

Earth Surf. Dynam. Discuss., referee comment RC1
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Comment on esurf-2022-12

Greta Wells (Referee)

Referee comment on "Volume, evolution, and sedimentation of future glacier lakes in Switzerland over the 21st century" by Tim Steffen et al., Earth Surf. Dynam. Discuss., <https://doi.org/10.5194/esurf-2022-12-RC1>, 2022

General comments

This manuscript thoroughly discusses future glacial lake evolution in the Swiss Alps derived from newly acquired glacier topographic data. It clearly frames the study in the context of previous research, explains existing data gaps, and offers a robust methodology to fill these gaps. The manuscript adequately answers the fifteen evaluation criteria questions, scoring particularly highly on organization, explanation of methods for reproduction by other scientists, and discussing the study in relation to existing work and future research implications.

The paper does an excellent job of maintaining the balance between model generalization and case study specifics. One of its strongest features is comprehensively explaining the selection process and potential uncertainties or unknowns for each model parameter. The authors also demonstrate a firm understanding of how field variables (i.e. real-life topography, sediment, and glacier melt dynamics) are represented by model components, and how changes in field variables will influence model input parameters and results/outputs. I think such a clear link is often missing in modeling papers.

Specific comments

- Title: Maybe replace "formation" with "evolution" to imply how lakes will continue to change through time rather than when they will initially form. "Evolution" would also better describe lakes that disappear due to sediment infilling. Also consider adding the

study time scale into the title—something like *Volume, evolution, and sedimentation of glacier lakes in Switzerland over the 21st century*.

- Do mass wasting (i.e. from surrounding slopes) and/or supraglacial debris (i.e. transferred from the glacier surface to the lake) significantly contribute to sediment infill? Maybe not, but is it worth considering?
- While the paper explains the model generalizations and parameter uncertainties for lake bathymetry, I think this point merits further discussion. For example, are variabilities in overdeepening morphologies expected at individual glaciers or between the four river catchments in the study area? Even though a thorough analysis of basin morphometry is beyond the scope of this paper, specific discussion in the context of the study area would be interesting.
- Similarly for sediment infill—the paper does a great job of explaining the model parameters/uncertainties for sedimentation rate, but I think it's worth expanding the discussion on how local/site-specific variations may influence results. For example, are there significant anticipated differences in sedimentation rate (i.e. due to local bedrock lithology or erodibility) between the four studied Alpine catchments? Also, in section 5.2 (lines 480-484), it would be helpful to detail the type of field validation required (i.e. bathymetric surveys or sediment influx river/lake measurements).
- The figures are great, but I think the paper would be strengthened by adding a schematic diagram to accompany the sediment input graph in Figure 5. Maybe a cartoon visualization of a lake (like the cross-section shown in Figure 6) that shows the locations on the landscape of sediment source zones (headwall erosion, subglacial abrasion, and proglacial erosion). Also maybe draw upstream lakes to illustrate sediment trapping. Though the information is described in the text and existing figures, a "landscape view" would help to visualize sediment sources and transport.
- A map showing the locations of the glaciers mentioned in the text would be helpful (i.e. those in Table 1)—though I did notice that the lake polygon shapefiles are online in "data availability."
- Conclusion (section 6): It would be nice to expand discussion of future climate change (lines 575-579) in terms of:
 - Specific glacial lakes in the Swiss Alps. Based on results, do certain river catchments/glacial lakes in the study area have higher outburst flood risk, greater hydropower potential, or higher ecological relevance?
 - Other glacial regions worldwide. How can this method be applied to other regions—i.e. are there any factors that make its application unique to the Swiss Alps? Even if this is beyond the scope of the paper, I think it is useful to develop this idea in a few more specific sentences.

Technical corrections

The paper reads very smoothly—these are all minor!

- Line 31: "...amongst other *features*" (or add a similar word)
- Line 57: Switch order: "205 additional lakes..."
- Line 62: replace "or" with "and"

- Line 68: "...once the glacier *has* retreated..."
- Line 85: replace "combing" with "combining"
- Line 111: "... has been shown to yield *the* most robust results"
- Line 114: remove "to" : "...as the "mean bedrock topography""
- Line 134: remove "as" : "...the procedure described above."
- Line 157: maybe replace "political environment" with "policy decisions"?
- Line 174: change to "after glacier *retreat*" (remove "-ed")
- Line 189: I think bedrock lithology should be included as a factor in basin erodibility
- Line 239: "*The same* is true when comparing the lakes..."
- Line 250: "The uncertainty in lake volume is *also* controlled by..."
- Line 302-303: "*In the first instance*, the correlation between lake size and glacier extent can be attributed *to* the fact that..."
- Line 305 (Figure 1): delineate the catchment boundaries more clearly on the map—it is difficult to distinguish between the Rhine and Inn basins, particularly. It would also be helpful to add an inset map showing the study area location within the larger region/Switzerland. The label "B" also does not clearly show up on the panel.
- Line 315 (Figure 2): add a temporal reference frame (what time scale does this show?)
- Line 319: remove "s" in lakes (...of each individual *lake*)
- Line 323: remove "a" (...provide confidence intervals...)
- Line 346: ...disappear again *by* 2100?
- Line 349: ...the rate is *approximately* constant...
- Line 395 (Figure 3): perhaps this is obvious and I missed it, but explain abbreviation "CH" on panel B
- Line 403 (Figure 4): explain what the grey areas denote—I assume it's uncertainty, but clarify it in the caption.
- Line 425: "*Although* in terms of area and volume..."
- Lines 427-8: "...in *the* first place..."
- Line 432: ...glacier lakes *has been* conducted..."
- Line 443: perhaps this is a technical term I'm not familiar with, but the word "embedding" is unclear in this sentence. Maybe replace with "position" or "formation"?
- Line 454: I think you mean plant/vegetation/floral colonization, but maybe add a word to clarify this
- Line 469: use another word besides "related"—maybe "presented"?
- Line 503: "The differences between GlaTE and ITVEO *are* dependent..."
- Line 516 (Figure 6): add an inset map to show the location of this site within the study area/Swiss Alps.
- Line 568: specify when "mid-term" is (mid-century?)