

Response to Reviewer 1

Reviewer comment: <https://doi.org/10.5194/hess-2021-274-RC1>

Reviewer comments are in black. Author responses are in blue.

I read this paper with interest. It deals with an issue that is becoming more and more important, i.e., hydrologic change. Increasingly we are having to attribute possible causes of change and to develop models that can reproduce past change and predict change in the future. In this paper the authors are dealing with the Upper Jhelum catchment in the headwaters of the Indus River, which has experienced decreasing streamflows. The paper is aimed at attributing possible causes of the decreasing streamflow. They implement the notion of multiple working hypotheses to assess a combination of alternative causal explanations for this observed decrease. I found the analyses to be insightful and valuable, albeit somewhat inconclusive due to data limitations and uncertainty.

While the paper is publishable (eventually), I found the presentation to be confusing and unnecessarily diffuse.

We would like to thank the reviewer for considering the manuscript and providing constructive and helpful feedback. As the following three comments all relate to the framing of the paper, we address them together, below.

Firstly, for some reason, the authors have conceived the paper as a methodological advance, and have gone to a lot of trouble to give an overly philosophical introduction, talking about top-down and bottom-up and multiple working hypotheses etc. I had to read four manuscript pages before they introduced the problem they are studying. I would like them to start with data evidence of both the cause and effect, before presenting the alternative hypotheses as part of their methodological presentation.

Secondly, this is a place-based study, the sooner you get to the problem, the better its readability. The philosophical discussion can be kept to a minimum. I would like to know more about the streamflow decrease as early as possible, and the history of climatic, and anthropogenic changes to land use and land cover as possible causal factors. In other words, I like more of an introduction to the basin and its hydrology that can help motivate why it is that they form their multiple hypotheses.

Thirdly, I am not even sure if the authors are correct in calling their modeling approach a bottom-up study. The way I read it, the authors analyze data at the catchment scale and find a decreasing pattern of streamflow. They then systematically try to attribute it to change in rainfall, evapotranspiration, land use and land cover change etc, or a combination of these. In my opinion, this is in fact a data-based, top-down study. I go back to the original source (Klemes, 1983), who defines the downward (top-down) approach "starts with trying to find a distinct conceptual node directly at the level of interest (or higher) and looks for the steps

that could have led to it from a lower level". This is the way I see the authors' attribution work.

Thank you for these comments. We agree that the paper focuses primarily on understanding the hydrology of the Upper Jhelum. We will therefore increase the emphasis of the Upper Jhelum within the introduction, and reduce the emphasis on the methodological approach. With that said, we do not want to relegate the approach entirely to the methods section, because we believe it presents an alternative to the many emerging studies of hydrological attribution that rely on predictive inference (e.g., basin hydrological simulation), particularly when focusing on watersheds at spatial scales as large as the Upper Jhelum. We had hoped to emphasize this contrast by referring to our study as a "bottom-up" attribution. However, we now recognize that this terminology is confusing and should be avoided.

In response to these comments, we will reduce the scope and length of introductory paragraphs, so that we briefly describe the importance of hydrological attribution and review existing literature that focuses on attribution. This will allow us to better situate the changing hydrology of the upper Jhelum in response to ongoing human activities including both drivers and outcomes. In providing greater emphasis on the Upper Jhelum, we will also discuss the decline in streamflow in greater detail along with an expanded literature review on potential causes and mechanisms for the drying of the upper Jhelum. We hope this will provide better framing for our approach, hypotheses, and subsequent analysis.

Finally I would like to see a clear statement of their conclusions, focusing more on the hydrology of the place and perhaps less on methodological sophistication. In my opinion, the paper raises a number of important issues about the hydrology of this region, and placing the result in the context of the local hydrology would be much more useful than whether this is a bottom-up or top-down method.

Per your suggestion, we will de-emphasize the methodological components throughout the paper (including removing references to bottom-up and top-down) and focus the paper more on the implications for local hydrology. Additionally, in the conclusions, we will better situate the methodological discussion as part of a broader discussion on the hydrology of the Upper Jhelum, including key questions for future research.

The paper is definitely publishable after major revisions to address or discuss (in case the authors want to dispute my comments) the issues I have raised in my review