Response to Maarten Kleinhans's review

Responses *italicized and blue*.

Note: some comments have been rearranged in order to condense responses.

This manuscript presents algorithms to improve river and delta channel networks derived from water/land-binarised and skeletonised imagery, specifically to assign flow directions to the links between channel nodes. The set of algorithms is tested against expert judgement and found to be accurate. As such the manuscript adds to a growing family of channel network production tools needed for graph-related and other network analysis tools.

The paper is mainly method-oriented and presents no tests or explanations why certain algorithms were added to, or left out of, the workflow. It almost reads as a cooking recipe that tells the reader to add an ingredient without explaining why, and without explaining what would happen without it or with an alternative ingredient. Perhaps this can be resolved by much better figures that explain what the method does and what comes out of it, placing much of the present technical material in a supplement and focusing the paper on the science rather than the method. While this can potentially be repaired, it requires doing such analyses and writing a paper about it, with much of the present manuscript in a supplement, suggesting rather major revisions. In general the paper is very difficult to read as anything other than a recipe for accomplishing something, and what I would expect for this journal is emphasis on that something.

The evaluation can also be part of [refocusing the manuscript], including explanatory reasons why those few links went wrong because that may tell us something very interesting about the method, why it works, and what basic understanding it embodies about fluvial systems. Or perhaps this manuscript is more suitable for another journal, if not a supplement to a paper about the science.

We thank Maarten for his review, and note that his concerns regarding the suitability of this paper for Earth Surface Dynamics (ESD) were shared by the other reviewer. This paper is atypical for ESD in that it is methods-oriented, but per our discussions with the handling editor is acceptable for publication here. However, we appreciate Maarten bringing to our attention the expectations of ESD readers and have attempted to give the paper more relevance among the ESD audience in three ways: First, we have added text to describe the reasoning behind each DPA while citing the relevant work supporting this reasoning (L109-119, L151-154, L170-173, L201-205, L218-223, L246-247, L253-255). Second, we have tried to contextualize this work better by better-defining the existing research landscape (L50-54, L60-62, L102-105). Third, we have tried to highlight the interesting process-form implications that arise from our study—particularly how the effectiveness of DPAs give us clues into the universality (or not) of particular morphodynamic features, and how the variability of the strength process-form relationships renders a morphology/topology-only approach difficult yet achievable (L21, L64-66, L70-71, L413-414, L437-444, L494-497).

There is some data analysis but very little discussion and comparison to work done in the literature.
We have added relevant comparisons as described in the above reply. However, we are unaware of a similar approach/method in the literature to compare directly against. We are aware of directions being set for each link of a CN, but only manually (Marra et. al., Tejedor et al., etc.). Our comparison of the

recipes against the expert decisions is essentially testing against these previous works, though not on the same CNs.

For example, section 3.1 is very hard to read and is probably much better understood when graphically presented in schematics.
We have reduced the clutter by eliminating redundant acronyms. We intend for readers to refer to Figure 2 while reading Section 3.1, as it does provide schematic illustrations of the DPAs.

Detailed comments

Text and figures are cluttered by abbreviations, many of which can be resolved. For instance DPA is unnecessary because the entire paper is about that thing so why not name the subalgorithms by the name that says what they do.
It says DPA everywhere so that is clearly redundant.
It is important to denote to readers that each DPA belongs to the class of all DPAs, hence the original notation. However, we have removed the "DPA" label from all text and figures and replaced it with the bold, italicized acronym for each DPA.

Figures are unclear and not so suitable in background choice for journal publication. This can easily be resolved.
Fig1: black background is beautiful for presentation but make more readable white background for the paper. This also applies to some other figures.
Fig4: again nice for presentation but as a figure it does not work. Why not make blue links for downstream and red for upstream with gray in between and white background.
*We chose the black background for some figures for both practical and aesthetic reasons. The darkness of a black background provides a wider range of contrast that allows us to more clearly show lots of information (e.g. densely-packed flow directions for each link). We did try many color combinations on white backgrounds but found them all less clear than the black backgrounds. Please see Fig. 1 at the end of this document for some comparisons. We note that all figures in this manuscript comply with Earth Surface Dynamics figures guidelines (*https://www.earth-surface-dynamics.net/for_authors/manuscript_preparation.html).

Polish needed: there are multiple grammatical and spelling errors and figure panels need letters for reference in captions.
We have re-edited and spellchecked the manuscript. Letters have been added to figure panels.

Fig2: if in DPA_mdc colours between equation and schematics are supposed to correspond then something is wrong.
This is now fixed.

Fig 3. The caption refers to the text for symbology, but readability would really improve if a figure explains that symbology. It says 'min dir change DPA_mdc' with different omega_ang in multiple places, but why and why these values cannot be understood from the figure.
Fig 3: likewise, this fig is very very hard to read with all the unexplained symbology. Perhaps put in the supplement and make a fig for the paper that explains rather than technically records what the recipes do. For braided rivers the cycles are not connected to the rest, and that bit is the same as in the deltas so for clarity merge the two.

Unfortunately, the definitions of the thresholds (ω) are too involved to include in this figure. However, we have added two sentences to the caption to help explain their purpose and where to find their definitions. We explain in the text and the caption that recipes are combinations of DPAs with the purpose of setting all links' directions. The explanation for what the components (DPAs) do is given in detail in Section 3.1.

Fig6: Nice results, but write out meaning of legend so it becomes readable
The DPA abbreviations have been fully written in the revised caption.

40 missing the most important problem here: bed slopes are nearly as much upward in downstream direction because of shoals and bifurcations, which requires a very different method to get the networks (Kleinhans et al. 2017, Van Dijk et al. 2019).
We were motivated by techniques that are globally-applicable, and high-resolution bathymetry is not widely available for most CNs (especially large ones). We have added text that clarifies our motivation and mentions the difficulties cited in this comment.

46,51 then why is there this remark in the online supplement readme that "Important: The Colville, Kolyma, Lena, Mackenzie, Yenisei, and Yukon channel network masks are not included in these Supplementary Data, as they were painstakingly created by Anastasia Piliouras"? What was so much work about it?
The devil's in the details. While it is now quite easy to create or obtain a binary channel mask, the quality of the mask can vary substantially, and the desired quality depends on the use. The adjective "painstakingly" was included to indicate that attention to detail was paramount in these masks' generation, and that it included a significant amount of fine-scale corrections. We have replaced this adjective with more precise terminology in the Supplementary readme.

136 why this weight? this needs arguments and support. In Marra et al (cited in the paper) we tested and discuss a number of possibilities in view of fluvial morphodynamic functioning.
Marra et al. used width, 1/length, and width/length as possible weights for computing topologic metrics. Here, we found that width alone was sufficient to define "main channels" and did not test other metric. This choice is now further explained in L201-205.

The link to the data https://doi.org/10.15485/1505624 leads to the repository but gives a blank page as result.
We are not sure why a blank page resulted—we are able to download the data from the provided DOI as of 9/24/2019.

References

van Dijk,W.M., Hiatt, M. R., van der Werf, J. J., & Kleinhans, M. G. (2019). Effects of shoal margin collapses on the morphodynamics of a sandy estuary. Journal of Geophysical Research: Earth Surface, 124. https://doi.org/10.1029/2018JF004763

Note: this paper comes from a community where the authors are in alphabetical order. Willem Sonke is the lead author and did this work as part of his PhD thesis.
Kleinhans, M., M. van Kreveld, Tim Ophelders, W. Sonke (lead author), B. Speckmann (PI), and K. Verbeek (2017). Computing Representative Networks for Braided Rivers. 33rd International Symposium

on Computational Geometry (SoCG 2017), pp. 48:1-48:15. Editors: Boris Aronov and Matthew J. Katz. http://dx.doi.org/10.4230/LIPIcs.SoCG.2017.48

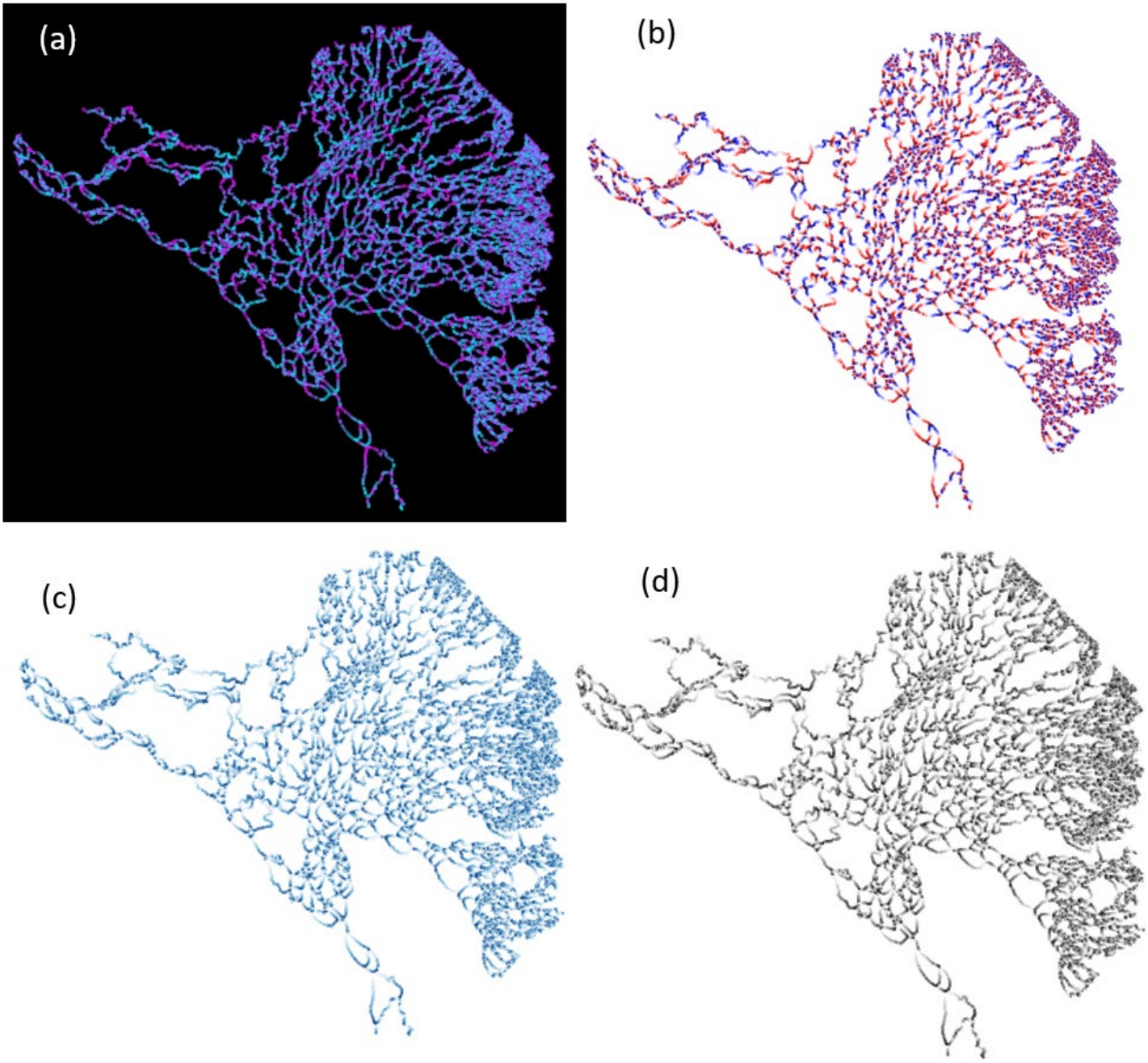

Figure 1. Comparison of color schemes for the Lena Delta.

The red-blue approach suggested (Fig. 1b) is very difficult to interpret. Additionally, the grey between the red-blue transition becomes nearly invisible on a white background. We tested a variety of other colormaps, but they were all difficult to interpret on a white background. To avoid the busy-ness of dense, multiple colors, we also tried single-color colormaps (Fig. 1, c and d). These suffer two problems: (1) again, the brighter portion of the colormap blends into the white background, rendering channels

invisible and (2) human vision tends to lump the darker colors together, making it difficult to readily identify the upstream portions of individual links. In contrast, (a) has both elements of (1) differing contrast (bright to dark) that allow full visibility along each link's length, and (2) different color which makes clear the upstream-downstream differentiation.

This principle applies to the other figures as well. For example, in Figure 5, we use nine entries in the legend that require visual distinction. The use of contrast differences provided by the black background helps make these differences clear, striking, and obvious. We agree that this technique is likely not necessary for Figure 1, but here we choose it for its aesthetic and are unaware of principles that dictate this choice unsuitable.