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Reply on RC3 by T. Wagener

Michael Stoelzle and Lina Stein

Author comment on "Rainbow color map distorts and misleads research in hydrology – guidance for better visualizations and science communication" by Michael Stoelzle and Lina Stein, Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-118-AC3>, 2021

We thank Thorsten Wagener for his well-conceived comments on our manuscript. Find our answers [1-3] below:

[1] This is a very interesting point. We do not have a data set on the correlation between rainbow color map occurrence and the used software to produce the corresponding visualizations. But from our paper survey it is obvious that authors often use the standard color scheme, e.g., in R statistics to generate graphs such as line or point plots. As we mentioned in L41-43 the color preset of R version 3.x uses "black, red, green and dark blue" for the first four data sets, and color confusion is hence a logical consequence. MATLAB changed its default color system in 2014. Instead of blue, green, red and turquoise for the first four data points the colours are now blue, orange, yellow, purple. And instead of "jet", the MATLAB rainbow equivalent, "parula" is used. However, "parula" is not considered as 100% perceptual uniform either as the luminance gradient is steeper at the edges and flatter in the middle of the color map. The parula color map could be found in a lot of papers from our survey. Same presets might exist in other software or visualization products/tools. However, advocating the companies to change a non-colorblind safe preset might force authors to implement their former choice as they are used to it. We assume that often the reason for the fame of visualization with the rainbow color maps is – as we wrote (L38-40) – that these figures look really colorful, appealing and attract attention. We guess that the authors also think that rainbow color boost their visualizations in a way to be more impressive or outstanding. However, a lot of software products and programming languages offer the possibility to load your own color maps. In other words, we think you cannot forbid the scientist to use a specific color map, but we might have possibilities (or at least make some efforts) to forbid the authors to publish papers with rainbow visualizations (and also red-green-figures) as the rainbow color map is considered to be scientifically incorrect.

[2] Thanks for this important comment. Yes, it seems to be reasonable to add a precise statement on potential standard tools (like colorbrewer2.0). We will revise the Section "Improve color" accordingly and will also revise the Section "trust color" arguing that a cross-check (e.g., with a CVD emulator) helps the authors to be more confident about the use of color in their visualizations.

[3] We think ColorBrewer 2.0 (<https://colorbrewer2.org>) is great tool to start with when thinking about figures and creating scientific visualizations with appropriate and valid color

maps. However, it focuses on cartography and might be not sufficient for color choices for other graph types. ColorBrewer 2.0 is also limited in some ways, e.g., for qualitative color maps with 5 or more distinct colorblind-friendly colors the tool fails to present an appropriate color map. However, we agree on the point that more color choice guidance should be given to the reader and the proposed step-wise guide seems to be promising. Therefore, we will add a table (or similar) to the revised manuscript that can be used as a checklist or a step-wise guide.

In our opinion *laziness* is an understandable explanation for having that much color issues in scientific visualizations, but it is not good reason. With recent updates to the default colour map in MATLAB, R or others it seems that often the reason is a laziness to change anything (i.e., if others have used these colours in their publications it must be okay). We think such laziness could be fought with more rigorous obligations to check your own visualizations for CVD. Here we see the role of the journal (compare also our answer to CC by J.C. Refsgaard, <https://doi.org/10.5194/hess-2021-118-CC1>) in moving from a recommendation to an obligation by updating the author guidelines regarding the use of color. It is then the role of editors (and may be also the reviewers) to insist on this journal obligation later on. This would encourage authors to overcome “laziness” or personal preferences more reliably. We will strengthen this point in the revised manuscript.