Dear Referee #1:

Thank you for the valuable comments. We have carefully read all the comments, and our responses to your questions are listed below. We greatly appreciate your time and efforts to help us to improve our manuscript for further revision and publication.

**General comments**

This study sought to evaluate the impacts of LID practices on urban inundation at a watershed scale in China. Extensive modeling was used to assessed various LID implementation scenarios with a hydrodynamic inundation model, which coupled SWMM and IFMS Urban models. The study is interesting and will contribute to the understanding of LID effectiveness related to flood reduction. However, the scientific quality and presentation quality were poor. First, English in this paper is poor. some contents are difficult to understand. I would strongly recommend the editing by an experienced or even better native English speaker. Next there some major and obvious weakness in methodology and results. I listed them below. Also, it requires lots of improvements in other sections.

Re: Thank you for your recognition for our research. The language of this paper has been proofread by "Editage", a worldwide professional editing company. Since it is still difficult to be understood, we will invite one or two native speakers in our research area to proofread it again. I am so sorry that the poor expression of this paper make you confused. Therefore, in the following part, we will try our best to explain your questions and we also have modified them in the revised manuscript. Thanks again for your patient reading and valuable advices.

**Introduction:**

1. Review should be correct. In page 3 line 16, "we find that few researches use hydrodynamic models, like SWMM ...". In fact, there are many studies of SWMM in LID field, especially in 2017 in China. Also, the introduction is very universal, does not clearly lead to the specific content of the manuscript and is missing a central theme. For readers to quickly catch your contribution, it would be better to highlight major difficulties and challenges, and your original achievements to overcome them in a clearer way.

Re: Our statement about coupled models is imprecise. Thank you for your kind reminder, and we will modify the expression and here is the revised version of the last paragraph of Introduction.

It is noteworthy that peak flow reduction, runoff reduction, and hydrograph delay are widely used indexes when evaluating the performance of LID practices (Ahiablame and Shakya, 2016; Qin et al., 2013; Zhang et al., 2016). However, these indexes are not very intuitive and how LID practices perform on urban inundation is more beneficial to local residents, such as providing guides for their travel behaviours.Indeed, some 1D-2D models have been applied for flood management such like ESTRY-TUFLOW (Fewtrell et al., 2011), InfoWorks ICM (Russo et al., 2015) and MIKE FLOOD (Loewe et al., 2017). However, most of these models are not free that limits their applications, and the open-source model (like SWMM) with LID module that can be coupied to simulate the urban inundation is needed in recently researches (Burns et al., 2015, Wu et al., 2017, Hu et al., 2017).

Therefore, the goal of this study is to demonstrate through a case study the effectiveness of LID practices to mitigate urban inundation in an urban watershed. The specific objectives were to (1) establish a 1D-2D hydrodynamic model coupled SWMM and IFMS Urban; and (2) evaluate the effectiveness of LID practices under different scenarios and hazard levels; and (3) explore the effiency of designed scenarios that related to the effectiveness of LID practices and the proportion of implementation areas. This study hopes to enrich the inundation mitigation research of LID on an urban watershed scale and provide some references to urban stormwater management and inundation mitigation for local government.

**Materials and methodology:**

1. Why you selected these two events? Were they have special characteristics?

Re: We chose two rainstorm events (11 May 2014 and 10 May 2016) for model simulation. On the one hand, the rainfall data and patterns for these two events are available that can be used for model calibration and validation. One the other hand, the increase in the frequency and intensity of urban flooding events associated with these types of rainstorm events (http://www.chinanews.com/gn/2014/06-10/6260988.shtml) highlights the need for these types of rainstorm events. So we think the two events have representations to carry out the research.

2. How you downscaled the dem resolution? The bias from downscaling was corrected?

Re: We resampled the DEM using Resample tool in ArcGIS 10.1. The aim is to compare the accuracy with the results of Kriging interpolation and we did not use the downscaled DEM for model simulation. This sentence seems useless and we will delete in the revised manuscript.

3. land use area should be described as well as the implementation area of each LID scenario

Re: Revised as requested.

4. Is there discharge Data for SWMM calibration？

Re: According to our detailed investigation on local government agencies, there is no discharge data that can be used for our model calibration. Indeed, lacking hydrologic data is a common problem for this type of research and it is even worse in China. Notheless, using inundation data to calibrate the model is an alternative and wide accepted way to calibrate models, and it has been applied in Hu et al. (2017) and Wu et al. (2017).

5. Why you coupled SWMM and IFMS Urban models? What the advantages compared with others? This study discussed inundation depth, area and time. There three indices could be got from some 2D inundation model. As I know, the outputs of SWMM are outflow, peak flow, flood volume, etc. This study didn’t mention any of them. So, why you need SWMM?

Re: The reasons for choosing and coupling these two models are not clearly stated in section 2.3 and 2.4 of our original paper, we have made some descriptions to revise it in our revised manuscript:

SWMM is a 1D rainfall-runoff model which can use the given hydrology data and hydrodynamics to simulate the quantity and quality of rainfall-runoff. Nontheless, when the node overflow occurs, SWMM cannot simulate the spatial and temporal distributions of surface inundation, but the IFMS Urban can using 2D shallow water equations. However, the simulations of IFMS Urban must base on the simulated results of SWMM. So we coupled these two models to realize the simulation on the spatial and temporal distributions of surface inundation. And the outputs of the coupled model are inundation depth, inundation areas and inundation time. Indeed, we are more concerned about the results of surface inundation, and the outputs of SWMM are not showed in this research.

SWMM is an open-source model and it has been widely used to simulate the hydrologic performance of LID practices. IFMS Urban has great compatibility with ArcGIS and SWMM, and it can simulate surface inundation using DEM. What's more, the process of data conversion and model coupling are accomplished in IFMS Urban, and it doesn't need any other software programming, which is convenient for researchers and non-expert users.

**Results:**

1. The results for hazard level seem very sensitive to the thresholds chosen. Please give information on the thresholds chosen.

Re: The main basis for the thresholds is according to the relationship between vehicle speed and inundation depth researched in Su et al. (2016). Comparing their results with the study status, we set the three hazard levels for this research. Indeed, different thresholds might inform the results for hazard level and researches on more accurate thresholds are needed in future studies. We will put it in the Limitations and future studies in  the revised manuscript.

2.  Results are contradicted. The authors reported on Page 7 line 11-12 "the reduction effects become more evident as hazard level increases", "the roles of LID practices with respect to urban inundation mitigation are less obvious at High levels than thoseat Low levels". So which one is correct?

Re: From line 4-5 on page 7 of our manuscript, our research results show that for the High levels, the ***depth reduction*** after the construction of LID practices is from 0.11 m to 0.19 m (greater than that for the Low levels) and the ***depth reduction rates*** are from 22 % to 40 % (lower than those for the Low levels) under Scenarios 1 to 4. We didn't express clearly about the results in our original manuscript but we will improve it in the revised manuscript.

3. please show the spatial distribution of reductions in inundation depths instead of average reduction

Re: Figure 5 shows the spatil distribution of reductions in maximum inundation depths of the study area. And from this figure we can see the spatial changes of inundation depth in different scenarios. So we didn't show the spatial distribution of reductions in inundation depths.

4. please give more information of PP and GR implementation area, otherwise, you cannot say PP performs better than GR

Re: Thanks to point out our careless on the information missing. Data information is as follows:

The available implementation area of PP and GR is 5.95 $km^2$ and 8.92 $km^2$, respectively. The depth reduction rates of 100% PP are 67%, 38% and 23% at Low, Medium and High levels, and the depth reduction rates of 100% GR are 61%, 31% and 21% in three hazard levels. The area reduction rates of 100% PP are 37%, 65% and 67% at Low, Medium and High levels, and the area reduction rates of 100% GR are 32%, 56% and 67% at three hazard levels. Although the implementation area of PP is smaller than GR, the effectiveness of PP on urban immunation mitigation is greater than GR. So we say that PP performs better than GR in this study.

5. in section 3.3 you said the reduction in inundation area under High level was more obvious, but in section 3.1, reduction in inundation depth was less obvious. Please explain.

Re: Poor expression makes this part confusing to be understood but we have improved the expression in the revised manuscript. From the simulated results shown in section 3.2, the ***depth reduction*** after the construction of LID practices is greater but the ***depth reduction rate*** is lower under the High levels compared to Low levels (***question 2, Results***).

In section 3.3, the ***area reduction rate*** is greater under High level compared to other hazard levels (line 22 on page 7). This is because that after the construction of LID practices, in High level, the inundation depth has been decreased and most inundation areas are downgraded from High level to Medium or Low levels, but most inundation areas heavn't been eliminated which make the ***depth reduction rate*** lower than other levels. This is the reason why the ***depth reduction rate*** is lower and the ***area reduction rate*** is greater in High level compared with other levels.

6. please show the spatial distribution of reductions in inundation time instead of average

Re: Through the analysis of inundation depth and inundation area, we can draw the conclusions of this study approximately, and the analysis of inundation time comfirm effectiveness of LID practices from another aspect. Considering from the full text, inundation time is not the key point in this study, so we didn't show the map of inundation time. If necessary we will discuss it further in the revised manuscript.

7. one of the key points in your study is to compare the differences of all scenarios at three hazard levels not to find the differences among three hazard levels

Re: Indeed we both consider the two groups of comparisons in results. From Figure 6 we can see that as the propotion rises from 25% to 100%, the ***depth reduction rate*** (a) and ***area reduction rate*** (b) both increase in the Low, Medium and High levels. It is clear that the reduction rate grows slowly associated with the increasing of proportion of LID implementation from 25% to 100%, which means the efficiency of LID implementation decreases from Scenario 1 to Scenario 4. To better describe the phenomenon, we will built a cost-effectiveness indicator (RPI) in the revised manuscript:

$$\mathrm{RPI} = \frac{R}{P}$$

R means reduction rate of inundation depth and inundation areas, and P means the proportion of LID implementation. From Table 6 we can see that the RPIs of 25% PP+25% GR are always higher than the other scenarios while higher RPI indicates higher efficiency. From the comparisons, we can conclude that the simple increase of the proportion of LID implementation cannot necessarily contribute to the higher efficiency. Finally, we find that the efficiency of 25 % PP + 25 % GR is higher than other scenarios in this study. This indicates that we should not only consider the effectiveness but also the cost of LID practices in the construction of "Sponge City".

Table 6 RPI under differrent scenarios.

| | | 25%PP+25%GR | 50%PP+50%GR | 75%PP+75%GR | 100%PP+100%GR |
|---|---|---|---|---|---|
| Maximum inundation depth | | 0.64 | 0.44 | 0.35 | 0.29 |
| Average inundation depth | Low | 2.40 | 1.48 | 1.05 | 0.80 |
| | Medium | 1.08 | 0.86 | 0.68 | 0.54 |
| | High | 0.88 | 0.60 | 0.48 | 0.40 |
| Average inundation areas | Low | 1.23 | 0.87 | 0.68 | 0.53 |
| | Medium | 2.22 | 1.37 | 0.97 | 0.75 |
| | High | 2.86 | 1.62 | 1.14 | 0.90 |

**Discussion:**

1) The discussion is lacking depths. What are the same and different points comparing your study and others? What you studied from this research.

Re: Compared to the existing studies about LID, this study tries to explain the cost-effectiveness of LID for urban inundation risk mitigation. Moreover, this study focuses on the cost-effectiveness changes in different hazard levels under different scenarios.

1. The effectiveness of PP for urban inundation mitigation performs better than that of GR in this research. This conclusion might be different in other regions because of the differences of LID parameters, implementation area, spatial pattern, rainfall intensity, rainfall frequency and other factors. But it gives a reference for local residents and policy-maker that PP might be a good choice for local areas because of the great effectiveness and the large potential for reconstruction in the built-up region (PP could be gradually applied in roads and parking lots, while GR is hard to implement in density construction lands, especially in the urban villages);

2. Through the analysis in section 3.2 and 3.3, we can find that in High level, the inundation depth has been decreased and most inundation areas are downgraded from High level to Medium or Low levels, but most

high inundation hazard areas heavn't been eliminated and the ***depth reduction rate*** is lower than other levels. This indicates that LID practices can only ease the inundation depth and downgrade the inundation hazard level in High level. And some other methods of stormwater management should be used together to deal with severe waterlogging in High level areas;

3. Through the analysis in ***question 7, Results***, we find that the RPI decreases as the proportion of LID implementation increases from Scenario 1 to Scenario 4 and the efficiency of 25 % PP + 25 % GR is higher than other scenarios in this study. This indicates that the simple increase of the proportion of LID implementation cannot necessarily contribute to the higher efficiency, and we should not only consider the effectiveness but also the cost of LID practices in the construction of "Sponge City". These findings may provide some suggestions for LID designs in other regions.

2) The discussion on cost-effectiveness completely fell from the sky on page 9 line 3. You neither present how the costs were estimated nor discussed them in the Results.

Re: The main difference among scenarios from Scenario 1 to Scenario 4 is the proportion of LID implementation, and the cost will be higher as the proportion of LID implementation increases. Therefore, we develop a cost-effectiveness indicator (RPI) to discuss on the efficiency of LID practices (***question 7, Results***). We will add these descriptions in the revised manuscript.

3) In page 9 line 22, "we also find that spatial distribution of landscape patterns ...". This information completely fell from the sky. You neither present them in the Results.

Re: Thanks for pointing out the expression problem that these results are from Kim and Park (2016) and Giacomoni and Joseph (2017), and we will modify it in the revised manuscript.

4) You reported 25% of PP and GR had the highest efficiency. Is it correct? Do you consider the effect of rainfall intensity and frequency? LID effectiveness is highly related to rainfall intensity and frequency.

Re: You made a very constructive suggestion. We did find that rainfall intensity and frequency will influence effectiveness of LID. However, this study focuses on the trade-offs between implementation cost and effectiveness of LID practices, and we did not change the rainfall intensity or other factors in this study. In our research, once-in-100-years heavy rain happened on 11 May 2014 (144.9 mm) is selected to simulate the urban inundation situation. Because we find heavy rain of this intensity attacks Shenzhen almost very year associated with climate change. In this research, place-based references are provided for the policy-makers, and we do not suppose all the findings of this research can be directly transferrable to other places, cities even countries but the analytical methods and the efficiency analysis.

**Specific comments**

1) Page (P) 1 line (L) 15-19, too long to understand.

Re: This study proposes a hydrodynamic inundation model, coupling SWMM (Storm Water Management Model, 1D) and IFMS Urban (Integrated Urban Flood Modeling System, 2D), to assess the effectiveness of LID practices under different scenarios and hazard levels. The results are shown as follows.

2) P1L25, considering cost-effectiveness, you don't give any information on it.

Re: The information about cost-effectiveness is mentioned above (***question 2, Discussion***).

3) P2L4: what are secondary disasters? it is better to delete.

Re: Amended as requested.

4) P3L18-20, there some studies on this topic, please review them.

Re: Amended as requested.

5) P3L29, give rainfall information from April to September.

Re: April to September marks the rainy season in Shenzhen. There are 38 rainstorm days (95% of the whole year) in 2017 and the average rainfall is 170-350 mm every month during this period.

6) P4L5-10. simplify the description.

Re: The study site is located in Guangming New District of Shenzhen, China (Fig. 1). The total area of this study site is 37.68 $km^2$ with 69.8 % of it is the construction land. Because of the intensive inundation disasters, Guangming New District was selected as the first pilot area for LID practices in Shenzhen in October 2011. Therefore, there is a need to research the effectiveness of LID practices on urban inundation mitigation in this area.

7) P4L12, delete"needed for modeling".

Re: Amended as requested.

8) P4L18-19, how to do.

Re: We resampled the DEM using Resample tool in ArcGIS 10.1.

9) P4L20-22, improve.

Re: The reason why we choose the two events is mentioned above (***question 1, Materials and methodology***) and we will improve it in the revised manuscript.

10) P5L1-3, improve.

Re: We have reorganized section 2.3 and 2.4 in the revised manuscript.

11) give clear information on the model.

Re: The detailed information about the model is introduced above (***question 5, Materials and methodology***) and we will improve it in the revised manuscript.

12) P5L31-32, "we found ..."???

Re: We have not explained the details for this part. In fact, there are some special attributes for buildings on the dense construction land in our research area. Through the detailed urban planning and field investigations of our research area, we found the 80% of the residential lands are urban villages, desnsely constructed on construction lands. The structures and shapes of roofs for urban villages are diversity which makes it difficult to build green roofs on them. More important, the complex owenership and financing pathways which also make it difficult to construct the green roofs for the dense construction lands in our research area. Therefore, we temporarily didn't set green roof in the dense construction land in this study.

13) P6L3, strength? is it density?

Re: We will instead "Construction strength" of "construction density" here.

14) P6L19, relative error 30% is acceptable?

Re: Lacking observation data is a universal problem in model simulation, and some models did not have a calibration (Hu et al., 2017). In this study, the relative error of calibration seems a little high, while the relative errors of validation are 5-20%, which is met the requirements of the Standard for Hydrologic Information and Hydrologic Forecasting in China (GBT_22482-2008). If there are more detailed inundation records, the model can be further improved in the future study. We will discuss the limitation in section 4.4 Limitations and future studies.

15) P6L24-25, give more literature to support

Re: Amended as requested.

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