## Response to comments

We sincerely thank all referees and editors for his/her careful reviews and valuable advices. Based on the comments and suggestion, we read through comments carefully and have made extensive modification on the original manuscript. The responses to the comments are marked in blue and presented following.

**Referee #1**

1. **what is the innovation of this paper?**

   Thanks for your comments, this paper focused on simulating the whole flooding evolution process of a serious levee breach-induced compound flooding by using a 2D hydro-inundation model. On the basis of the historical flooding event, this work revealed the compound effects of levee breach-induced fluvial flooding and heavy rain.
   The main innovative aspects are

   - It's the first time to investigate the dynamic compound flooding process and mechanism of heavy rain and levee breach-induced flooding.

   - Real-life cases of historical flooding events have been adequately investigated which can demonstrate the feasibility and robustness of the model.

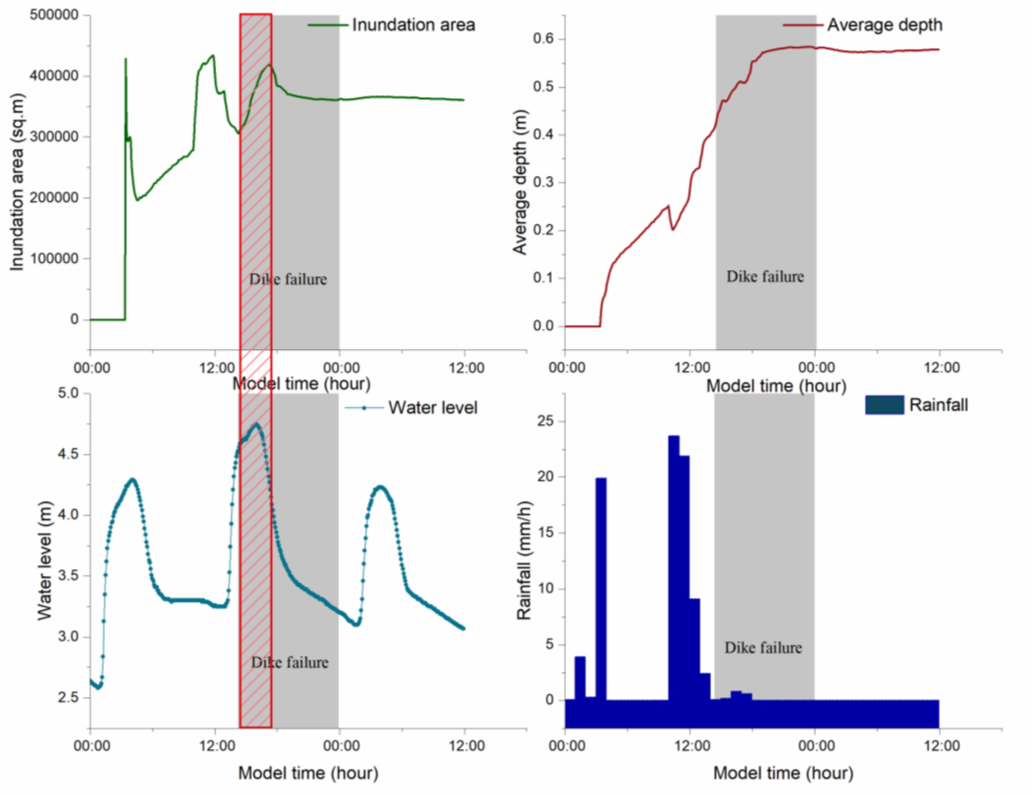
   We have stressed more the novelty about this paper in the abstract (Line 22), discussion and conclusion (Line 362).

2. **It was mentioned that the critical time to minimize damage (should further take actions) is the first a few hours after levee breach; however, readers would perhaps anticipate this conclusion before reading this article.**

   Thanks for noting this. We obtained this conclusion from the simulating time-series of spreading flooding scenario, and from the figure below, we can find that the inundation area and the water depth continue to increase rapidly in the early 1-3 h after levee breaching, chiefly because of the water level increasing at the same time, however, during the falling tide period, the flooding diffusion tend to be slow.

   We have added this discussion in **Conclusion** as below (Line 375):

   "Second, within 1-3 h after the dike failure, the floodwaters spread rapidly, and the inundation area and average water depth reached the peak value; chiefly because of the rising riverine tides at the same time, however, during the falling tide period, the flooding diffusion tend to be slow. Thus, this is the key period for repairing the levee."




3. **In addition, I'm not fully convinced by one of conclusion, which concludes that the model is strongly sensitive to roughness value, maybe it should further explain that why the flood extent not consistently increases with the increasing of the roughness value after levee breach (compares to the flood extent before levee breach)**

Thanks for your suggestion, the sensitivity analysis result statement are inaccurate and we have revised the description and added the further explain in **Results** as below (Line 355):

"Interestingly, there were differences in the sensitivity to the roughness before and after the levee breach for the flood inundation extent. The inundation area increased obviously as the roughness increased during the rainstorm, however, it is decreased slightly with an increase in the n value during the levee breach when the river flooding was the main force. The main reason which causing the sensitivity differences is the unlike formation mechanism of inundation extent between rainstorm and fluvial flooding."

**Minor comments:**

4. **I feel parts of the introduction is concatenated with literatures (e.g. line 68 to 86), it would be nice to summarize the findings rather than simply list the findings one after another.**

Thank you very much for your suggestion, the Introduction has been changed as below (Line

73):

A number of approaches for levee breach-induced flood modeling were developed. Some previous studies have investigated the breach mechanism and the hydrological process of dike failure flooding, Vorogushyn (2010) proposed an Inundation Hazard Assessment Model (IHAM), which coupled a 1D hydrodynamic model of river channel routing, a probabilistic dike breach model, and a 2D raster-based inundation model. Cannata et al. (2011) used a GIS-based approach to simplify a 2D dam break simulation. Recent advances have been made in the application of methodologies for predicting the dike failure -induced flooding, Yin et al. (2020) predicted dike failures and flood inundations in Shanghai, China, under various emission scenarios using an interdisciplinary process-based approach.

Similarly, numerous studies analyzed the compound effects of various flood hazards at different scales (Ganguli et al., 2020). Most previous study focus on calculating the joint flood risk probability. For instance, Lian et al (2013) evaluated the joint probability of rainfall and tidal level both exceeding their threshold values through the copula and then analysis the combined effect of them on flood risk in a complex river network in a coastal city in China. Moftakhari et al (2017) proposed a bivariate flood hazard assessment approach to account for compound flooding from river flow and coastal water level. Bevacqua et al (2019) predicted the increasing probability of compound flooding from precipitation and storm surges in Europe under anthropogenic climate change. At a global scale, Couasnon (2020) and Eilander (2020) explored the compound flood potential resulting from storm surges and riverine floods.

5. **Line 25-26: 'In low-elevation areas, temporary drainage measures and flood defenses are equally important'. This has neither studied and nor proved in the paper.**

   Thank you very much for your comment, we have added explanation in discussion as below (Line 380):

   "the water does not drain rapidly only by infiltration or evaporation, and the waterlogging lasted for more than 12 h, resulting in loss of farmland with high vulnerability. Therefore, for levee breach-induced flood response in rural area, in addition to repairing the levee in time, it is necessary to remove the flood water using drainage measures at the same time, such as setting water pumps near the farmland or other low-lying area, when necessary, government should guide nearby residents to evacuate to a safe place as well."

6. **Line 66: what is the economic damage in this area?**

   Thanks for your comments, sorry, we cannot find any official reports of the economic damage of this flooding events, and from the field investigation we knew that the government did not assess the property losses of local residents.

7. **How does the model control the levee height during the breaching process in section 2.3?**

Thanks for your comments, we first overlay the remaining intact levee height onto the original bare-earth DEM (remove the 15m levee breach), due to the model cannot change the topography boundary during the running time, so we control the levee height by changing the relative water level, namely before the levee breach, the relative water level is 0 because of there was no flooding, while during the levee breaching period, the relative water level is the historical river water level, so that the flood spread from the breach section.

**8. Line 184: what does 'remaining' mean? Does it mean the height of floodwall was decreased to 4.9-5m?**

Thanks for your comments, the 'remaining' means the remaining intact floodwall without the breach section, and the levee height was about 5 m above Wusong Datum.

We have added the description in section 2.3 in more detail (Line 186):

"The levee height and location were obtained from the Shanghai Municipal Institute of Surveying and Mapping. The height of remaining intact floodwall without the breach section (about 5 m above Wusong Datum) were then overlaid onto the original bare-earth DEM using the raster calculator in ArcGIS 10.6 software."

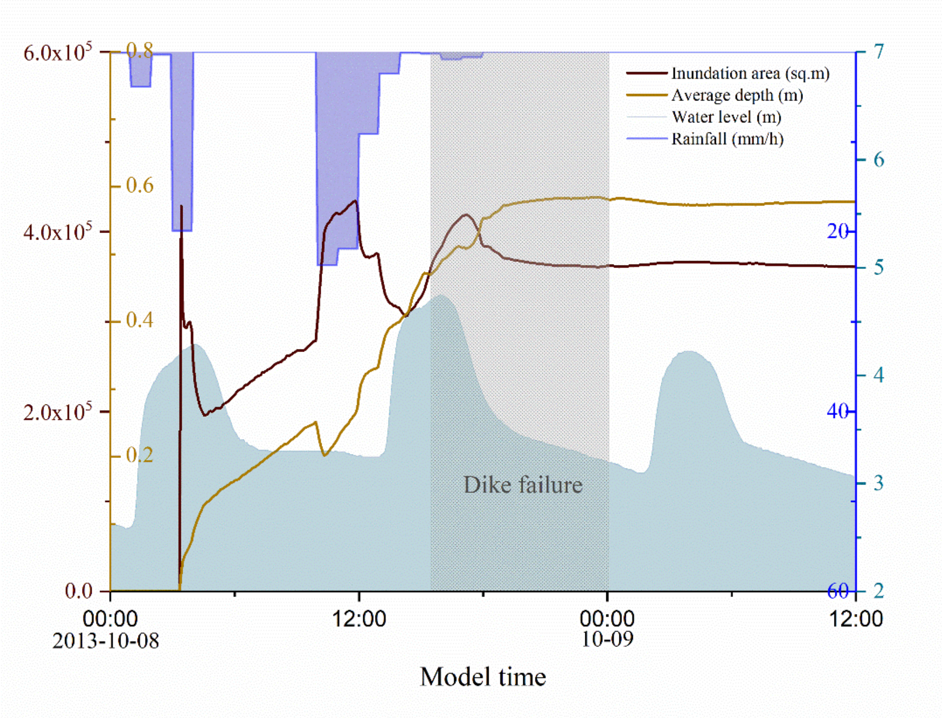
**9. Line 269: the assumed evapotranspiration value is based on what?**

Thanks for your comments, and we have added description about evapotranspiration value in Line 271

"we assumed evapotranspiration of 3 mm/day, a value that which generates a good inundation prediction in the urbanized area (Yin et al., 2016; Yu and Coulthard, 2015)."

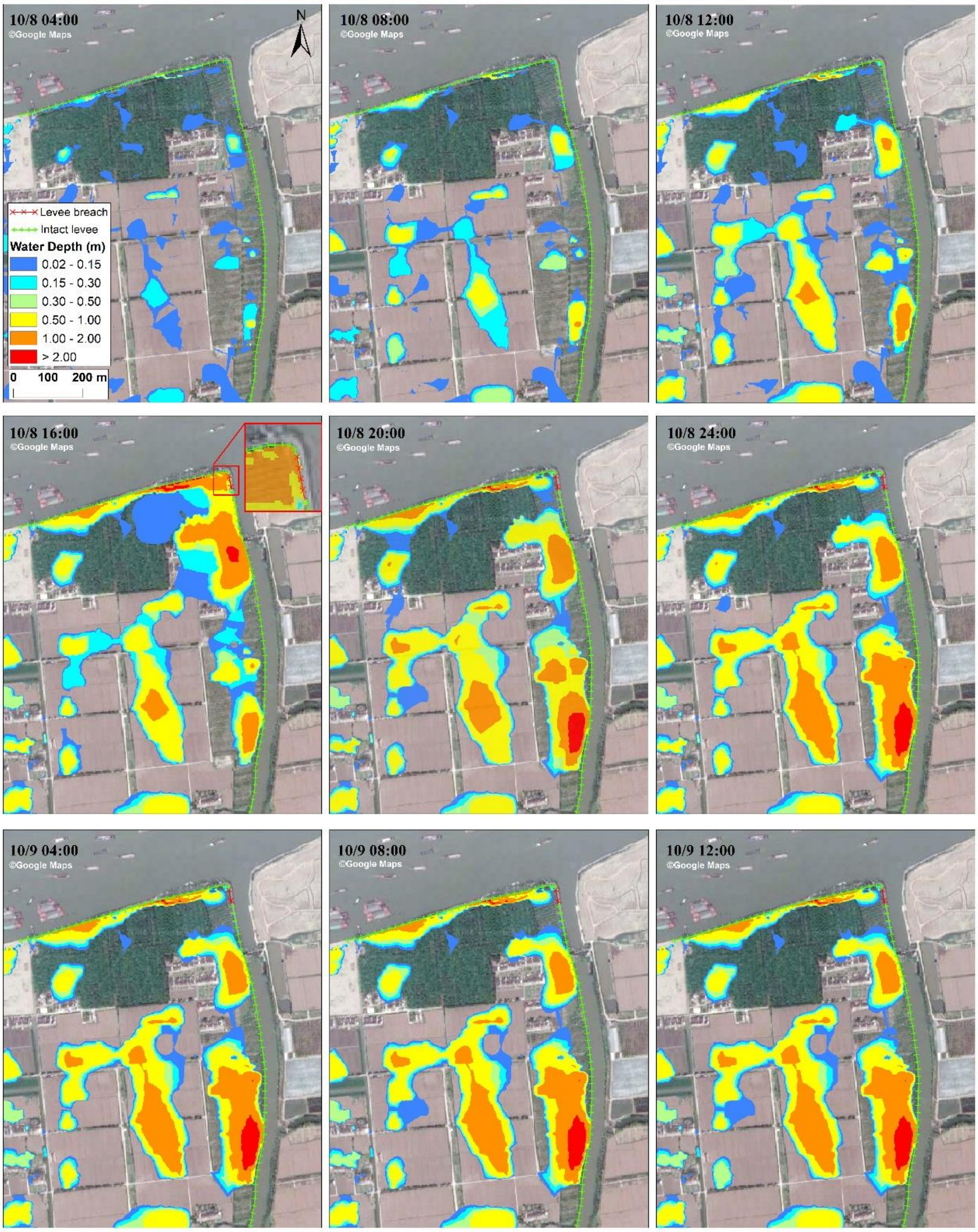
**10. it would be better to combine figure 2 and 5, which can clearly show the inundation process due to rainfall and sustained high water level in the river.**

Thanks for your suggestion, we have added the rainfall and water level change in figure: (Line 525)




11. **Line 321: maybe it's better to show the breach location or highlight waterfront area in Figure 4.**

Thanks for your suggestion, we have added the breach location in figure 4 (Line 523):




12. **Line 348: decreased from 0.6 to 0.55?**

Thanks for noting this. It has been corrected (Line 352).

13. **In Figure 3, it seems that these six points are building locations, how about the roadway and farmland? This is not consistent to the text line 367-369.**

Thanks for your suggestion, in Figure 3, we choose some representative sample of flood locations with relatively clear water depth marks. However, the water depth records of roads or farmland were all from investigates' dictation and lots of these locations were repaired after that event, so we didn't get too many reliable pictures of roadways and farmland.

**Referee #2**

1. **In abstract, there shall be a statement on the effectiveness of the 2D Floodmap model. To what extent do the modeling results match with the real flood patterns? What are the advantages of the model? This is a key message that must be clearly stated in the abstract.**

   Thanks for your comments, we have added the description of Floodmap in the Abstract as below (Line 21):

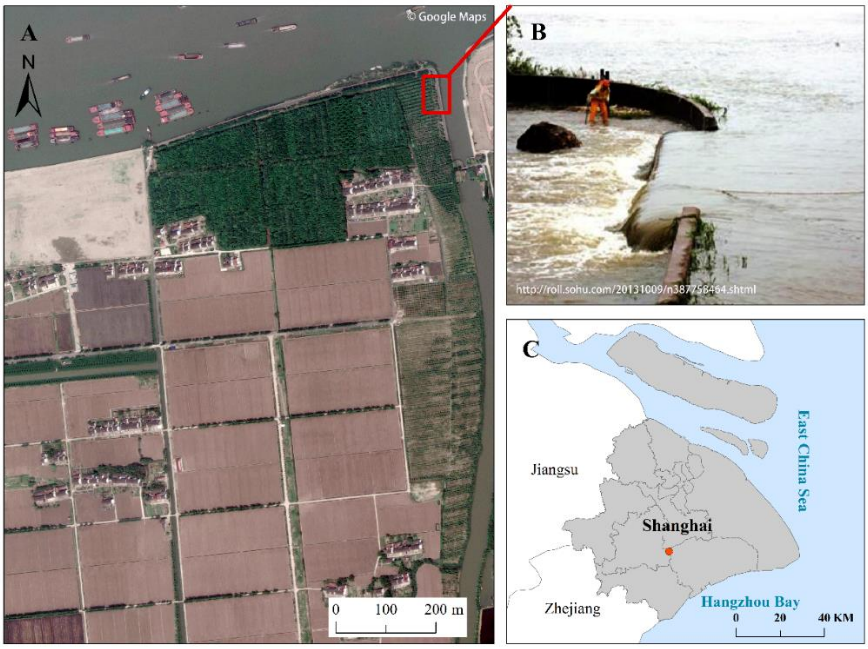
   "…using a well-established 2D hydro-inundation model (Floodmap) to reconstruct this typical event. This model coupled urban hydrological processes with flood inundation for high-resolution flood modeling, which has been applied in a number of different environments and now Floodmap is the mainstream numerical simulation model used for flood scenarios."

2. **Page 3, line 54-56, the "Himalaya glacier outburst flood in northern India" needs a reference**

   Thanks for your comments, the sentence was referenced from the news (Scores missing as Himalayan glacier bursts in northern India (france24.com)),we have added the reference in paper (Line 443).

3. **Figure 1, the sources of the image and picture shall be clarified.**

   Thanks for your comments, Figure 1(A) was from Google Maps, and the Figure 1(B) was from historical news, we have added the picture source URL and the Copyright information on each picture (Line 513).




4. **Figure 2, there needs more explanations of the three peaks of the water level curve. Especially why is there a "third peak", what caused it?**

   Thanks for your question, Figure 2 shows 36 h riverine tidal hydrographs of Huangpu River, the three peaks were main due to the rising tidal process but not the rainfall. However, the heavy rain also directly increased the water level (the second peak).

5. **As I understand, Compound flooding is an extreme impact event resulting from the interaction of multiple drivers (Zscheischler et al. 2018), mostly rainfall and tides (Bavacqua, et al 2020). But in this study, the flood was obviously mainly caused by heavy rainfall from Fitow, and there seems no tides or storm surges at the study site. Thus I suppose the authors shall not call it as a compound flood.**

   Thanks for your comments. It's a very important question, in previous study, compound flooding mostly due to the co-occurrence of high sea level and precipitation, however, in this study, the levee breach was caused by the compound effect of the rapid rising riverine water level and the heavy rain. The flood not only caused by the heavy rain but also the record-breaking river tides by the storm surge brought by the Typhoon "Fitow". When the heavy rain met the rising riverine tides, what made water level much higher, resulting in levee breach. Therefore, this flooding event was considered as a compound flooding in this paper.

6. **The discussion and conclusion section is weak. The discussion shall be improved and extended with more on the possible strategies and measures to reduce such levee breach and associated risks. E.g. according to the flood pattern and process, which areas and which measures could be most effective in reducing the flood impacts? From engineering perspective, how could the levee be strengthened, to which level? In addition, it would be also valuable to compare the present study findings with other Some flood adaptation**

**studies and household responses measures may be referred and compared, for instance:**

Thank you very much for your suggestion. The discussion regarding this question is presented following (Line 380):

"…. Third, the water does not drain rapidly only by infiltration or evaporation, and the waterlogging lasted for more than 12 h, resulting in loss of farmland with high vulnerability. Therefore, for levee breach-induced flood response in rural area, in addition to repairing the levee in time, it is necessary to remove the flood water using drainage measures at the same time, such as setting water pumps near the farmland or other low-lying area, when necessary, government should guide nearby residents to evacuate to a safe place as well.

Beyond the flood emergency response measures, effective long-term engineering measures may be more suitable for fundamentally decreasing the unpredictable levee-breach flooding risk, local specifications for the flood-control engineering should be updated with the increasing flood risk in the context of climate change (Yang et al., 2015)."

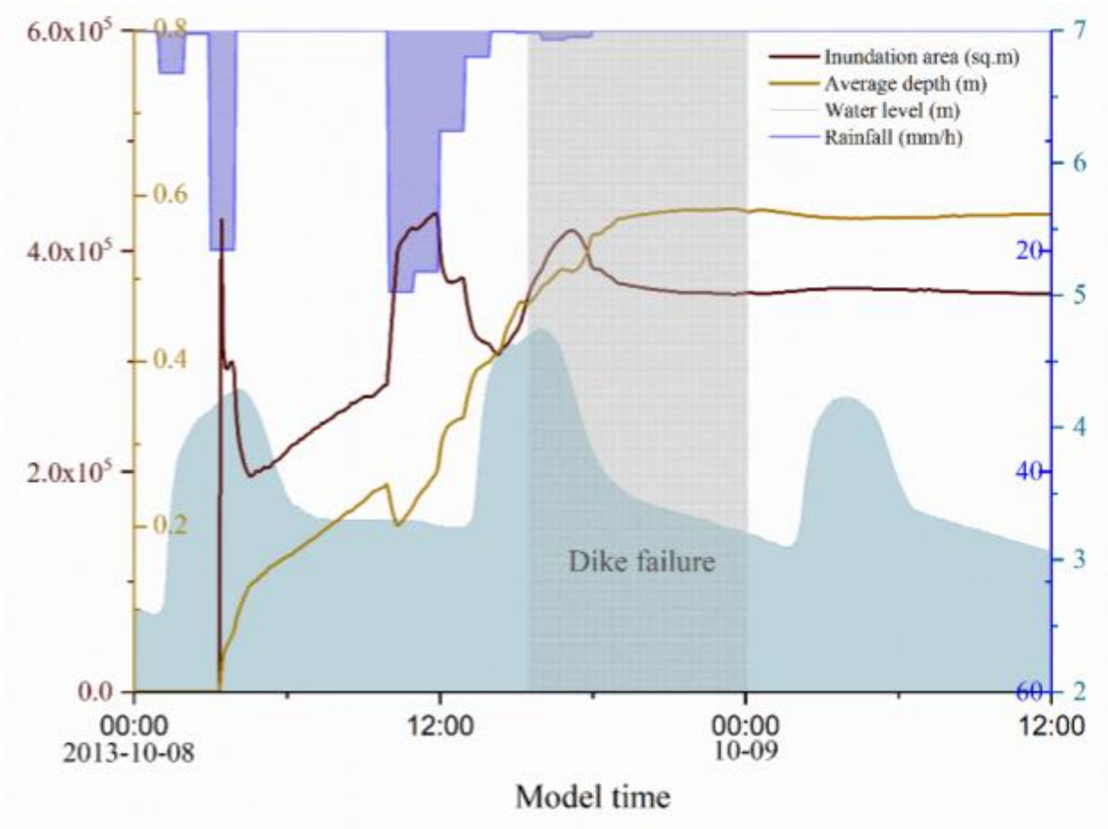
7. **Meanwhile, there is no conclusion in the current section 4. I would suggest to add a paragraph to summarize the key findings in this study, with simple and clear sentences. This helps readers to quickly get the key points of the study.**

   We deeply appreciate your suggestion. We have added some sentences to summarize the findings in **section 4** as below (Line 362):

"Simulation of real-life historical severe flooding events can reveal the dynamic flooding process and mechanism. In this study, a serious compound levee breach-induced flooding during the typhoon "Fitow" have been adequately investigated used by a simple 2D hydro-inundation model (Floodmap). The surface runoff caused by the rainstorm and river overflow were considered well in the model.

The following conclusions can be drawn from the simulation results. First, one key advantage of this modeling approach is the analysis of a single historic flood event. The flooding results showed the time series of the flooding extent and inundation depth, indicating that the low-lying area especially for farmland areas near the river had a very high flood risk. The compound flooding caused extensive damage to low-lying areas not only due to the elevation but the lack of a drainage network, resulting in the average water depth over 0.5 m more than 12 h. Second, within 1-3 h after the dike failure, the floodwaters spread rapidly, and the inundation area and average water depth reached the peak value, chiefly because of the rising riverine tides at the same time, however, during the falling tide period, although the dike has not been repaired, the flooding diffusion tend to be slow, the flood risk decreased as the water level dropped as well. Thus, it can be indicated that the levee breach-induced flooding spread was heavily dependent on the change of riverine tides, the key period for levee breach-induced flooding control (such as repairing the levee, evacuation) was from levee breach to the end of rising tide. Third, the water does not drain rapidly only by infiltration or evaporation, and the waterlogging lasted for more than 12 h, resulting in loss of farmland with high vulnerability.

Therefore, for levee breach-induced flood response in rural area, in addition to repairing the levee in time, it is necessary to remove the flood water using drainage measures at the same time, such as setting water pumps near the farmland or other low-lying area, when necessary, government should guide nearby residents to evacuate to a safe place as well."




8. **The English language is in general not sufficiently good for a scientific publication, which must be further modified.**

Thanks for your comments, we apologize for the language problems in the original manuscript. The paper will be carefully revised to improve the grammar and readability.