Earth Surface Dynamics Discussions

Earth Surf. Dynam. Discuss., referee comment RC1
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Comment on esurf-2021-99

Anonymous Referee #1

Referee comment on "Unraveling the hydrology and sediment balance of an ungauged lake in the Sudano-Sahelian region of West Africa using remote sensing" by Silvan Ragettli et al., Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2021-99-RC1, 2022

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General Comments:
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This study provides several different sets of outcomes, and for the most part they are handled very well. The clearest (yet somewhat less innovative) part of the paper is about modeling water levels in a lake based on a combination of environmental data (precipitation, evaporation) and remotely sensed measurements of lake shoreline position, which in turn are based on overlaying a binary land/water mask on a digital elevation model (DEM). I thought this aspect of the paper was quite convincing. The second part of the work, also remote-sensing focused, was on quantifying sedimentation and erosion, by examining departures from uniform elevation along observed shorelines on different dates. This aspect was innovative and interesting, and the combination of these first two parts makes a nice model for how others might proceed to do similar kinds of analysis in other locations.

The third aspect of this paper was a water budget analysis, based on the other components, from which the authors claim that the observed long-term downward trend in lake water level is due to erosion (deepening) of the outlet channel. That is certainly plausible, but I found the explanation somewhat unclear and unconvincing. Despite obvious increases in water loss during the dry season -- increased evaporation, decreased net inflow, and the resulting more-negative trend in water levels during each dry season -- the authors argue that the lower dry-season water levels can be explained mostly just by lower water levels at the start of the dry season. I have questions about that interpretation, as discussed below.

Particularly on the remote sensing side, I would applaud the authors' thoroughness and attention to small details. There are many points in this analysis where the authors actually go somewhat further than I would normally expect, e.g., the iterative approach used in quantifying shoreline deposition and erosion described at lines 255-261. Overall,

the remote sensing analysis appears very comprehensive and well planned. I believe these parts of the manuscript do make a valuable contribution to the literature.

Before moving on to my specific comments and technical corrections, I will briefly respond to queries from the journal's peer review criteria:

Does the paper address relevant scientific questions within the scope of ESurf?
Yes.
Does the paper present novel concepts, ideas, tools, or data?
Yes, though some parts are more novel than others.
Are substantial conclusions reached?
Yes, many substantial conclusions are included.
Are the scientific methods and assumptions valid and clearly outlined?
For the most part, yes. See comments below.
Are the results sufficient to support the interpretations and conclusions?
The remote-sensing based conclusions seem well justified. I am a bit more skeptical (or confused by) some of the interpretations.
Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?
Yes.
Do the authors give proper credit to related work and clearly indicate their own new/original contribution?
Yes.
Does the title clearly reflect the contents of the paper?
Yes
Does the abstract provide a concise and complete summary?
Yes
Is the overall presentation well structured and clear?
Yes, with the exception that some of the presentations of the results, and of the authors' interpretations, were confusing or unclear to me.
Is the language fluent and precise?
Yes, with minor corrections noted below.
Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?
Yes, with minor corrections noted below.
Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?
See comments below.
Are the number and quality of references appropriate?
Yes.
Is the amount and quality of supplementary material appropriate?
Yes.

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Specific Comments:
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1. I am a bit confused by the attribution process here, and it's probably just my own

failure of understanding (but if so, perhaps some things could be written more clearly). The last line of the abstract states unequivocally that lowering the floor level of the outflow (erosion) "explains the decreasing trend in WSH". But as lines 445-450 note, a long-term change decrease in groundwater recharge (perhaps due to regional warming and increasing ET rates in the lake's watershed) could also contribute to the observed reduction in surface height. All the discussion of evaporation in the manuscript appears to focus on evaporation from the lake itself (and even that does appear to explain a significant fraction of the overall change in lake level, as shown in figure 9). Would it be more realistic to say that the declining trend in WSH is explained in part by evaporation from the lake surface (~15% or whatever), and that the remainder is attributed in part to a potential lowering of the outlet channel, but long-term changes in groundwater recharge are unknown? (I have larger concerns about the attribution issue below.... see my comments 2, 7, and 9 below.)

2. Lines 147-148 say "The analysis focuses only on the loss part of the year to explain the ecologically most critical conditions for the lake." However, the main conclusion seems to be that what matters is the starting point of each dry season (what is the water level at the beginning of the dry season?). But the general downward trend in the "starting point" could in principle come from an increasingly negative water balance during either the wet or dry season. In other words, how do we know whether the problem is bigger losses during the dry season, or smaller gains during the wet season? I understand from lines 148-150 that cloud cover during the wet season prevented assessing the dynamics *within* wet seasons (e.g., time series in lake properties from June to Sept). But looking at the net change in area and water level (volume would be better...) from the start to the end of each season should be possible, I'd think? Basically, what are the long-term trends in (a) the change from Oct 1-May 15; and (b) the change from May 15 to Oct 1? I'm trying to extract that information from Fig 4 and not really succeeding.

3. Section 4.4.1: I am not completely convinced by the coregistration explanation; the calculations of erosion and sedimentation would seem to be very sensitive to minor errors in coregistration. Ideally it would be helpful to include a sensitivity analysis of that. I'm open to the argument that the long-term trends visible in Figure 3 suggest that any errors caused by coregistration are random not systematic and are canceling out over time (i.e., contributing noise rather than bias). But a bit more discussion of the assumptions and effects related to image coregistration is needed.

4. I really had trouble interpreting the image with water levels in Figure 1. My initial understanding was that the large gray patch was the actual image of the lake in the orthoimagery, when it was at 328.7 m. Only later did I figure out that this is a partially-transparent gray polygon superimposed on the orthoimage to represent the area between 328.7 m and 330 m (... at least, I think this is correct) and that the areas below 328.7 m are the two large "island-like" patches outlined in black, one of which has a greenish color and one a more tan color. I initially perceived those as actual islands sticking up above the 328.7 meter contour, when they're actually pools that extend below it. To make this map clearer, consider instead using two different and contrasting colors for outlining the 330 and 328.7 meter contours, or use two different opaque fills (like dark and light blue, or dark and light gray) for areas below 328.7 and from 328.7 to 330 m. This is a problem because I initially assumed there were no elevation values available within the entire gray area.

5. Figure 4: The pattern of colors and shapes is inconsistent between (c) and (d) - I assume they should be ordered the same (top to bottom), but for clarity, use the same colors and shapes for the lines and point symbols. The legend starts in panel (c) and extends onto panel (d) - maybe move it to the bottom of the figure, or between (c) and (d), with a horizontal rather than vertical layout?

6. Figures 7 and 8: The values for dh(rate) are shown as positive. I assume they are actually negative (decreasing height). Perhaps it might make sense to label them all as components of change in height, i.e. dh(E), dh(P), dh(Q), dh(Total) with dh(E) and dh(Total) being negative, and dh(P) and dh(Q) being positive? Likewise, in line 389 (bottom of page) it is confusing to say that an increase in evaporation caused an increase in dh, when dh is becoming more negative. Finally, in Figure 8's legend, there are values given for the slopes that are the same units as the Y axis itself. Should the slopes be in mm d-1 y-1 (mm/day/yr)?

7. Lines 393 and following return to the attribution question, and I am still confused and failing to follow the authors' argument. They write "The observed lake level decrease over the 22-year period is much higher than what can be explained by the changes in dry-season water balance components. The average lake levels of the months January-March decreased by 644 mm..." But 644 mm over 22 years is 29 mm per year. Meanwhile, the daily rate of dry-season change in water level (dh) according to the blue line in Figure 8 changed by about 1 mm/day (from 5 mm/day to 6 mm/day) over the same period. If there are 200 days in the dry season (an underestimate), then 1 mm/day = 200 mm/season. If the lake is losing an extra 200+ mm more each dry season than it did in 2000, why would that be unable to explain a 644 mm change in water level? It would only take 3 seasons with the extra 200mm of water loss to add up to 600 mm total water loss.

8. Lines 411-412: The authors write "Still, as expected, net sediment deposition is evident at the mouths of the two tributaries." But in figure 3c, it looks like there is net erosion at the extreme east arm of the lake, where the eastern tributary enters (I believe). There is net deposition (red) slightly further along, but where the tributary actually enters it looks more like erosion (blue).

9. Line 422: See above comments about attribution. I am still having trouble following the authors' argument that lake levels are getting lower at the end of the dry season because they're starting out lower at the beginning of the dry season, and that changes during the dry season itself are unimportant. But if all else (wet season contribution) stays the same, and slightly more water is lost each dry season, there will be a downward trend in the starting levels for each dry season, purely due to the increasingly negative balance in the previous dry seasons. In oher words, the authors appear to be saying the cause of the long-term decline is not A (what happens during dry season) but B (starting point for the dry season) ... but A in all previous seasons affects B in all subsequent seasons. I am probably misunderstanding things, but I just don't think the authors are demonstrating the argument for attribution very clearly here.

10. Section 7 is labeled "Accuracy Assessment", but the firrst part (through line 464) is

not really an accuracy assessment; it's a discussion of how generalizable the methods used here are for other sites elsewhere. More generally, in the remote sensing community this phrase "accuracy assessment" usually involves some comparison with a second, external dataset that's used to validate estimates produced from the first dataset. In this case, both the original estimates of uncertainty, and the calculated ones in this section (465-481) are both derived from the same source - the UAV's DEM produced in Photoscan. Errors in that DEM would affect both the "results" and this "accuracy assessment" ... in other words, the accuracy assessment isn't really independent. Consider just treating this section as a continuation of the discussion? Or move the first part (through line 464) into the discussion, and name Section 7 "Uncertainty Estimates" or something like that?

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Technical Corrections
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11. In general, there should be no hyphen in "wet season" when it's not used as a modifier. So remove it in line 12, in line 278, and in the caption to Figure 9. It's OK to keep it hyphenated at line 148 (modifying "water balance") and 486 (modifying "area loss"). Likewise, for "dry season", remove the hyphen when it's not being used as a modifier (e.g., remove it in line 277, but keep the hyphen in line 279).

12. The sentence extending from lines 78-79 is a bit garbled at the end ("or for Water volume estimates of desert lakes Armon et al. (2020)"). Perhaps the authors mean something like "...Xu et al., 2020), or for water volume estimates of desert lakes (Armon et al., 2020)."

13. Line 86: I would delete the word "within" ("... at the lake shores and the lake bed...")

14. Figure 1 caption: I would say "Orthoimage mosaic from UAV on 9/10 May 2019 [...] and on the days of the UAV flights ..." In general, the authors use "UAV" more frequently than "drone", and I would recommend being consistent in usage (replace other uses of "drone" with "UAV" or "drone survey" with "aerial survey" in lines 114, 460, and 461.

15. Line 106: Maybe replace "effluent" with "outlet"

16. Line 128: There is an unclosed parenthesis before "Section 4.2: GLDAS..."

17. Line 138 (last line on page 5): should be "were therefore also..."

18. Line 147: Add space in "dryseasons"

19. Line 180 and 182: "orthoimage"

20. Line 245: This sentence (starting with "Not" on the previous line) is rather confusingly worded. Consider something like this: "While individual dates' SEA values may represent noise, the longer-term trend in SEA values (dSEA, units mm/year) point to deposition and erosion processes."

21. Line 300: Add space in "wetseason"

22. Line 344: Replace "outfolw" with "outflow"

23. Lines 386 and 387: Use either "leads to" and "causes a" or "led to" and "caused a"

24. Line 492: "raise" not "rise"

25. Line 502: "finding" not "fining"