Peer Review: Continuous Measurements of valley floor width in mountainous landscapes

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Review by: Matthew Morriss, PhD (USGS)

Overall impression

In this paper, the authors lay out a method for continuously measuring valley width along an individual channel or within a network. This paper highlights an important hole in our measurements of channel and valley processes; we as geomorphologists have numerous methods for extracting continuous or nearly continuous data on the vertical components of channels, their ΔZ, but not the changes in channel or valley widths ΔW. The paper lays out the clear implications of changes in valley width and the studies that have previously examined this measurement (W_v). The authors have a clear grasp of the literature on both tectonic and fluvial geomorphology and where their study can add to the understanding of valley widening processes. The authors test their methods in a series of tectonically quiescent regions with both homo- and heterogeneous rock types to evaluate the potential scaling effects of drainage area with valley width proposed by other authors (equation 1; e.g. Tomkin et al., 2003; Brocard and van der Beek, 2006; Schanz and Montgomery, 2016).

$$W_v = K_v A^{c_v} \qquad 1$$

Where K_v is the influence of rock type on valley width; A is drainage area, and c_v is a descriptor of how valley width changes with drainage area (positively or negatively).

Based on my critical review of the submitted manuscript, I would recommend this paper be: **Accepted with Revisions.**

I would also like to add that I'm excited for where this paper ends. Specifically, how the applied methods could be incorporated into future large scale, regional analyses of rivers in just the same way as χ or k_{sn} are often applied around the world today.

- Matthew Morriss, PhD USGS

Major Comments

While I am certain this paper is worthy of being accepted, I want to provide the authors with a critical list of comments to better their manuscript moving forward. These will largely be comments line by line through the text. I will also provide a second set of comments for minor issues I noticed in my review. I will also try to preserve the tongue-in-cheek language the authors spread throughout their paper, for the benefit of subsequent readers.

Line 57: The authors base the power-law relationship for valley width and drainage area on the firm footing of literature; however, here, it is revealed that empirical studies suggested this power-law relationship have been conducted on bedrock rivers. I have not found another reference or description through the text of the test cases examined by the authors as bedrock rivers. It would further strengthen this paper to justify that the test sites are in fact bedrock channels and not alluvial channels unless the authors seek to make a more general case about valley width scaling beyond just bedrock rivers. A potentially germane reference for alluvial rivers is Leopold and Maddock (1953) or some of the subsequent citing literature.

Figure 1: This figure does a good job of summarizing the preceding sections forcings on channel width. However, the figure itself does not match all the forcings described in the inset text. Perhaps worth adding “Uplift” and “Incision” as arrows to the figure otherwise it seems disconnected with the text directly above.

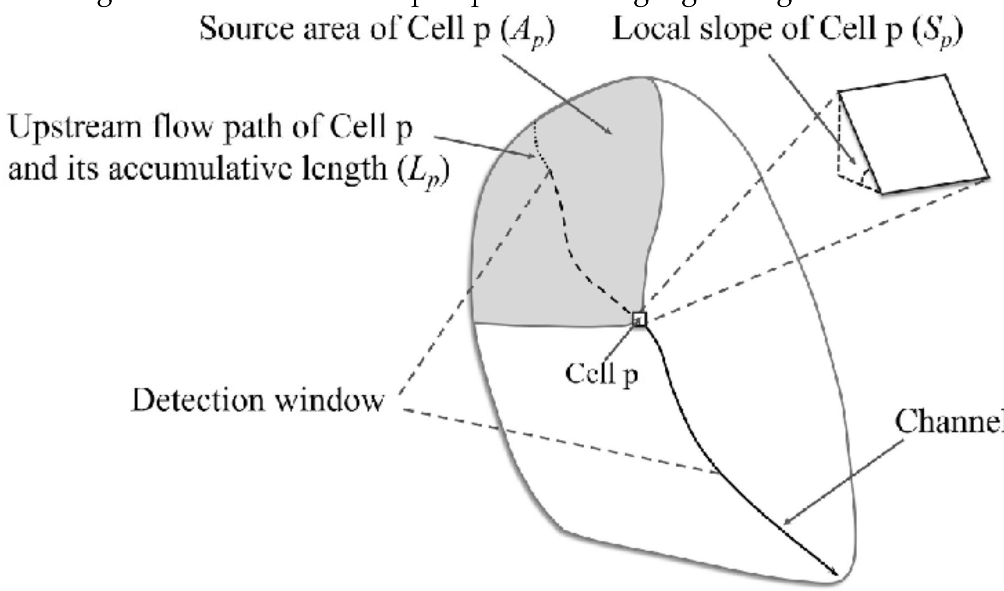
Lines 151-158: Again, are these bedrock channels? That seems key to your later investigations of power-law scaling.

Line 165-167: This will not be my last comment regarding several places where methods are mentioned but not documented nor shown to the reader. Please remember to “show and tell” your methods. I – as the reader – cannot conjure up the numbers you used and to protect your work going forward its important to add this type of detail. “Thresholds for elevation above the channel and local slope can either be calculated statistically using qq plots of the distribution of slope and elevation across the landscape, or they can be set manually by the user.” This text reads more like a manual for code rather than a paper. To improve it, I would recommend adding a table / figure to the supplement highlighting this workflow and examples of the thresholds. You needn’t do it for all of your sites, but at least once please.

Line 175-180: I am unclear if the process of using either the steepest descent path or the method highlighted in the next few paragraphs is an automated choice and if so how it is made or if the user interacts at that step?

Line 181-203: This section of text describing the method for delineating the valley center line, I found to be exceedingly difficult to follow. To clarify this section, I recommend the following:

- Consider numbering the steps in the process. The text, as written, uses the phrase "We begin" or "We then" or "we X" at least six times in this section. Could replace and make easier to follow with a numbering system.
- I think this method is the perfect place for a diagrammatic figure. I realize the authors cite figure 2, but that figure doesn't show the nuts and bolts for how the code is working. Below are a few examples pulled from google images of what I'm imagining:



- This 👆 is obviously not a perfect example as its not made for your paper, but something diagrammatic like this figure or to that effect would vastly clarify 1) the workflow being conducted here and 2) the decision points being made either automatically or by someone interacting with the code. Rather than having to draw out an example for myself as the reviewer, or reader, provide your own visualization as there are a lot of concepts being discussed that a good visual aid would help.

Line 188-189: The method describes subtracting elevation by a multiplying the distance from the bank with a "scaling factor." What is this "Scaling factor"? Again, please opt toward explicit discussions of such variables and highlight what they are and how you chose them.

Line 191-192: How many times is the valley carved and filled? The author doesn't describe or detail that in the text. Is it provided as an option for the users? Or is it in Linsday (2016?)

Figure 2. This holds true for all maps in this paper, if you make a map, it needs a scale bar, a north arrow, and a legend. I will call out each figure individually in my comments, but I want to see the authors add at least a scale bar and north arrow to all their maps. Yes, I know that the projection is UTM so the coordinates on the margins are meters, but those labels are quite small; a scale bar could still be useful! I also can't tell the difference between the "dark blue" and "light blue" the authors cite in the caption – perhaps try different, higher-contrast colors?

Line 229: The River Tweed is gravel bedded? Does that mean your assumption of a power-law is valid? Or perhaps the power-law relationship extends to non-bedrock rivers?

Line 275: The authors make the argument that mean valley floor widths tend to increase with increasing DEM grid size; however, the 3rd widest mean valley floor width is for the 2 meter data. Can this be explained? Why the 5 meter and 10 meter data seem anomalously successful in their performance compared to the 2 meter data? Also, the 2 meter data has the largest variance of any dataset, but perhaps that's to be expected?

Line 370-377: It would behoove the authors to add in another reference to the actual values of K_v determined from other studies.

This Study: K_v = 0.07-2.65 m m^{-2}

(Brocard and van der Beek, 2006): 8-160 m $km^{-0.8}$

(Langston and Tucker, 2018): 0.16 +/- 0.052 m m^{-2} (model result)

(Tomkin et al., 2003): 2.81 m $km^{-0.8}$

These values above are from the papers cited in the introduction. Note that the units here also do not match the units used by the authors. This seems like a great place for a table restating the K_v values from the literature, with matching units to the authors. This will add power to the statement regarding this study finding intermediate range of values for K_v. As it is written, the audience must flip back to the Introduction to confirm their intermediate status and then check that the units match, which they don't. Confirm similar units, then confirm intermediate erodibility values in this study as compared with others.

Minor Comments; Line by line Edits

Line 12: How well does your method extract valley width? Good place to put some #s in the abstract

Line 43: Another reference is needed here: (Wang and Willett, 2021).

Line 104-15: Fantastic explanation – very much enjoyed this.

Line 113-114: Perhaps an exception to the lack of post-glacial models is (Leith et al., 2018). Could add this citation and that there are "limited studies on post-glacial fluvial erosion."

Line 233: "of 5 m." to "We found …" is an abrupt transition consider rewording.

Line 235: in this width calculation and henceforth in all other width calculations is it the $width\ +/-\ 1\ \sigma$? Or 2σ? Just would appreciate your clarifying and then its easier to know for all other measurements.

Figure 3. North arrow and scale for two main maps and inset map please.

Figure 4b. These plots could benefit the reader with a second y axis that is the actual difference between the two datasets in meters. Shouldn't be too difficult to do.

Figure 5. Nice work on the scale for insets. Please label each panel for easy comparison to caption and add scale and north arrow to main map.

Line 290: Authors reference "BGS;" however this section is for the Russian River in California. I think they mean: USGS.

Figure 8: 1) Please label all map plate pieces and insets and refer to them in your caption. 2) Add north arrows to all main maps. Thank you for including a scale bar! Labeling insets may allow you to remove the tie-lines between one inset and main figure.

Line 320: Short Creek and Stinnett Creek don't display only the lack of increasing valley width with drainage area; they show a negative relationship! Maybe be a bit more clear about this in this sentence.

Figure 10: 1) Add state lines to reference map. 2) potentially switch a and b to have smaller scale map first and then larger scale map. 3) In caption, please use decimal degrees not DMS – easier for reviewing audience to look at locations used in paper.

Line 374: I believe standard notation should read m m^{-2}.

Line 391: Here[,] ← add the comma after "Here"

Supplementary Material:

This reviewer had no comments on the supplementary material attached with this manuscript. However, I did try to find the code associated with this project and only found the link at the end of the text lead to a github page for downloading all of LSD Topotools. Is there a direct link to the code for the tool described in this paper that the authors can provide? Perhaps the direct link to the Zenodo? https://zenodo.org/record/5788576#.Yi9eCnrMIuU

References

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Leith, K., Fox, M., and Moore, J.R., 2018, Signatures of Late Pleistocene fluvial incision in an Alpine landscape: Earth and Planetary Science Letters, v. 483, p. 13–28, doi:10.1016/j.epsl.2017.11.050.

Schanz, S.A., and Montgomery, D.R., 2016, Lithologic controls on valley width and strath terrace formation: Geomorphology, v. 258, p. 58–68, doi:10.1016/j.geomorph.2016.01.015.

Tomkin, J.H., Brandon, M.T., Pazzaglia, F.J., Barbour, J.R., and Willett, S.D., 2003, Quantitative testing of bedrock incision models for the Clearwater River, NW Washington State: QUANTITATIVE TESTING OF RIVER INCISION MODELS: Journal of Geophysical Research: Solid Earth, v. 108, doi:10.1029/2001JB000862.

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