Paper Details

Title: Using unmanned aerial vehicle and volunteered geographic information to sophisticate urban flood modelling

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Review Details

Recommendation:

Reject manuscript. It would be more suitable for a conference presentation.

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.

Specific comments:

- The paper covers a small spatial area and the limitations of UAV's in this regard is not discussed.
- Boundary conditions are the edge of the spatial domain are not considered/discussed.
- 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.
- 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.
- The study only uses 3 ground control points for UAV surveys which is not enough. At least 8 required, with many studies recommending 16+.
- There is no discussion of flight regulations limiting UAV operations in urban areas and other similar considerations.
- 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.

- 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.
- 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.
- 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.
- 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.
- 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.
- 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 prpose to hide a poor quality DEM at ground level.
- 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).
- 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.

Technical corrections:

Line number	Previous version	Correction
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
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.
17	acquired from social network are served to establish and validate the CFS model, respectively.	acquired from social networks are used to establish and validate the CFS model.
19	The results show that flood scenario	The results show that the flood scenario

26	Flash flooding resulted from extreme heavy rainfall	Flash flooding resulted from extremely heavy rainfall
47	DEM data are derived by airborne Lidar	DEM data are derived from airborne Lidar
50	two raising techniques namely unmanned aerial vehicle	two rising techniques namely unmanned aerial vehicle
53	(DEM) derived by UAV have similar performances in urban	(DEM) derived from UAV aerial imagery have similar performance in urban
58	study of 2013 Boulder flood.	study of the 2013 Boulder flood.
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.
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.
82-96		Remove this section. They do not independently implement this technique. 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.
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.
105-108		3x GCPs is not nearly enough!
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.
118	The vegetation such as shrubs and grasses is detected by	Vegetation such as shrubs and grass were detected by
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 etc? How were walls and other important aspects accounted for?
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
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 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.
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.
159-161		This is methods not results.
159	DEM resolution on flood simulation, the gird meshes of the CFS	DEM resolution on flood simulation, the grid meshes of the CFS
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.
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.
173	"This implies that, when DEM resolution decreases, the topography becomes	Not really! How was sub grid scale roughness accounted for? Should this say:

	rugged, the friction increases, and the flood water travels slower.”	“This implies that, when DEM resolution increases, the topography becomes rugged, the friction increases, and the simulated flood water travels slower.”
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”.
200	For disaster emergency response in regional scale, flood simulation under coarse grid resolution is enough to gain a fast and overall understanding of flood pattern.	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.
205	CFS in urban area is a challenging	CFS in urban areas is a challenging
206	Aided by the rapid growing	Aided by the rapidly growing
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
215	applicable in acquiring necessary data for high-resolution CFS.	applicable for acquiring the necessary data for high-resolution CFS.
Table 1		Sloppy typos. Possibly indicative of many more hidden errors. “San Paulo” -> “São Paulo” “Daintree, New Zealand” -> “Daintree, Australia”
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.
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 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!
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.
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 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% 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.
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.
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.
Figure 8		Again poor selection of DEM scale. Lumped flood bins used 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?
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.

Further specific suggestions:

Section	Suggestion
Abstract	Quantify the accuracy, rather than saying 'more accurately'.
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 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.
4 Conclusions	4 Summary and conclusions