours or thicknesses for the pumping conditions. The same should then also be done for Fig 8. It would make comparison easier.

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11) Need to explain what distribution is being modelled.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 7475, 2012.