Responses to Anonymous Referee #1

MS No.: hess-2020-59

General comments:

The authors attempt to combine (1) UAV aerial surveying data with, (2) volunteered geographic information (VGI) and (3) computational flood simulation (CFS). Combining all three approaches is a useful topic and the authors are encouraged to pursue further fieldwork and research in this area. However, the paper skims the surface of each topic, has poor quality input data, buries the details of data analysis, incorporates a number of poor/dubious practices, and hides the quality of output data inside lumped categories. The conclusion of the paper that a higher resolution DEM produces better CFS results is common sense and hardly new. Other factors that are arguably more important are resolving critical sub grid scale features such as walls, and how these can be incorporated into a coarser (or variable resolution computation grid). The factors above and comments below make it impossible to recommend publication.

Response: Thank you for the comments. We made several changes on the validations and added some materials to make it clearer. Please see the following point-by-point responses.

Specific comments:

1 The paper covers a small spatial area and the limitations of UAV's in this regard is not discussed.

Response: Compared with other surveying and mapping methods, UAVs are more easily deployed to quickly update the 3D spatial information after disasters. However, the flight height of UAVs is limited by the regulations in urban areas. Thus, in consideration of the limitation of flight height and the ground resolution requirements in the study area, the UAV was set to fly at a height of 100 meters to perform vertical surface shooting. Relevant discussions have been added to the revised manuscript.

2 Boundary conditions are the edge of the spatial domain are not considered/discussed.

Response: For the CFS, the rainfall and DEM data are given at each grid center within the simulation domain. At the edge of the domain boundary, the water is allowed to outflow freely. The descriptions above are added to the revised manuscript.

3 A freeway/motorway takes up a substantial proportion of the study domain, but is removed from the DEM without sufficient information on how the DEM was estimated where this was removed, or how roughness/friction parameters were estimated.

Response: The freeway is elevated and supported by the pillars at the centerline of the Keelung Road (shown in the following photo). The freeway is removed for the CFS because flood water is allowed to flow across underneath the viaduct. Since the ground elevations were observed by the UAV at the divisions between the viaduct lanes and the buildings on the roadsides, the DEM underneath the conduct can be estimated. For the CFS, the friction parameters are estimated by the Manning's coefficients subject to land covers (Chow, V.T., 1959). The discussions above have been added to the revised manuscript.

Reference: Chow, V.T. (1959) Open Channel Hydraulics. McGraw-Hill, New York.

Fig. 1 The freeway is elevated and supported by the pillars at the centerline of the Keelung Road

4 Vegetation takes up a substantial proportion of the study domain, but is removed from the DEM without sufficient information on how the DEM was estimated where this was removed, or how roughness/friction parameters were estimated.

Response: The regions of vegetation are detected using the ExG-ExR binary index (Meyer and Neto, 2008) by subtracting the alternate excess red vegetative index (ExR = 1.4r−b) from the excess green vegetation index (ExG = 2g−r−b), where r, g, and b are the chromatic coordinates. To consider the friction effects by the roughness of vegetation, the Manning's coefficient is set as 0.04 for the CFS.

Reference: Meyer, G. E. and Neto, J. C.: Verification of color vegetation indices for automated crop imaging applications. Computers and electronics in agriculture, 63(2), 282-293. https://doi.org/10.1016/j.compag.2008.03.009, 2008.

5 The study only uses 3 ground control points for UAV surveys which is not enough. At least 8 required, with many studies recommending 16+.

Response: The coordinates of the three GCPs were obtained by referring to the publicly released values of Taipei City Government and using the static positioning of Global Navigation Satellite System (GNSS) with positional accuracy in centimeter level. The difference between the coordinates obtained by these two methods can be used to evaluate the accuracy of the ground control points. The 0.5m and 5m DEMs are created and validated according to the initial UAV-based DEM with resolution of 0.03m. We have added more discussion on the GCP requirement in the revised manuscript. The reasons we used only three GCPs are (1) the study area is relative small (0.0637 km2) and the GPS information on the UAV could produce 3D coordinate with certain degree of accuracy; (2) there are exactly three GCPs released by the Taipei City Government in this study area and we also double check the released values with the static positioning of Global Navigation Satellite System (GNSS) with positional accuracy in centimeter level; (3) The number of GCP depends on the surveying areas, flight altitudes, resolutions and application goals. According to the user manual of Pix4D (https://support.pix4d.com/hc/en-us/articles/204272989-Offline-Getting-Started-and-Manual-pdf), a minimum number of 3 GCPs is required. To provide more information to readers, we have added more discussion on the GCP requirement in the revised manuscript.

6 There is no discussion of flight regulations limiting UAV operations in urban areas and other similar considerations.

Response: In the study area, the flight height is limited under 100 meters according to the UAV operation regulations in urban areas. This statement has been added to the revised manuscript.

7 The study talks about a computational sewer model being used, but provides no details of this and where sewers were or how flow was accounted for.

Response: The pipelines and manholes of the sewer systems are displayed in the following Figure:

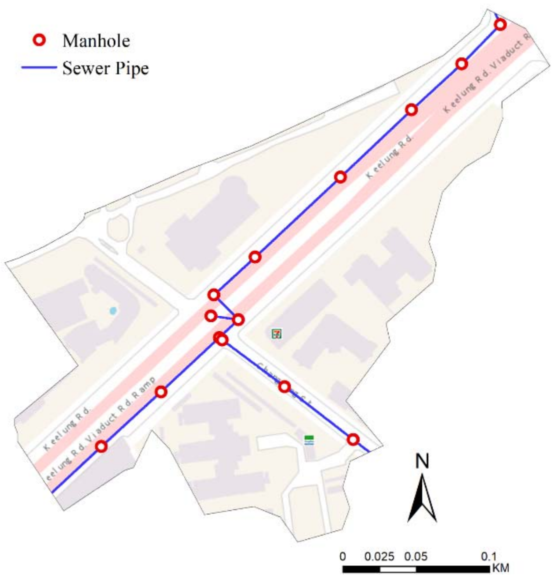


Fig. 2 The pipeline and manholes of the sewer systems in the study area.

When rain drops, the overland flow model (OFM) is firstly initiated for surface water routing. Then, the surface runoff travels for a distance and enters the sewer pipes via the street inlets to trigger the sewer flow model (SFM). When the sewer pipes get full, the sewer water surcharges back onto ground surface via the manholes or inlets. In the simulation process, the water exchanged between the two models are determined by weir and orifice functions via one-to-one relationship as shown in the schematic diagram below. These explanation have been added to the revised manuscript.

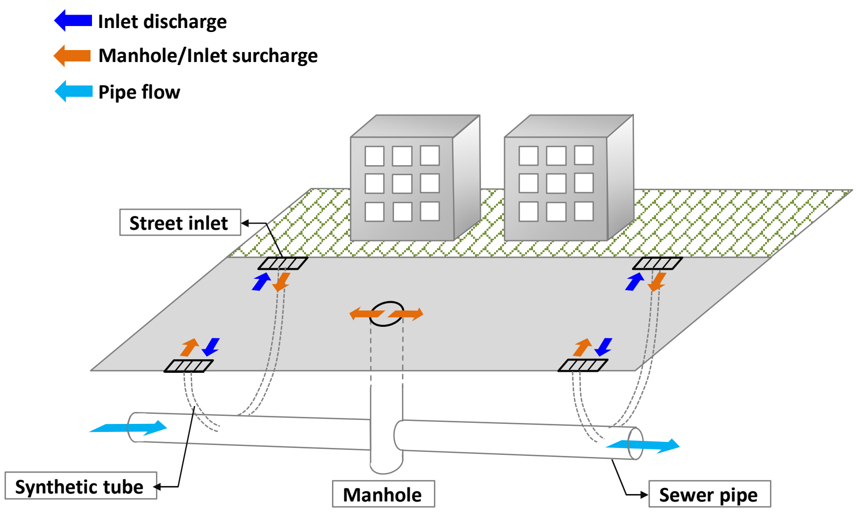


Fig. 3 Illustration of the water simulation process between ground surface, inlet, sewer pipe and manhole.

8 The study provides very limited details of the CFS model. Other papers are referenced, but no local information is provided on roughness of different terrain types etc that must be used inside the CFS but are local to the study area.

Response: The Manning's coefficient n is used to represent the surface roughness subject to land covers. Since the land covers are mostly concrete and short grass, the value of n slightly varies from 0.03 to 0.04 according to Chow, V.T. (1959). Although the skin friction represented by Manning's n changes little, the form frictions caused by road curbs and building walls can be more significantly presented as DEM resolution increases. The discussions above and more details about the CFS, as shown in the previous comments, have been added to the revised manuscript.

9 The paper provides irrelevant equations and information about DEM reconstruction and camera lens distortion (section 2.1). These are a red herring and completely irrelevant. The authors used Pix4D to do their aerial image processing and have not implemented the equations themselves. Pix4D or Agisoft Metashape are the appropriate software packages for this type of work, but the authors should spend more time discussing the appropriate workflow for data processing. It is likely that they did not follow a recommended workflow since they only used 3 ground control points.

Response: We revised the Section 2.1 by adding necessary information about the determination of roughness and DEM for areas of vegetation and underneath the viaduct. The Pix4D workflow of data processing is displayed in the following Fig. 4 and is identical to the manual suggestions (Pix4D, 2017). The basic theories of collinearity and lens distortion are keep in the manuscript for reader's reference. According to the Pix4D manual, three GCPs have met the basic requirement for UAV image processing and validation. We have added some discussion on the GCP requirement in the revised manuscript.

Pix4D, User Manual v4.1, pp.26. https://support.pix4d.com/hc/en-us/articles/204272989-Offline-Getting-Started-and-Manual-pdf. 2017

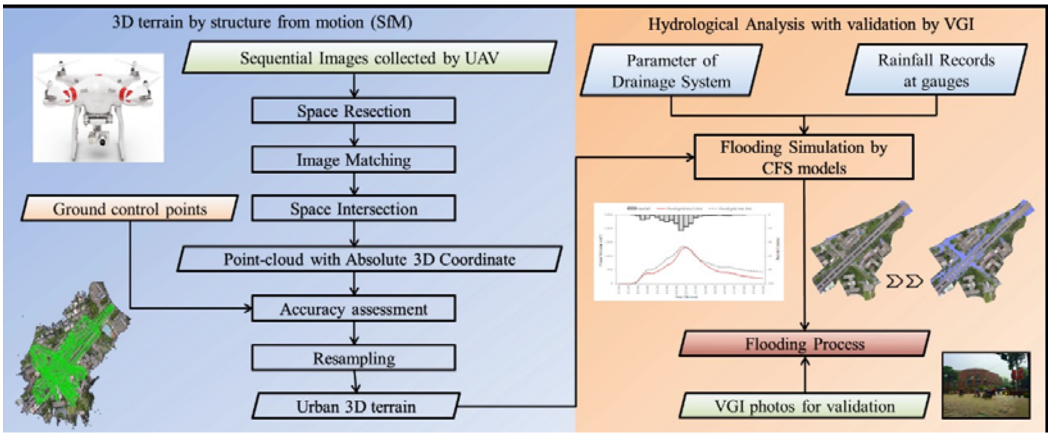


Fig. 4 Conceptual flowchart of this study (the VGI photo was adopted from PTT, Taiwan)

10 The timestamp of the photos from 'picture posting time' is not at all defensible. The authors should extract the EXIF information from the photos and look at image capture time. If images were captured with a cell phone then the timestamps should be accurate.

Response: The VGI photos acquired from internet, for example from the PTT in this study, are usually not the original photos and therefore the EXIF information is not available. We checked it using http://metapicz.com. However, we are appreciate for this suggestion and relevant explanation is added to the revised manuscript.

11 The authors did not adequately survey flood depth at locations from the VGI images. They should have gone out with an RTK GPS survey system and a ruler after the flood and measured the spatial location of depth reference points and the associated depth. Not doing this ('flood depth estimated from photos") is very poor practice.

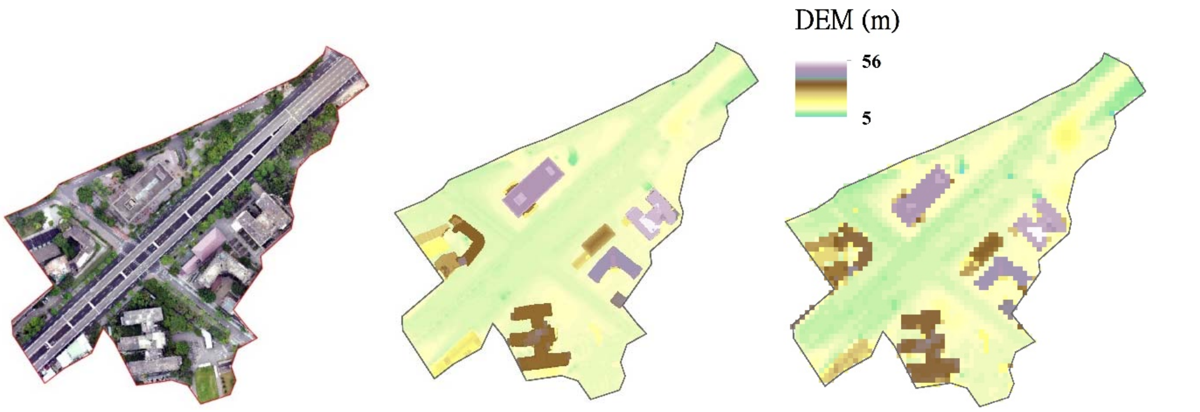
Response: Our estimation of flood depth form photos are based on some obvious targets such as wheel size of bikes and height of road curbs. The geometry of these targets are standard so that the flood depth can be estimated by mutual comparison.

12 Other errors throughout the paper from lack of attention to detail (see technical comments below) also call the accuracy and research quality of the paper into question.

Response: All the technical comments have been reviewed and the corresponding revision have been made (see the responses to technical corrections for detail).

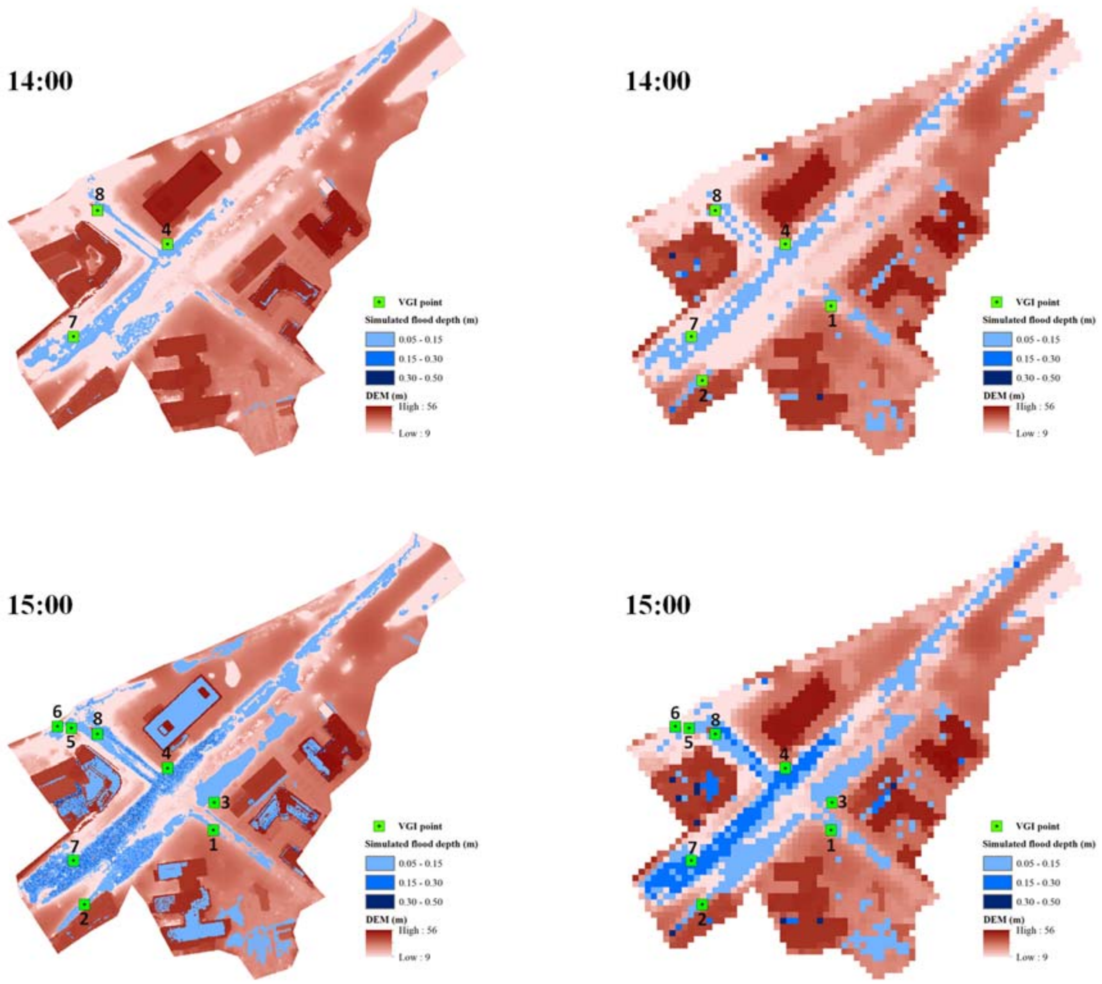
13 Scaling of figures 7 and 8 is poorly selected and shows nothing of the fine scale DEM at ground level which is critical for the flood modelling. The selection of this scaling raises questions as to whether it was selected on purpose to hide a poor quality DEM at ground level.

Response: The scaling of the two figures are based on a continuous classification of DEM automatically generated by a GIS software. The ground levels are not displayed in detail because the height of buildings outweighs the variation of ground levels which results in the stretch of color bar. In order to highlight the details of ground level, the scales of these two figures have been adjusted in the revised manuscript and are displayed as below:



(a) (b) (c)

Fig. 5 The processed (a) orthophoto and the DEMs with spatial resolution of (b) 0.5 m (c) 5 m



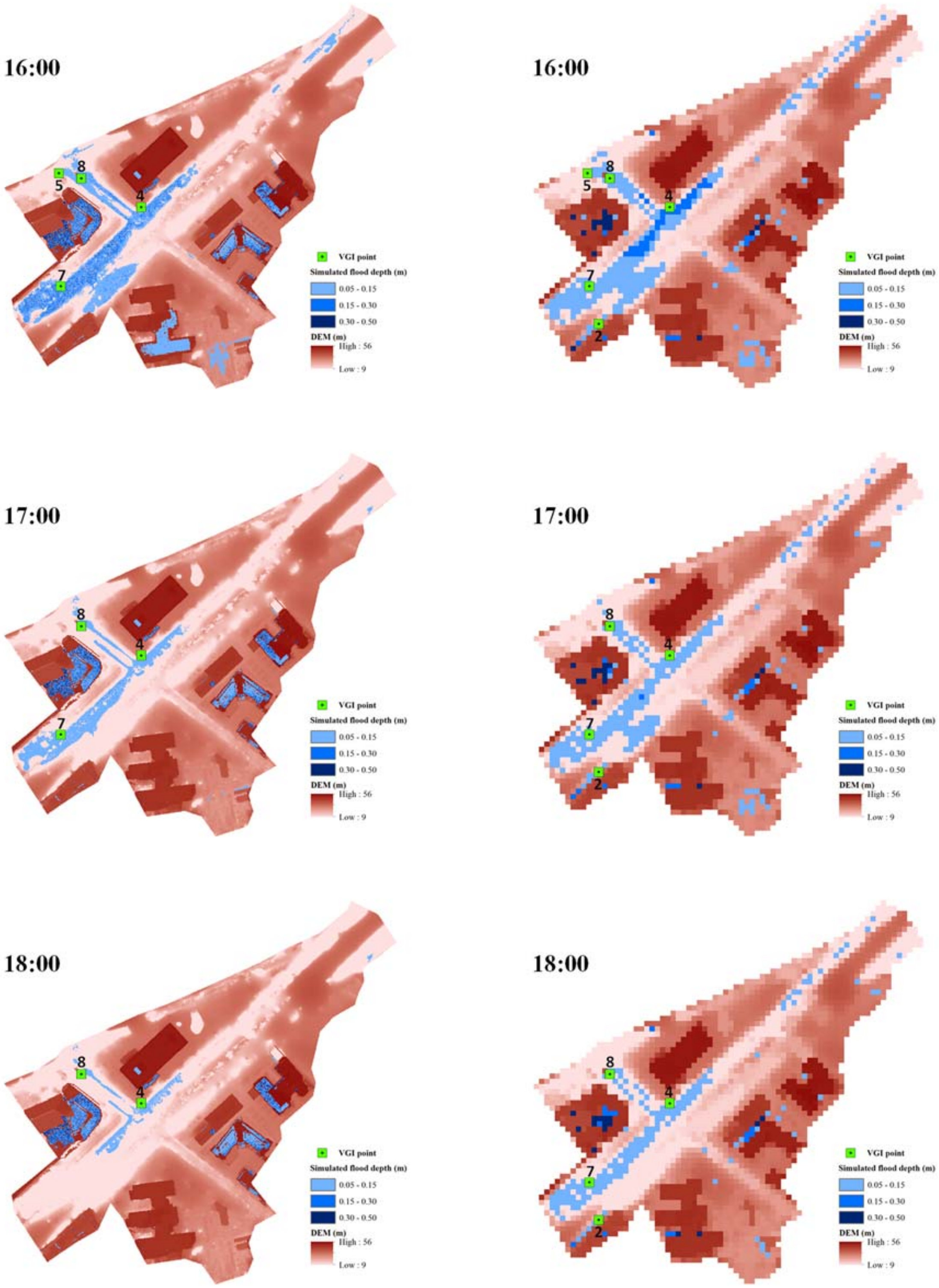


Fig. 6 Simulated flood extents at different time under DEM resolution of 0.5 m (left) and DEM resolution of 5 m (right).

14 Data in Table 4 have been thresholded by the arbitrary category of water depth over 5 cm deep. This simple thresholding makes it far easier for data to appear correct (i.e. assigned to binary over/under categories). The data should compare actually flood depth (from ground

truth measurements at VGI photo locations compared to observed water levels in photos) with flood simulation depth and quantify the error (discrepancy between the two).

Response: For flood impact assessment, binary scaling of flood depth is commonly used because certain water depths have specific meanings. For example, 0.05m represents the height of ankle, when water depth exceeds it, people experience inconvenience; 0.3m is the depth above which furniture damages start to take place; 0.5m of water depth is the lower bound for compensation application in Taiwan. Therefore, the scalings in Table 4 and Figure 8 are not randomly selected but deliberately arranged to highlight the impacts of flooding.

As to the comparison with observed water level, the lack of onsite measured data is always the issue for CFS validation. This study proposes an approach to extract useful information by image processing technologies from VGI and UAV photos for urban flood modeling. From the comparison of CFS results with VGI photos, the building sidewalls and terrain depressions are demonstrated to have a great influence on flood extent, depth, and occurrence which can only be simulated by the CFS with high-resolution DEM. The original statements have been revised according to the above discussions.

15 The paper is well written in some sections, and poorly in others. Many sections would benefit from a rewrite, information being removed, information being added, or information being moved to other sections. This is beyond the scope of what is expected from a reviewer, hence I have only listed some of the obvious errors, suggestions, and grammatical corrections in the technical corrections below. Hopefully these will help the authors to rework the paper to become a high-quality conference paper, or with very thorough reworking and further analysis it may possible for it to be eventually published as a journal article. However, it may be faster for the authors to record another more thorough dataset (in a more suitable location) to analyse for a future journal paper.

Response: The original manuscript has been thoroughly revised by adding necessary information, removing unnecessary parts, arranging the text structures, and correcting the errors in grammar and methodology according to the suggestions by the reviewers. Hopefully, these revisions will make this paper more acceptable for publication in HESS.

Technical corrections:

Line	Previous version	Correction	Response
Title	Using unmanned aerial vehicle and volunteered geographic information to sophisticate urban flood modelling	Using an unmanned aerial vehicle and volunteered geographic information for sophisticated urban flood modelling	Revised accordingly.
15	simulation (CFS) to reconstruct the flash flood event occurred in 14 June 2015, GongGuan, Taipei.	simulation (CFS) to reconstruct the flash flood event that occurred on the 14th of June 2015 in GongGuan, Taipei.	Revised accordingly.
17	acquired from social network are served to establish and validate the CFS model,	acquired from social networks are used to establish and validate the CFS model.	Revised accordingly.

	respectively.		
19	The results show that flood scenario	The results show that the flood scenario	Revised accordingly.
26	Flash flooding resulted from extreme heavy rainfall	Flash flooding resulted from extremely heavy rainfall	Revised accordingly.
47	DEM data are derived by airborne Lidar	DEM data are derived from airborne Lidar	Revised accordingly.
50	two raising techniques namely unmanned aerial vehicle	two rising techniques namely unmanned aerial vehicle	Revised accordingly.
53	(DEM) derived by UAV have similar performances in urban	(DEM) derived from UAV aerial imagery have similar performance in urban	Revised accordingly.
58	study of 2013 Boulder flood.	study of the 2013 Boulder flood.	Revised accordingly.
64	The DEM generated by UAV can be served as the boundary conditions to increase the spatial resolution of CFS	Presumably this should be: "The DEM generated from UAV aerial imagery can be used as the boundary conditions to increase the spatial resolution of CFS" However, I have no idea what they are talking about with 'boundary conditions to increase the spatial resolution of CFS'? DEM resolution is arbitrary and depends on how SfM or LIDAR data are resampled and output. Boundary conditions at the edges of the spatial extent of the computational domain should be properly addressed and this information is not clear in the paper.	The original statements is not clear and has been revised as "The DEM generated from UAV provides detail terrain of an urban area which significantly increases the spatial resolution of CFS compared to traditional practices" Because the ground levels are given in grid unit in CFS, there exists an invisible wall between two adjacent grids with different elevations. When DEM resolution varies, the heights of these walls vary as well that affects the inter-cell water communications
74	rain gauge are shown in the Fig. 2. The DEM derived by UAV and the flood photos collected from VGI are served to establish and validate the CFS, respectively	rain gauge are shown in Fig. 2. The DEM derived from UAV aerial imagery and the flood photos collected from VGI are used to establish and validate the CFS.	Revised accordingly.
82-96		Remove this section. They do not independently implement this technique.	We revised the sentences and mentioned the process is based on the Pix4D but the basic theory of

		They simply use Pix4D and the actual algorithms contained within are far more complex than the information provided in this section. Focus on the workflow for image processing in Pix4D.	the collinearity condition are keep in the manuscript for readers' reference.
97	DJI Phantom 2 Vision+ (Da-Jiang Innovations) which weights 1.2 kg and has a camera with 4384×2466 pixels.	DJI Phantom 2 Vision+ (Da-Jiang Innovations) which weighs 1.2 kg and has a camera with resolution of 4384×2466 pixels.	Revised accordingly.
105-108		3x GCPs is not nearly enough!	According to the Pix4D manual, three GCPs have met the basic requirement for DEM processing (Pix4D, 2017). We have added more discussion on the GCP requirement in the revised manuscript.
109-116		Remove the section on lens distortion. Completely irrelevant to the study. Again Pix4D calculates and accounts for lens distortion. They do not do it themselves. Remove table 2 about the camera on the UAV. It is irrelevant and does not generalise to the equipment used by other researchers.	We revised the sentences and mentioned the process is based on the Pix4D but the basic theory of the lens distortion are keep in the manuscript for readers' reference.
118	The vegetation such as shrubs and grasses is detected by	Vegetation such as shrubs and grass were detected by	Revised accordingly.
117-125		I am dubious about their psudo NDVI method of vegetation detection from RGB imagery and the thresholding to detect the viaduct. How 'removed' elements were then accounted for is not stated. Interpolation how? What roughness values were assigned to the unknown terrain? How was water drainage accounted for on building roofs? Down pipes	The regions of vegetation are detected using the ExG-ExR binary index (Meyer and Neto, 2008) by subtracting the alternate excess red vegetative index (ExR = 1.4r−b) from the excess green vegetation index (ExG = 2g−r−b), where r, g, and b are the chromatic coordinates. To consider the friction effects by the roughness of vegetation, the Manning's coefficient is set as 0.04 for CFS. The water accumulated on rooftops because

		etc? How were walls and other important aspects accounted for?	there are usually parapet walls with about 1 meter height on the rooftops around the borders of buildings in Taiwan. When the DEM resolution is high enough, the elevations of parapet walls can be represented by the grid-based mesh system in CFS and the water detention on the rooftops can be simulated. The rougher the grid/DEM resolutions, the faster the stored water will evacuate through the gaps between two adjacent grid cells.
130-134	Based upon the Act, the VGI data used in this study are collected from the most famous Bulletin Board System (BBS) in Taiwan named PTT. There are 8 photos collected from PTT posted during 15:20~16:30 on 14 June 2015. From these photos, we visually identified 8 locations in the study area as shown in Fig. 6. The timestamp and the virtual water depths in these photos are served to validate the CFS model. Although the timestamp when photos were posted on internet may	Based upon the Act, the VGI data used in this study were collected from the most well-known Bulletin Board System (BBS) in Taiwan named PTT. There were 8 photos collected from PTT posted during 15:20~16:30 on 14 June 2015. From these photos, we visually identified 8 locations in the study area as shown in Fig. 6. The timestamp and the virtual water depths in these photos were used to validate the CFS model. Although the timestamp when photos were posted on the internet may	Revised accordingly.
135-137		Photo capture timestamps could be extracted from EXIF information stored within the image data. Most images have this info. Sometimes GPS data will also be contained in EXIF information. This should be checked. Flood depth estimation from photos is very poor	The photos acquired from PTT were not the original photos and the EXIF information were not available. We checked with http://metapicz.com/

		practice. Field surveying after floods should be used to measure water depths corresponding to observations from photos.	
139-150		It is not clear where the sewer system is within the computational domain. It is also not clear how boundary conditions at the edges of the computation domain are accounted for (i.e. flow in and out of the domain). The sewer system will also connect out of the computational domain, the effects of which should be accounted for.	The sewer system is displayed in the response to specific comments #7. The surface water and pipe flow are allowed to flow freely at the edges of the computation domain.
153-157		Three GCPs are not enough! Agisoft recommends 10-15+ https://www.agisoft.com/index.php?id=34 More GCPs are needed if also used for independent validation of DEM and Orthomosaic spatial accuracy.	This recommendation is for another software "PhotoScan", not the one "Pix4D" used in this study. According to Pix4D's manual, three GCPs are enough. We have added more discussion on the GCP requirement.
159-161		This is methods not results.	The sentence "to discover the influence of DEM…" has been moved to method section 2.3.
159	DEM resolution on flood simulation, the gird meshes of the CFS	DEM resolution on flood simulation, the grid meshes of the CFS	"grid" has been corrected.
163	in which the VGI points out of the 8 locations are marked if the simulated flood depths exceed 0.05 m.	in which the VGI points of the 8 locations are marked if the simulated flood depth exceeds 0.05 m.	Revised accordingly.
163-169		This >0.05 m depth criteria is completely arbitrary and is a way to divide the data into two lumped categories (flood vs no flood) which makes their results appear artificially better. They should compare simulated with measured depth directly and quantify the error properly.	See the responses to specific comment #14 for detail.

173	“This implies that, when DEM resolution decreases, the topography becomes rugged, the friction increases, and the flood water travels slower.”	Not really! How was sub grid scale roughness accounted for? Should this say: “This implies that, when DEM resolution increases, the topography becomes rugged, the friction increases, and the simulated flood water travels slower.”	Because the ground levels are given in grid unit in CFS, there exists an invisible wall between two adjacent grids with different elevations. When DEM resolutions decrease, these walls become higher which result in larger blocking effects that reduce inter-cell water communications. This phenomenon explains why the flood water travels slower in the simulated results.
176-182	The timestamps and estimated water depths (WD) are obtained from the VGI photos in Fig. 6, and the flood durations at the eight VGI points when the water depth exceeds 0.05 m are determined based on the CFS results. It is seen that the timestamps of VGI photos all lie within the simulated flood duration at the points with observed WD larger than 0.05 m (points #1, #2, #4, #7, and #8). At the rest points, the simulated and observed WDs are both smaller than 0.5 m. This good agreement between observation and simulation reveals that the flood model is accurate in rebuilding the process of flood transport under both DEM resolutions.	This arbitrary lumping into >0.05 m depth does not correspond to ‘good agreement’. They should measure flood depths properly, not just estimate them, then quantify the error (predicted – observed). There is also presumably a typo of “WDs are both smaller than 0.5 m” which likely should be “WDs are both smaller than 0.05 m”.	The typo has been corrected.
200	For disaster emergency response in regional scale, flood simulation under coarse grid resolution is enough to gain a fast and overall	For disaster emergency response at regional scales, flood simulation under coarse grid resolution is enough to gain a fast and overall understanding of flood patterns.	Revised accordingly.

	understanding of flood pattern.		
205	CFS in urban area is a challenging	CFS in urban areas is a challenging	Revised accordingly.
206	Aided by the rapid growing	Aided by the rapidly growing	Revised accordingly.
208	we adopt the UAV and VGI to sophisticate CFS modeling in the reconstruction of a flash flood event occurred	we use UAV and VGI data for sophisticated CFS modeling to reconstruct a flash flood event that occurred	Revised accordingly.
215	applicable in acquiring necessary data for high-resolution CFS.	applicable for acquiring the necessary data for high-resolution CFS.	Revised accordingly.
Table 1		Sloppy typos. Possibly indicative of many more hidden errors. "San Paulo" -> "São Paulo" "Daintree, New Zealand" -> "Daintree, Australia"	Table 1 has been deleted.
Table 2		Irrelevant. All other researchers will have different cameras and don't care about the specific camera used. Just discuss the workflow for image processing in PIX4D where camera parameters were determined and imagery is de-warped before further processing.	Although other researchers will have different cameras but we believe that this information is fundamental information for similar applications that should pay proper attention.
Table 3		When generating a georeferenced orthomosaic or DEM from aerial imagery and Structure from Motion (SfM) techniques, more GCPs are needed for orthorectification and DEM generation than just 3 validation points. Yes, the UAV has a rough GPS location, but it is not RTK or PPK accuracy and should only be used for aligning images. Or if accurate DEMs are not required then at least discuss this. It is particularly critical for vertical elevations and	The coordinates of the three GCPs were obtained by referring to the publicly released values by Taipei City Government and We further used the static positioning of Global Navigation Satellite System (GNSS) with positional accuracy in centimeter level to double check these values. The difference between the coordinates obtained by these two methods can be used to evaluate the accuracy of the ground control points. We have added more discussion on the GCP requirement in the revised manuscript .

		generation of DEMs to use enough GCPs distributed throughout the study site.	
Table 4		This is not a 'comparison between CFS and VGI results'. This is arbitrary thresholding to make data correspondence look better. Just show predicted vs observed and quantify the difference!	The thresholds are deliberate arranged to assess the flood impacts. Please see the responses to specific comments #14 for details.
Figure 3		Their workflow doesn't make a lot of sense and doesn't follow the same sequence/layout as most other people who use Pix4D or Agisoft Metashape for SFM. Also, how do they claim to use only 3 GCPs for 'Point cloud with absolute 3D coordinates', then at the next step also do 'Accuracy assessment'? Independent GCPs from those used for georeferencing are needed for accuracy assessment.	The Pix4D workflow of data processing is identical to the suggestions in references. We have added more discussion on the GCP requirement in the revised manuscript.
Figure 4		This is irrelevant to the study. They have not independently implemented these algorithms, but are just using Pix4D, so no point showing any diagrams like this.	Figure 4 has been deleted.
Figure 5		Motorway takes up a large part of the DEM, as does vegetation. It is not at all clear how this is accounted for after it is 'removed'. The 3 GCPs are not enough, nor are they properly distributed throughout the study domain. There are unknown edge effects in the orthomosaic/DEM. Usually a UAV is set to fly a regular grid with zig-zag lines with 80% front overlap of images and 60%	The freeway is elevated and supported by the pillars at the centerline of the Keelung Road. Since the elevations of the pillars are higher than the surrounding road surface, it has no impact on the flow. The freeway is removed for CFS because flood water is allowed to flow across underneath the viaduct. Since the ground elevations were observed by the UAV from the divisions between the two viaduct lanes and those between viaducts and the buildings on the roadsides, the DEM underneath the conduct can be estimated. As for the overlap rate, the front

		side overlap of images (more overlap is better). This then generates a DEM and orthomosaic where the edges are low accuracy (due to insufficient overlap), with edge areas being cropped out of the final orthomosaic and DEM. Here there is a strange scattering of points and rough boundaries at the edges of the orthomosaic which raises questions about the accuracy of the orthomosaic, DEM and the UAV flight paths used. The orthomosaic and DEM are cropped in figure 6 and beyond (which is good), however the anomalies in figure 5 are not accounted for.	overlap is 85% while side overlap is 75%. The coverage of each photo is shown in the following figure. We have added these information in the revised manuscript.  Fig. 7 The coverage of UAV photos
Figure 6		Check EXIF information for photo capture time. This information may be scrubbed from images automatically by PTT, but is worth checking. Photo locations should be surveyed with RTK GPS and depth measured with a ruler by comparing water level on reference objects such as walls, buildings, bike tires etc.	The photos acquired from PTT were not the original photos and the EXIF information were not available.
Figure 7		The colour scheme and graduation does not resolve the finer scale features needed for CFS. It would be better with a logarithmic scale. Or just from 5-6 m and buildings will all be one colour. Potentially the colour scheme was selected to hide a poor quality underlying DEM.	The color scheme has been changed to highlight the details in DEM with different resolutions.
Figure 8		Again poor selection of DEM scale. Lumped flood bins used	The scaling of the figure has been adjusted to highlight the DEM details on ground level. The

		rather than a continuous colour bar. Why? To hide problems? Or just poor choice of data representation? Where are the sewers and manholes? How are they accounted for? Why did they choose to run the study in an area where the motorway blocks so much of the computational domain?	scaling of flood depth is arranged on specific purposes. The figures displayed sewer and manholes are added. Details can be found in the responses to specific comments #7, #13, and #14.
Figure 9		Validation? Upstream flow into computational domain? Which is better? Results of 0.5m or 5m simulation? No real way to prove it as no external validation. The VGI data is hardly proof. Even if 0.5m grid is more accurate (as everyone expects) this is not news. Finer grid usually gives better computational results.	Figure 9 shows the comparison of CFS results with different DEM resolutions. The validation of CFS results is not the point here because the flood model has been validated elsewhere in previous papers. In fact, the CFS results in both cases show good agreement with the VGI photos. Indeed, finer grid gives better CFS results is a common sense, but how to prove it is another story. The founding in this study is symbolic because it is the first time CFS can actually be conducted with 0.5m DEM resolutions with the aid of UAV and demonstrate its strength in considering building sidewalls and terrain depressions on water transport.

Further specific suggestions:

Section	Suggestion	Response
Abstract	Quantify the accuracy, rather than saying ‘more accurately’.	Revised accordingly.
1 Introduction	DEM resolution is important, but the proper representation of sub grid scale features is often more important (e.g. wall, stop-banks, culverts, bridges etc). How these are represented in a coarse DEM is critical. Multi resolution DEMs are possible. Also discuss how roughness is parameterised. I.e. if a modelling cell contains vegetation vs rocks vs concrete. This is also relevant at the end of the results	The considerations of wall and bridge pillars and the roughness parameterization can be found in the responses to specific comments #3, #4, and #8. The computational time for the CFS are 1,127 mins and 16 mins (with Intel I7 processor at 4.2 GHz) for the cases with 0.5m and 5.0m grid size, respectively.

	section where it talks about computational efficiency and grid resolution.	
1 Introduction	Discusses DEMs from UAVs and LIDAR. See technical correction above about explicitly stating 'UAV aerial imagery'. LIDAR can also be flown on UAVs.	Revised accordingly.
4 Conclusions	4 Summary and conclusions	Revised accordingly.