RESPONSE TO REVIEW #1

We highly appreciate and are very thankful for the time and effort that was invested in reviewing our manuscript. Thank you for initiating this discussion. After carefully studying the constructive queries and comments, we have thoroughly revised our manuscript in an attempt to clarify as much as possible the content of the draft manuscript. Below you will find our comments (in blue) to your feedback (in **black, bold**).

**General comments:**

**In this paper the authors describe the impact of Typhoon Usagi rainfall on the hydrology around Ho Chi Minh City, Vietnam on 25th November 2018. In particular they evaluate the impact of intense rainfall and storm surge, on the hydrological system using tools to characterize these coastal vs surface runoff ('continental') contributions. The authors contrast the river, surface runoff and coastal (tidal) responses at two river gauge stations upstream of the Typhoon-struck coastline. The preprint is well referenced and structured, with good quality figures and tables to support the key messages. The hypothesis is given, but objectives have not been stated clearly. References are occasionally missing to back up statements in the text. Some technical terms and conclusions should probably be explained further for a general audience to avoid confusion. Some of the technical aspects in the method (and conclusions drawn from this) were difficult to follow so perhaps would benefit from being clarified/rewritten (e.g. surface runoff assumptions downstream of a dammed area). The standard of English is good, the title reflects the contents of the manuscript also. While the abstract could more concisely describe method and results, in the main body of the paper the methodology, the presentation of results, and the conclusions reached are all satisfactory. I have not checked the statistics contained in the appendix tables - these are accepted 'as is'. The manuscript requires some editorial assistance from NHESS (some grammar errors noted).**

**However, the approach taken in this paper is an interesting one, and therefore I believe the manuscript will ultimately contribute something new to the scientific discourse. I recommend accept subject to (quite a few) minor revisions as described below:**

Thank you very much for your contribution. The aspects to be improved found in your comment will be considered in the revised manuscript. The objectives of the paper will be stated more clearly in addition to the hypothesis. We will review and strengthen statements that were found to be lacking reference. Overall, we will take your comments below and implement them in order to make the draft as clear as possible in the revised manuscript.

**Minor revisions:**

**While the Aim of this manuscript is clear (to investigate the precipitation and storm surge impacts from Typhoon Usagi on the local hydrology of the Saigon river, HCMC), the manuscript would benefit from having the objectives clearly stated in the introduction section too (L46-51).**

Thank you for this comment. The objectives of this manuscript are as follows:

1. To provide a multi-approach methodology based on distinct sources of data to characterise the hydrologic response of a tropical, urban tidal river to a typhoon.
2. To better understand which of the potential contributors to urban flooding (precipitation, storm surge or river flood) were most relevant during this particular event.

3. To create a holistic picture of how the different parts of the hydrological system (terrain elevation, land cover, precipitation, tidal river and coastal surge) contribute to the response of the river to this extreme event as well as to the flooding experienced by HCMC residents.

We will clearly define the objectives of the manuscript in the revised manuscript.

**It would benefit the paper to be clearer with terminology, from the beginning of the manuscript, and to use it consistently throughout. Some examples:**

**1. A cleaner differentiation between river levels and sea levels (and river gauge vs tide/sea gauge stations). The phrase 'water levels' is a little generic even when discussing data from around a tidally influenced river /estuary.**

Indeed. We will standardize the terminology throughout the manuscript. Thank you.

**2. What is H / water level? It is not stage (with a datum from the river gauging station), seemingly. Is it depth of water above the (unknown) channel bed level, or head?**

Thank you for your comment. We utilize the term 'water level ($H$)' to refer to the height of the column of water above the pressure gauges in the river. The tidal oscillations are propagated from the coastal tide gauge to the river gauges. This is the signal that is captured by the gauges and that we call 'water level ($H$)'. Since there is no fixed datum between river and tide gauges, we normalize all signals by mean removal. This makes the tidal harmonics to oscillate about zero for all gauge locations thus, making them comparable. In addition, the $dH$ parameter in the equation to estimate discharge (Eq. 2 in the manuscript) provides an additional calibration parameter that helps mitigate this problem. We will make this clearer in the revised manuscript.

**3. In section 3.6: Water discharge is a phrase that doesn't translate well - do the authors mean river (fluvial) discharge?**

Yes, we mean river (fluvial) discharge. We will use this terminology in the revised manuscript. Thank you.

**It would benefit the paper to support particular statements with more references. E.g.,:**

**- L 30 "Vietnam lies within the most active cyclogenesis regions in the world".**

Thank you for this remark. The western North Pacific which includes the South China Sea is the most active basin of cyclone activity in the world. We will further support this statement using a selection of the following references:

1. Gao, S., Zhu, L., Zhang, W. et al. Western North Pacific Tropical Cyclone Activity in 2018: A Season of Extremes (2020). Science Reports 10, 5610 https://doi.org/10.1038/s41598-020-62632-5
2. Klotzbach, P. J., Wood, K. M., Schreck, C. J., Bowen, S. G., Patricola, C. M., & Bell, M. M. (2022). Trends in global tropical cyclone activity: 1990–2021. Geophysical Research Letters, 49, e2021GL095774. https://doi.org/10.1029/2021GL095774
3.

Feng, X., Klingaman, N.P. & Hodges, K.I. Poleward migration of western North Pacific tropical cyclones related to changes in cyclone seasonalit (2021). Nat Commun 12, 6210. https://doi.org/10.1038/s41467-021-26369-7

4. Ruifen Zhan, Ming Ying, Peiyan Chen, On Tropical Cyclone Activity Over the Western North Pacific in 2012 (2013), Tropical Cyclone Research and Review, https://doi.org/10.6057/2013TCRR01.04.

**- L38 & L74-76. HCMC is one of the most vulnerable coastal regions in the world to flooding: Why does it rank most vulnerable (More of a certain type of flood hazard than other LECZs? A greater population at risk? More likely to /higher frequency of flooding than other locations?)? It has already been stated that the probability of typhoon occurring in southern Vietnam is not large (L33).**

Thank you for your comment. Ho Chi Minh city is often presented as one of the most vulnerable cities in the world with respect to climate change. Some of these vulnerabilities are water-related issues such as lack of urban services like drinking-water management, sanitation and rainwater drainage, In particular, flooding vulnerability is linked to sea level rise, rainfall intensification and ground subsidence, which can reach 0.02 m/year (in some geological areas), while 65% of the city is located at less than 1.5 m above sea level. In addition, HCMC is home to almost 10 million inhabitants and its population grows at about 3% per year with these risks posing a threat to many livelihoods. The urban growth rate (about 16 $km^2$ per year since 2000) is also an important factor as imperviousness of soils reduces infiltration potential and increases the flood risk (UNESCO Water, megacities and global change: portraits of 15 emblematic cities of the world, 2016).

Several studies that consider HCMC as a hotspot of vulnerability to climate change can be found in literature such as

1. Nicholls, R. J. (1995). Coastal megacities and climate change. GeoJournal, 37(3), 369-379.
2. Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., & Yan, J. (2007). The impact of sea level rise on developing countries: a comparative analysis. Climatic Change, 93(3-4), 379-388.
3. Nicholls, R. J., Wong, P. P., Burkett, V. R., Codignotto, J. O., Hay, J. E., McLean, R. F., … & Woodroffe, C. D. (2007). Coastal systems and low-lying areas. Climate Change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
4. Carew-Reid, J. (2008). Rapid assessment of the extent and impact of sea level rise in Viet Nam.
5. Webster, D., & McElwee, P. (2009). Urbanization dynamics and policy frameworks in developing East Asia.
6. ADB (2010). The economics of climate change in Southeast Asia: a regional review.
7. Birkmann, J., Garschagen, M., Kraas, F., & Quang, N. (2010). Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change. Sustainability Science, 5(2), 185-206.
8. Fuchs, R.J.(2010) Cities at Risk: Asia's Coastal Cities in an Age of Climate Change
9. Fuchs et al.(2011) Floods in Megacities: A case study of vulnerabilities and response capacities in Metro Manila 10.Hanson et al.(2011) A global ranking of port cities with high exposure to climate extremes

We will clarify why HCMC is especially at risk in the revised manuscript and provide the relevant sources.

**- L47-48 Perhaps introduce the concept of/your meaning of the terminology "coastal and continental effects".**

Indeed, a formal explanation of our understanding of "coastal" versus "continental" effects is missing. All typhoon-related phenomena that influences coastal dynamics (such as storm surge, wind, tide) is referred to as "coastal" effects. On the other hand, typhoon-related phenomena influencing the continental hydrology (precipitation, surface run-off, river discharge, flooding) is referred as "continental' effects. Thank you for your comment, we will provide this explanation in the text and connect it with Fig. 3 of the manuscript for clarity.

**- L48-50 the sentence beginning "For the first time in a data scarce region, satellite and in-depth measurements were gathered and jointly analyzed during an unprecedented extreme event ..." might require some qualification for two reasons. Firstly there are gauges and data as shown in Fig 1 (is data scarce because it is incomplete?). Secondly, more generally, there are a number of papers that have combined satellite data with (limited) data collected on the ground in areas which are considered 'data-sparse' and this is often explored through the lens of extreme flood events as case studies. E.g. Dung et al., 2011 (https://hess.copernicus.org/articles/15/1339/2011/), Kuenzer et al., 2013 (https://www.mdpi.com/2072-4292/5/2/687), Mohammed et al., 2018 (https://www.mdpi.com/2072-4292/10/6/885), Tegos et al., 2022 (https://www.mdpi.com/2306-5338/9/5/93 ). Perhaps it is just sentence construction -i.e., it's the first time this new method has been applied, in a "data scarce" region?**

Thank you for this comment. You are correct in that it is a sentence construction issue and the literature provided is very relevant. The message we would like to put across is that the methodology has never been used in such a region (to the best of our knowledge) but also, that the use of multi-source data has never been used in this specific basin namely, the Saigon river basin. We use the term "data-scarce" to refer to the fact that it is very difficult to obtain reliable, free data in this region given that it exists. We will re-phrase this sentence accordingly.

**- L72-74. The Trinh et al., 2020 reference I believe refers to the wider Northwest Pacific Ocean being one of the most active regions of the world for Tropical Cyclones [TCs] (~30% of all annual tropical storms), not the South China Sea region. Many of the NWP TCs don't travel into this smaller area. It would be beneficial to clarify/correct this statement.**

Thank you for this comment. Indeed it is the Northwest Pacific Ocean which includes the South China Sea (also known as East Sea of Vietnam) that is referred as the most active region in the world. We will correct this statement in the text of the revised manuscript.

**– L 74. Please define a typhoon (e.g., wind speeds or category scale) vs a tropical storm.**

Thank you. We use the terms tropical storm, severe tropical storm and typhoon according to the intensity classification of the Japan Meteorological Agency who officially monitors tropical cyclones that occur within the Northern Hemisphere between the anti-meridian and 100°E. The definitions are based on 10-min average maximum wind speed as follows:

| | |
|---|---|
| Tropical Depression | Maximum wind speed < 17m/s (34kt) |
| Tropical Storm | 17m/s (34kt) ≤ Maximum wind speed < 25m/s (48kt) |
| Severe Tropical Storm | 25m/s (48kt) ≤ Maximum wind speed < 33m/s (64kt) |
| Typhoon | 33m/s (64kt) ≤ Maximum wind speed < 44m/s (85kt) |
| Very Strong Typhoon | 44m/s (85kt) ≤ Maximum wind speed < 54m/s (105kt) |
| Violent Typhoon | 54m/s (105kt) ≤ Maximum wind speed |

We will add a source to this information and mention the relevant definitions in the text for the revised manuscript.

**– L127. Technically there are four categories in Table 2, not three.**

Thank you. We will correct this in the new version.

**– L168. Please define 'low net discharge' – i.e. low is relative to what/under what categorization?**

Thank you for this comment. 'Low net discharge' is in comparison with the instantaneous discharge due to tidal fluctuations which are one order of magnitude higher than the net discharge. We will precise this in the revised manuscript.

**– L216. dH is introduced to correct for an unknown datum. How was it derived/calculated?**

This parameter was derived by using a non-linear least-squares curve fitting of equation 1 to two 24 hour ADCP discharge measurements (as in Camenen et al. 2021). In short, we use this technique to find the best fitting possible between equation 1 and discharge measurements while taking into account measurement uncertainty. This effectively minimized the Root Mean Square Error (RMSE) between ADCP measurements and estimated discharge. We will clarify this in the revised manuscript.


1. Camenen, B., Gratiot, N., Cohard, J. A., Gard, F., Tran, V. Q., Nguyen, A. T., Dramais, G., van Emmerik, T., & Némery, J. (2021). Monitoring discharge in a tidal river using water level observations: Application to the Saigon River, Vietnam. Science of the Total Environment, 761, [143195]. https://doi.org/10.1016/j.scitotenv.2020.143195


**- datums generally are unstated throughout this paper?**

Thank you for this comment. As briefly mentioned before, there are no datums that can be used as reference for the water level measurements in the river. The tide gauge is the only one to have a station datum as provided in the repository of the Sea Level Center of the University of Hawaii (link to Vung Tau station datum information: https://uhslc.soest.hawaii.edu/stations/?stn=383#datums . However, given the unknown datum of the river stations we cannot compare them. In order to mitigate this problem with perform mean normalization across the gauges such that the tidal signal is fluctuating about zero, as previously mentioned.

**What is the mean sea level reference datum - Is that local mean or global mean? Also, in L237-240 – the datum could be provided for the SRTM DEM; this is relevant if (river and coastal) flood levels are measured against these elevations.**

Indeed, this information is not present in the text. The SRTM vertical datum is global mean sea level and is based on the WGS84 Earth Gravitational Model (EGM 96) geoid as specified in:


1. U.S. Geological Survey, Earth Resources Observation and Science (EROS) Center. (2018). USGS EROS Archive - Digital Elevation - Shuttle Radar Topography Mission (SRTM) 1 Arc-Second Global. Retrieved from https://www.usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-shuttle-radar-topography-mission-srtm-1

Throughout the manuscript when using the term "mean sea level" we refer to the global mean sea level used as datum for the SRTM data. We will add this information in the revised manuscript.

**- L221-224 – the introduction of K, dt and dz parameters is difficult to understand without context, perhaps rephrase this paragraph to clarify why they are important, what they mean and how they are used to optimise RMSE if this is important to your manuscript.**

Thank you for this comment. We will introduce and precise the importance of these parameters for the discharge estimation in the revised manuscript.

- K, the Manning-Strickler coefficient of the river reach is a measure of channel roughness or friction and is assumed constant.
- dt, is a time lag required to account for the propagation of the tidal wave between the downstream location to the upstream location.
- dz (which is a mistake and will be modified in the revised manuscript to read '*dH'*), is used to compensate for the fact that the reference points of each location are different and unknown.

These parameters are the calibration parameters that allow adjustments in the output of Equation 1 such that RMSE can be minimized. We will clarify this in the revised manuscript.

**- Unclear about the statement that river slope explains seasonal variation in discharge rates (L344-346) and lack of discharge response after intense rainfall (L475-479). Perhaps explain a bit more the thinking in these sentences. [Hup-Hdn] should be relatively constant if levels at both locations change by approximately the same amount?**

Thank you for this comment. In both L344-346 and L475-479, the argument is similar.

For L344-346: We see that river water levels are generally lower during the wet season due to the coastal forcing. However, the estimated river discharge, which is a function of the slope, is higher in the wet season despite lower water levels. We propose that this is explained by an overall decrease in water level along the river such that the slope is less influenced than the water levels by this coastal forcing.

For L475-479: Similarly, here we find a quasi-simultaneous increase in river water levels at both upstream and downstream locations. This is due to the regional scale of the Usagi-brought precipitation. Hence, the slope should remain relatively constant (as mentioned in your comment). This is one of the drawbacks of the method used to estimate discharge.

We will clarify the thinking behind these arguments in the revised manuscript.

**L559-560- "…high tide removing possibility of surface runoff to the river". I don't understand this reasoning/sentence. Please explain? Do you mean obscuring the response?**

Thank you for this comment. From figure 7c) and figure 9b), we can see that the peak precipitation coincides with peak river discharge. Additionally, both of these coincide with an asymmetric tide period where high tide is followed by a high-water low tide (see figure 7b). What we mean in this sentence by "removing possibility of surface runoff" is that the river water levels were high and rainwater would not effectively drain towards the river but rather linger in the impervious streets of HCMC. In fact, during spring-tides it is common to have river-induced, short-lived flooding in the lower elevation areas of the city, namely in Thao Dien. Adding to this an extreme, persistent precipitation caused wide-spread flooding. So, we propose that river high water is delaying the surface run-off and prolonging the flood residence time. We will clarify this sentence in the revised manuscript.

**Fig A1 – colorbar units have been cut off.**

Noted. This will be corrected in the revised manuscript.

Thank you for your comments and corrections, which were very helpful to ensure the correctness of this paper. The invested efforts are much appreciated.