Revision Note

The authors thank the reviewer (Dr. Matthew Perks) for the suggestions and comments on how to strengthen the paper. Our specific responses to the comments are as follows:

Referee #2 (M. Perks)

1) Comments to author:

The paper "Technical Note: Monitoring of unsteady open channel flows using continuous slope-area method" by Lee et al. seeks to adopt the use of low-cost pressure transducers to better understand the role of hysteresis in open channel flows. In its current form, the article is difficult to follow. Therefore considerable changes are required before publication can be recommended. The concept of applying the continuous slope-area method is poorly defined and described in the introduction, as is the utility of this concept. Under what conditions would applying this method be beneficial? This is the fundamental part of the manuscript so a clear explanation is required.

Response

Thank you. We will modify introductions by adding better descriptions associated with the concept of applying the CSA method, utilities, and specific objectives of this research. Moreover, specific conditions such as channel bed slope (mild vs steep), vegetation conditions (heavy vs. light), and intensity of hydrologic events (i.e., rapid vs slow of water level changes) that this method would be more applicable/beneficial will be described.

2) Comments to author:

For a Technical Note, there is a lack of detail in the Methods section. A clearly presented Data Treatment section is required wherein the equations/calculations are presented. A conceptual diagram would also be beneficial to illustrate how the method is constructed and applied. A more thorough presentation of results is required, rather than simply directing the reader to the Figures.

Response

Thank you. We will add relevant equations (i.e., Manning's equation and 1D Saint Vernant equation) as well as a conceptual diagram that can help readers understand the process. More thorough presentation of results that describe how outputs (figures 6-8) are related to inputs and processes mentioned in the method section and why they are important with respect to specific objectives demonstrated in the introduction will be made.

3) Comments to author:

The data used to drive the CSA method appears to be based on flow measurement, I assume collected following the development of a stage-discharge relation(?) at the USGS Clear Creek monitoring station (no information or data presented). Does this rating adequately capture both

rising and falling limbs of the hydrograph? Some sensitivity analysis and discussion of this approach is required.

Response

Thank you. While the CSA method presented in the initial manuscript demonstrated the use of steady discharges (based on steady-based stage-discharge rating curves established by the USGS Clear Creek gage station) to estimate the Manning's roughness coefficients along with the measured cross-sections and the assumed "steady non-uniform slopes" at locations where pressure transducers are deployed. Manning's equation is used for this estimation. This USGS rating curve is steady-based stage-discharge curve, so it does not capture the effects of rising and falling limbs of the hydrograph on the estimation of discharges.

However, as we acknowledge that this previous approach lacks experimental and theoretical supports, we will change the manuscript by eliminating this approach, and introducing the suggested use of stage-*n* ratings. Stage-*n* ratings can be constructed by the use of field measured discharges for example from USGS historical records along with measured cross-sections, measured water surface slopes from pressure transducers (instead of assuming "steady non-uniform slopes"), and Manning's equation. While these field measured discharges are the basis of constructing steady-based stage-discharge rating curves, they implicitly captured the unsteadiness of flows. While the accuracy of this approach will largely depend on the availability of field measured discharges and their accuracy, it is scientifically well based approach. Sensitivity of computed discharges due to the uncertainties from the estimation of Manning's roughness coefficients and measured water surface slopes will be conducted and discussed.

Specific Comments:

4) Comments to author:

Page 2 Line 12 – 13: Reference required.

Response

The sentence will be modified as "Including more cross sections in the discharge calculation will minimize the effects of non-uniformity and will increase confidence in the computed discharges." The reference (Smith et al., 2010) will be added.

Reference

Smith, C. F., Cordova, J. T., and Wiele, S. M.: The continuous slope-area method for computing event hydrographs, US Geological Survey2328-0328, 2010.

5) Comments to author:

Page 2 Line 16: The acronym ‘CSA’ (first used on page 2 Line 16) is not defined in in the main body of text. This could relate to the conventional, or continuous slope area method.

Response

It will be corrected.

6) Comments to author:

Page 2 Lines 16 – 20: Strange presentation of other research. Simply stating Steward et al (2012) following their findings would suffice. No need for information about USGS/Arizona.

Response

It will be corrected.

7) Comments to author:

Page 2 Line 23: “Steep” – be specific.

Response

Information on Page 3 Lines 21-24 (shown below) will be moved to Page 2 Line 23 to better define steep (>0.001) channels.

“For comparison, the average channel bed slopes in the studies by Smith et al. (2010) and Stewart et al. (2012) were approximately 0.009 and 0.012, respectively, and the effects of unsteady flows were negligible in those streams. Sudheer and Jain (2003) indicated that flood waves show a marked kinematic behavior when a channel bed slope is greater than 0.001.”

8) Comments to author:

Page 2 Line 24: Replace “a.k.a” with i.e.

Response

It will be replaced.

9) Comments to author:

Page 2 Line 27: “They” – who is they? If it is the series of works referenced above then their findings should be placed prior to the reference.

Response

Thank you. The sentence in Page 2 Line 27 will be re-organized prior to the reference.

10) Comments to author:

Page 3 Line 1: What is a “proper” reach?

Response

Since “proper” reach is first defined in Page 3 Lines 8-16 and the content is repeated in that section, Page 3 Line 1-2 will be removed.

11) Comments to author:

Page 3 Lines 8 – 16: Useful justification for site selection. However you do not state how your chosen site meets these criteria. This information could be presented in a table.

Response

A table will be prepared and the site selection criteria that correspond to Clear Creek conditions will be indicated.

12) Comments to author:

Page 3 Lines 21 – 23: This information relating to bed slopes of sites used in other works is better suited to the introduction rather than a methods section.

Response

Thank you for pointing this out. We agreed on the reviewer’s opinion, and will move this to Page 2 Line 23 (See the response to comments #7).

13) Comments to author:

Page 3 Lines 28: Assume that the Q data utilized in this research is in the form of a rating curve? This should be presented and actual method described.

Response

Yes, Q data is obtained based on steady-based stage-discharge rating curve. The new method demonstrated in response to comments #3 will be presented while explaining how the Q data and other inputs are utilized in the proposed methodology.

14) Comments to author:

Page 3 Line 29: “Cross-sectional information” is vague. Be specific.

Response

It will be reworded by “area and hydraulic radius obtained from the surveyed cross-section”.

15) Comments to author:

Page 4 Lines 27 – 28: Any discussion provided by Smith et al (2010), or Stewart et al (2012) whereby the redundancy of their systems is discussed in order to back-up your use of only two sensors?

Response

Thank you. More discussions will be provided.

16) Comments to author:

Page 4 Line 29: What pressure transducers were used? What is the associated precision and accuracy?

Response

This information will be added.

17) Comments to author:

Page 5 Line 16: Be specific – How exactly does it compare?

Response

Coincidently, the slope surveyed by USACE was also 0.00039. So, we will be change the wording as "The surveyed slope was 0.00039, which coincides with the measurement conducted by US Army Corps of Engineers (USACE)."

18) Comments to author:

Page 5 Line 19 – 20: Strangely formed sentence.

Response

We will change the wording to be clear.

19) Comments to author:

Page 5 Line 19 – 20: This is the first mention of the Fread method. How does this fit in with the experimental aims? A lack of detail is provided. If the modified Fread method is to be used then details need to be provided as the cited publication is not currently published.

Response

The modified Fread method is to compare experimental results with the numerical method for an estimation of unsteady flows. More in-depth information will be provided while the cited paper is accepted as of Sep 19, 2016.

20) Comments to author:

Page 5 Lines 22 – 23: Small to mid-size is subjective. Catchment sizes should be given. The contributing area of Clear Creek should also be presented.

Response

Rather than defining small to mid-size, it is changed to define a low-aspect ratio channel being approximately less than 30:1 (width: depth) aspect ratio.

21) Comments to author:

Page 5 Lines 25 – 26: Would be good to see these events placed within the context of the hydrological regime e.g. recurrence intervals.

Response

We will try to find this information if available.

22) Comments to author:

Page 6 Lines 2 – 3: Axis information should be placed within the Figure caption.

Response

It will be corrected.

23) Comments to author:

Page 6 Lines 7 – 14: This detail, although interesting, is not related to the results. Indeed, you do not observe clockwise hysteresis so why comment on the processes driving its occurrence?

Response

We agree with the reviewer's comment, so this redundancy will be removed.

24) Comments to author:

Page 6 Line 16: Use of "strong" is a subjective term – be specific.

Response

We will reword the sentence as “As the event scale increases, dynamic forces would also increase.”.

25) Comments to author:

Page 6 Line 22: Use of “very high” is a subjective term – be specific.

Response

It will be corrected as “the value for event 3 ranges between 0.7 and 1.3” or better wording.

26) Comments to author:

Page 6 Line 22: Changes in the cross-section should be presented.

Response

Unfortunately, the cross-section after the third event was not measured, while USGS records indicated these changes in their database.

27) Comments to author:

Page 6 Line 25: “Sometimes not impossible” - double negative.

Response

It will be corrected as “Sometimes possible”.

28) Comments to author:

Page 6 Lines 26 – 27: Evidence of no major floods is provided. A Figure showing a hydrograph spanning the entire monitoring period would help place the three analysed events within the hydrological context.

Response

A figure will be added.

29) Comments to author:

Page 6 Line 30 – “Large differences” – be specific.

Response

We will replace the wording as “The computed discharge differences shown in event 1 and 2 are caused by…”

30) Comments to author:

Page 7 Lines 30 – 32: Weak end to the conclusion. The final sentence should be more profound than being about time synchronization issues.

Response

We will find the final sentence to be more profound once we have new results from the new proposed approach of estimating the Manning's roughness coefficients (see response to the comments #3).

31) Comments to author:

Figures:

General point: Appearance of all the figures and detail in the captions should be improved prior to publication.

Fig 1: A regional map as an inset would be useful to provide context. Credit to background image should be provided if appropriate.

Fig 2: Difficult to see details but at the peak stage, it looks like the steady non-uniform slope values are less that the rising and falling stage slope.

Fig 4: No useful information provided in the caption. Needs a better description.

Response

Thank you. Comments raised by the reviewer regarding figures will be taken into account in the revised manuscript.