Earth Surface Dynamics Discussions

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Comment on esurf-2021-61

Anonymous Referee #1

Referee comment on "Controls on earthflow formation in the Teanaway River basin, central Washington State, USA" by Sarah A. Schanz and A. Peyton Colee, Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2021-61-RC1, 2021

This study addressed the interesting question of how the timing and spatial pattern of earthflows relates to salmon habitat in Washington, USA. Spatially, the authors found that wide valleys tend to be present upstream of earthflows, which implies that they enhance salmon habitat. For the temporal dimension, the authors used radiocarbon dates from charcoal and estimates of lake sedimentation rates to constrain maximum and minimum ages, respectively, of several earthflows. They then used arguments about surface roughness to hypothesize about ages of other earthflows and noted that those ages may be broadly consistent with inferred trends in salmon populations.

Although I found the motivation for this study quite interesting, the data unfortunately aren't sufficient to support the inferences regarding the timing of earthflows and their relationship to temporal trends in salmon population. First, to test the hypothesis that high earthflow frequency corresponds to times of large salmon populations, the salmon population would need to be independently known over the Holocene. I'm not a salmon expert, but that information doesn't seem readily attainable, and the manuscript doesn't provide any independent references that have determined it. Instead, there is a suggestion that salmon populations may have stabilized 4-5 ka based on very broad scale inferences about climatic and tectonic changes. Second, the study did not present a significant, data-derived relationship between earthflow age and surface roughness, which would be necessary in order to use surface roughness to infer age of undated earthflows. So, although I wouldn't recommend this manuscript for publication at this time, I did find the research question quite compelling, and hope the authors will consider some more detailed comments if they choose to continue pursuing work on this study:

- Age vs. activity. Since age (~time since a landslide happened) and activity (~how active the landslide is currently) both affect a landslide's surface roughness, it can be quite challenging to disentangle these two effects for earthflows in particular. This may be one reason why there is not a relationship between landslide age and roughness for the study site. Fig. 5 is a bit misleading on this point, since it shows a modeling result, which by design will smooth the landslide deposit over time. If you add the age and

roughness values from Table 1 to the figure, it is clear that the radiocarbon-based ages and roughnesses are not correlated and do not follow the model-predicted trend. Those data are so scattered that that general inferences about mid or late Holocene timing aren't supported either (e.g. the smoothest landslide is the youngest (Dickey Cr.) and the oldest is the roughest (Indian Cr.)). Perhaps the fact that age and roughness don't correlate is a useful observation for thinking about what other factors control surface roughness of these earthflows.

- Landslide dates. As stated in the manuscript, charcoal provides only a maximum age, and often this age is not a close maximum. E.g. see Struble et al. (2020), GSA Bull. where charcoal from a landslide's deposit is up to thousands of years older than the landslide. Also in the present manuscript, the discrepancy between the minimum and maximum ages of the Rye Creek earthflow (346 and 4,353 yrs, respectively) suggests that either the earthflow's age isn't accurately enough known to determine an age-roughness model, or that a single age for the earthflow may not be representative of its long term behavior, such as persistent movement and/or reactivations.
- An exciting, if somewhat technical, finding of this work is that the chosen roughness metric decreases linearly with model simulation time. Previous studies have found an exponential age v. roughness relationship, which means that absolute uncertainties of predicted ages are quite large for the older landslides on the steeper part of that curve. A relatively simple fix of using this or a similar roughness metric may dramatically reduce the uncertainty on predicted ages of old landslides.