Interactive comment on "HESS Opinions: Repeatable research: what hydrologists can learn from the Duke cancer research scandal" *by* Michael N. Fienen and Mark Bakker

Michael N. Fienen and Mark Bakker

mnfienen@usgs.gov

We thank Dr. Geiger for his support of our Opinion Paper and for his suggestion on how to improve it. Dr. Geiger raises the following five points:

Other scandals There are unfortunately many other scandals on scientific studies where things went awry. The Netherlands (the home country of the second author), the scientific community was shocked in the past few years by a high-profile social scientist that had made up all kinds of data, which indeed had detrimental effects on his PhD students and the credibility of the scientific community. Every country seems to have its own high-profile cases, but many of these cases

concern deliberate activities to falsify data. Such cases are very difficult to catch if done 'well' and are not the topic of our Opinion paper, and we will revise our paper to indicate that. We have built our Opinion Paper around the Duke Cancer Research scandal, as this is a prime example where the researchers did not deliberately falsify data, but published results that could not be repeated as they were based on a few questionable choices. The protocols developed by the Institute of Medicine are intended to make it possible to repeat published results, and we were inspired to address similar practices in the field of Hydrology.

Stewardship of underlying data The issue of how to store and make data and code available is an important one. In the United States, this has been recognized at the highest level (see White House memorandum referenced in the Opinion Piece). It can certainly be cumbersome to follow rigorous data-handling protocols with large datasets but the reward is large in the future and there is an obligation for the public to have access to data that society pays for. Our main point in this work, however, picks up where the data stewardship leaves off. Documenting the path from original data through analysis and potentially forecasts is the context in which we write.

GUIs and commercial codes vs. scripts One of the main points of our paper is that research is not repeatable when a GUI is used, unless every button-push (and the order) are recorded. Our suggestion was to record such button-pushes in a script. As mentioned in the paper, several GUIs already have this capability, which makes the analysis instantly repeatable. Such a 'spit out a script' option will make it possible for researchers to produce repeatable research without becoming scripting experts.

Open Source The documentation of Open Source codes is indeed an issue. Writing documentation is considered (at least somewhat) boring by many code developers (including the authors of this paper), but, obviously, crucial. In that respect

we will emphasize this when discussing that the development of codes *and documentation* needs to be rewarded more appropriately by academia. We will think about if we can add a discussion of examples of best practices to make source codes available.

Plagiarism We are aware that some researchers don't want to make their code available, because they don't want others to change it a bit, then use it on their own problems, and then publish it. Luckily this can be regulated with the choice of an appropriate Open Source license, which gives authors the ability to specify what can and can not be done with their code. Further, the more detail of work is documented, the easier plagiarism can potentially be detected. It is indeed good to mention these issues in our paper.