Response to Reviewer #2, August 8th, 2024

We would like to thank this anonymous reviewer for their feedback, the comments have led to a greatly improved manuscript. Below are the reviewer's comments in regular type and our responses in bold type. We expect to update the manuscript to the EGU website after this Response to Reviewer.

Schenk et al investigate sediment source and their transport in a region of Arizona that has been impacted by wildfire. Their work is strongly framed around modelling approaches and comparisons. They also use empirical information to validate their model outputs and discuss mitigation efforts. Considering the context of such processes with respect to the occurrence of landslides processes such as debris flows; the present study is relevant to the audience of NHESS. However, I think that there is room for improvement, notably via an effort at presenting this work for a broader audience. Too often the manuscript reads as being very case-study focussed and the connection with other studies (either modelling or result based) is missed.

Overall I also agree with the comments of the first reviewer who points out to several key aspects. I have additional specific comments to hopefully improve the manuscript.

Thank you, please refer to our responses to Reviewer #1 from January 2024. We improved and clarified the manuscript based on their comments and suggestions.

Abstract:

The abstract sounds very technical, especially for readers that are not directly familiar with the models. Abbreviation are usually to be avoided here. Quantitative values, if mentioned, should ideally be compared/discussed with the broader literature.

We understand the need to avoid abbreviations in the abstract but unfortunately these model name acronyms are analogous to the model name (nobody references these models by their full names and each of these are discussed widely by their acronym as a surrogate for the model name). Attempting to write out the full model names in the abstract would be cumbersome and reduce the readability. The quantitative values provided in the abstract are directly comparable between observed rates of sedimentation and the different models. Providing a comparison with the broader literature, in the abstract, would not be practical since there are multiple variables that go into an event-based sediment laden flash flood event. The purpose of the paper is to discuss the precision and

accuracy of different sediment models and not provide a comparison of sediment flux between disparate studies of post-wildfire runoff. The numbers provided in the abstract are directly comparable between different models and the observed sediment deposition.

Introduction:

Overall, this section could be improved thinking about the broader audience. It needs to provide a better justification of the models used. The study area must also be better justified. . See specific comments below:

Lines33-34: the focus seem to only concern the American West. I would welcome an introduction that goes broader. In other words, can a researcher from Spain, Greece or Mexico for example be interested in this research as well?

We changed the sentence to be more inclusive to humans living at the WUI for semi-arid forests anywhere globally. At the time of the initial writing the WEPPcloud model was only available for the USA, it has now been expanded for soil classification databases on multiple continents making it of a more global use.

Line 60: three models acronyms (please explain the acronyms when mentioned the first time) are introduced without any justification. As it is the introduction, these models should be backed-up via the state of the art.

A sentence is added in the Introduction that provides the long form name of each model, the discussion of the modeling techniques is already included in the Methods including the rationale for using each of the techniques. We feel this justification is more applicable to the Methods section than the Introduction.

Line 21: the study area is mentioned without any broader context. In other words why is that study area of interest for the international audience. Why is that an ideal case study? The goal here is not to repeat what is proposed in section 2, but instead make sure that a reader from, for example, China, finds Flagstaff a place of interest.

This comment could be said for any study. We revised Line 21 to further explain the context of the fire area and study (removed the name of the watershed and explained the geologic underpinning of the burn scar).

Study area:

make sure that all the local names are relevant. Overuse of such names are not ideal for the understanding of the research.

We agree, however the use of local names in the Study Area section is intentional, it provides needed context if a researcher was to attempt to replicate this study or confirm the work that we are presenting. If a reader finds the detail distracting they can read ahead to the next section.

Method:

Overall, there is a lack of method justification with respect to the literature. See specific comments below.

Line 104: what does the acronym FLO-2D stand for?

While written like it is an acronym it is the actual name of the model, a search of the internet and a literature search on Google Scholar did not find a different name other than "FLO-2D".

Line 105-110: What Lidar data are used? Provide source, resolution information, etc.

Both lidar datasets (2015 and 2019) are available on the USGS National Map server. This information has been added to the manuscript including a link to the National Map server. The horizontal and vertical resolution vary between both datasets but are sub 10 cm accuracy or better.

Why (based on what physical criteria?) these grid scales in the flood modelling ?

The initial grid size was selected based on emergency conditions during the wildfire (the ability to provide quick results to the emergency management teams). The more refined grid element in 2019 was selected to provide a better resolution of rainfall-runoff. The relative trends for sub-watershed runoff did not change with the change in grid size. The overall watershed is sufficiently large that either grid size provided relatively precise results for runoff and flood events.

Lines 151-156: can you clarify on the sediment transport analyses carried out? Can you the back this up with literature?

This is a similar question to Reviewer #1, we have improved the manuscript after those initial comments to better frame how FLOWSED/POWERSED operates and how it has been used previously in the scientific literature. Thank you for sharing

a similar concern as Reviewer #1, we hope the revised text provides needed detail. Please refer to the Response to Reviewer #1 for more information.

Lines 184-186: any reference for these modelling approaches?

References to both modeling approaches are included in the manuscript.

Lines 200-205: any of the values used in the model can be justified from the literature?

The values used for the MUSLE model were predicted based on field conditions, this is now clarified in the manuscript. More information about determining the K value, C value, and P factor are available in the reference provided in the manuscript.

Lines 207. CoF staff?

CoF is defined on Line 82 (City of Flagstaff).

Lines 207-212. Reference(s) to support these methodological choices?

The rationale for the methodology of the empirical measurements is included in Line 212 (observations were noted for Federal and State disaster declaration reimbursements). Due to the emergency nature of the urban flooding there was no opportunity to collect more holistic measurements using precision surveys. Cleanup operations commenced during the falling limb of the flood, the most appropriate way to capture sediment deposition in the urban environment was the Federal and State disaster reimbursement paperwork submitted from the landfill and through flood observer photos.

Results:

General comment: can the erosion/sediment values obtained in this study be compared to other cases? That could help to make the discussion even more interesting/of a broader interest. Providing quantitative values without putting them into perspective is not always relevant.

The purpose of this paper, as stated in the Introduction, is to provide an example of three different sediment modeling techniques and compare the precision and accuracy with empirical results. Comparing gross sediment values to other studies would not be very interesting based on the number of confounding variables that make comparison difficult. This could include the number of flood

events, rainfall hyetographs, burn severity comparisons, slope, geologic provenance, watershed recovery/vegetation recovery, and other variables.

Lines 395. The author refer to gully erosion. This comes as bit as a surprised that this process is not mentioned earlier in the study area section. Something that remains unclear is the origin of these gullies. Where those gullies be already in place before the wildfire? If so, would these gully be associated with earlier wildfires? In some cases, gullies are not to be the consequence of landslide processes. Are their observation of landslides in the regions. Landslides could develop after wildfire of course, but could also be there as a basic geomorphic agent that bring sediment to the river system. Overall, some clarification (extra relevant information) around these mass movement/erosion processes would be welcome is that helps to better understand the model outcomes.

I believe there may be a definition miscommunication here. The hillslope gully erosion mentioned on this line is for the formation of hillslope gullies and rills through hillslope erosion. We are not talking about mass movement or mass wasting. No mention of landslides or debris flows is provided in the manuscript in terms of modeling or empirical observations. There are plenty of examples of gully erosion definitions in various government reports from agencies on multiple continents, this manuscript subscribes to the common definition of the term and is discussed at length in the Discussions section. Mentioning gully erosion as part of the hillslope erosion modeling is described in the Methods section.

The onset of gully erosion is interesting in this region due to the prevalence of gullying on hillslopes post-wildfire. The process is more fully explored in an earlier paper from the nearby Schultz Fire that is cited already in this manuscript. The reference for that paper is as follows:

Neary, D.G., Koestner, K.A., Youberg, A. and Koestner, P.E.: Post-fire rill and gully formation, Schultz Fire 2010, Arizona, USA. Geoderma, 191, pp.97-104, 2012.

Another reference to the Neary et al. study has been added at this line location.

Note here a reference of gully erosion modelling. Although targeting different scales, that could be useful: Vanmaercke, Matthias, Panos Panagos, Tom Vanwalleghem, Antonio Hayas, Saskia Foerster, Pasquale Borrelli, Mauro Rossi et al. "Measuring, modelling and managing gully erosion at large scales: A state of the art." Earth-Science Reviews 218 (2021): 103637.

Thank you for the reference, the paper is interesting and is now included in the Discussion section under the gully conversation.

Figures:

Figure 1: add elevation quotes.

Unsure of where the reviewer would like elevations called out, the topography is highly heterogenous. Example elevations for Mount Elden, Dry Lake Hills, Mount Elden Estates neighborhood, and Paradise/Sunnyside neighborhoods are now included in the Study Site section. Contour lines, and DEMs, for the area are freely available online at multiple sources (e.g. USGS National Map, Google Earth, City and County GIS portals, etc).

Figure 2. Indicate when the photos was taken. Provide also the geographical coordinates of the photo.

A year and season is now included in the figure caption as is an approximate location that can be compared to the site map.

Figure 10. Indicate when the photos was taken. Provide also the geographical coordinates of the photo.

A month was added to the existing year in the caption, the geographic coordinates for the "Ginger Fan" were added to the caption.