EGUSphere-2025-6128 – "Citizen science as a long-term environmental baseline: assessing impacts of a small dam removal in Montana, USA"

Response to Reviews

Responses in blue for edits made

Anonymous Referee #1

General Comments

The focus of this manuscript is to explore the effectiveness of working with citizen scientists to collect long-term environmental data with support from a project team, specifically focused on the impact of a small dam removal. In its current form, the manuscript does not clearly align with the stated aims and scope of the journal, it would be more appropriate elsewhere, or requires substantial reworking with major revisions at least.

1. The manuscript is presented as a citizen science focused project, yet there is actually very little detail on the citizen scientists themselves, including how they were recruited ethically, when they engaged with the project, how their engagement was distributed throughout time and perhaps most importantly whether they themselves benefited from the project.

This is a great point. We have added substantially to the information about recruitment (section 3.1) and from the citizen scientists (section 5) to address this important piece of missing information.

2. Building on the first point, the manuscript can be read as implicitly attributing data loss or quality issues to citizen scientists, which may be unintended. Careful use of language is required, especially when the authors are claiming that citizen scientists can collect useful data (a message which I agree with).

Thank you for pointing this out, we agree that the messaging is not what we intended. Our aim is to promote the value of citizen science and engagement of citizen scientists, we have rephrased appropriate parts of the manuscript to address this and clarify the message.

3. Much more detail is needed around the results - the methods section 3.1. is fantastic, lots of great detail but then only d50 and WAV are presented, and it is not clear why. Linked to this, the data analysis and result interpretation requires further detail, for example how were the error bars determined? Did you perform any statistical analysis regarding the difference between d50 at different locations?

The results presented in the original manuscript represent a small subset of the analyses completed. We have created new results figures that better show the data and have included all the other results in with the supplemental files.

4. The overall structure of the manuscript needs reworking, particularly ensuring that the correct text is placed in the correct location. Introductory text are presented in the discussion (e.g., L329-339), results are shown in L306-316 and L341-350 and so on.

We have substantially reorganized the manuscript thanks to the very helpful comments provided, paying special attention to ensuring that no introductory text appears in the discussion. The results the reviewer points out in lines 306-316 and 341-350 are not results, but rather context for the discussion (see comment below for L308-312). In the former, we state the discharge data from the nearest gaging station and for the latter we discuss limitations for data that could not be analyzed.

5. The supplementary data are lacking, with no clear readme file nor information regarding what the data relate to.

We agree that this was a major oversight, particularly the lack of readme file. We have generated a readme file and added several more files to the supplementary data in accordance with suggestions from both reviewers.

Line-by-line Comments

L27 "Both species" - what species are you referring to?

Thank you for pointing this out. We have fixed this to say: “species of fish and macroinvertebrates”.

L36 There are nine dams in the abstract, why are there now seven?

Thank you for catching this. Nine is the correct amount, and we have fixed this in the manuscript.

L53 "Local streams" - what are the size of these and location relevant to where the citizens are coming from?

For clarity, we have edited this statement: “Can citizen science projects effectively monitor wadeable streams local to their communities”

L60 By "above-dam levels" do you mean upstream of the dam?

Yes, and we have changed this to “upstream of the dam” for clarity.

L66 What about research outside of the US? Such as in central Europe on check dam removal?

We have added to the paragraph in section 2.1 to contextualize small dam removal within the global dam removal trend and situate our study within that context.

L78 9177 m is higher than Everest! Assume there is a typo here.

Thank you for catching this typo, the actual mean basin elevation is 1738 m and has been updated accordingly.

L88 Consider adding this information regarding the stream gauge to the Figure 1, alongside the actual data for the monitoring period as this will provide useful context for the rest of the manuscript.

We have edited Figure 1 to include all the upstream dams, the stream gages, and other additional relevant information.

L94 Seven dams again - please clarify whether this is correct or not and update the abstract accordingly.

Corrected as stated above (L36).

L105-114 "This paragraph is a little confusing and needs restructuring. At the moment, it is presented as: "citizen science is good for spatiotemporal scales, yet data quality is potentially not robust. Research has found it to be non robust enough, but this is like comparing apples to oranges, so citizen science data is robust."

I think this needs unpicking more as you can compare citizen science data to that collected as standard, by using the standard data as a reference point. While citizen science has demonstrated value in many contexts, it is important to clearly articulate where it is appropriate and where limitations exist.

Thank you for pointing this out, we agree that the messaging is not what we intended. Our aim is to promote the value of citizen science and engagement of citizen scientists, we have rephrased this paragraph (section 2.3).

L125 How were these hours distributed across the study period? Were they equal, or did more monitoring occur in 2018, for example. How did this effect your results? How many people were engaged and how many were the same over the monitoring period?

Thank you for these clarifying questions. We have added the monitoring hours from the study period to the manuscript (section 3.1) as well as the number of volunteers participating as citizen scientists.

L126-144 This information should all come in further up in my opinion when you are introducing the study site. This would then leave a dedicated section to discuss the citizen science objectives/protocol.

We agree, and have moved these paragraphs to the section on the geographic setting of Rattlesnake Creek.

L157 This sentence doesn't make sense, please clarify/revise.

We have revised this sentence as follows: “Stream Team has monitored Rattlesnake Creek from 2017 to 2024.”

L162-163 How were these sites identified? Why only two upstream but eight downstream?

Great question, we have added more detail to the manuscript in section 3.1 to explain the site selection process and limitations.

L171 More information is required regarding the width of the streams at the 10 monitoring sites, and why 20-50 intervals were chosen. Did you normalise the stream widths?

Stream widths were taken in 20-50 intervals to balance high resolution and moderate time in the field, as well as to make the math easier to ensure the correct intervals were used. Stream widths were not normalized as we were interested in comparisons between years, not sites. The sentence has been updated to read: “the width of the stream is divided into 20 to 50 intervals to balance resolution and time in the field, as well as allow for simple field calculations”

L230 "Winter season WEN" - this suggests that volunteers had different roles, please expand on this.

We have clarified the different roles by rephrasing: “During the winter season, after completion of the site visits, WEN volunteers entered the data”.

L230 Can you share the Excel sheet so that others with similar objectives can learn from your design?

Yes, that is an excellent idea. We have added an image of the sheet to the supplemental materials. WEN is open to sharing the Excel file with people who ask for it, so we have included that information as well.

L269-271 Why use the upstream sites as comparisons when you have three years of data before dam removal? This is the point of BACI. Furthermore, there might be changes upstream due to flow being no longer restricted.

Thank you for this question. You are correct that the point of BACI is to use data from before and after the event, which we did, but our phrasing was not clear. We have revised the explanation in the text accordingly to account for our study looking at data at impact sites and reference sites both before and after dam removal.

L273-274 What about the data before/after then as this would give greater detail into how the river responded to the dam removal?

Our phrasing was unclear originally and has been revised. Our analysis includes data before and after the dam removal, and from upstream and downstream of the dam site.

L275 How many observations? More detail required

We have added the number of observations to the figures.

L279 Why did you only calculate d50? If there are 100 measurements per sample site why not include the entire grain size distribution, including d16, d50 and d84 as stated in the methods?

We did calculate D_{16}, D_{50} and D_{84}, however, because there was no discernible trend, we chose to show D_{50} in the figure. We have made a new set of box plots that show the grain size distribution for upstream and downstream sites and have moved the D_{16}, D_{50} and D_{84} graphs into the supplemental data files.

L285 Figure 2 - I think that these figures would be better combined, showing the change throughout time based on the year. It is unclear where the error bars have originated from, why not use a percentile metric to calculate the 95% confidence intervals? See Eaton et al., 2019, ESurf, https://doi.org/10.5194/esurf-7-789-2019 for example.

We have included all the grain size data in the supplemental files and have presented the grain size distribution data as a box plot to show the data variability, lack of trend, and all grain sizes for all sites for all years. We think this way of presenting the data is much clearer and by including the rest of the data in the supplemental files, it is available for readers to review as well.

L289 Figure 3 - similar comment to Figure 2, I don't think separating the data in this way is additive, therefore please think about combining the plots. Also it's unclear how the error bars were calculated.

As with the grain size distribution data described above, we have made a box plot for the macroinvertebrates to present both datasets in a consistent manner.

L293-299 This paragraph would benefit from reframing, as it reads as if the citizen science data were effective in their collection, however a third of the data collected was not usable. Please consider how this is framed.

We agree, the framing of this paragraph unintentionally puts the citizen scientists at fault when it is the managers' responsibility to ensure that datasheets were complete before leaving the site. We have revised this section with an emphasis on the fact that the citizen scientists executed the protocol they were tasked with.

L301-305 This is not discussion as it doesn't link to the presented results as there was no significant change.

This is a great organizational point and we completely agree. This paragraph belongs in, and has been moved to, the results section.

L307 "sediment flow" - you have not reported measuring sediment flow, rather grain size distributions and WAV. Please reword.

We have rephrased using the more appropriate term “distribution” instead of “flow”.

L308-312 This is results rather than discussion, why isn't this presented earlier in the results section? It contains important information that has not been presented.

Since the citizen scientists did not measure discharge (these data come from the MDNRC gaging station), we did not include the discharge values in the results. These values are not site specific (we were unable to get site discharge without the cross section data), we used this downstream gauge for discussion context of the variability of discharge of the creek before and after dam removal.

L312 What irregular variation? More information is required.

Good point, we have rephrased this part of the Discussion to clarify that this is in reference to the irregularities in data collection arising from individual differences of the humans collecting the data.

L319-324 This is introduction to the area rather than discussion. Equally for the sluice gate statement, this should come earlier in the text.

We have added information about the recreation usage of the area in section 2.2. The sluice gates were already introduced in section 2.2 and discussed again in section 3.2 before they are mentioned again in the discussion section.

L329-334 This is not discussion, it is introduction. Secondly, the results presented don't back up these claims as there's no evidence to support them. It's also not what the focus of the manuscript currently is. If you have anecdotal stories/evidence that would be more effective.

We have added quotes from WEN volunteers as anecdotal evidence in the revision of the Discussion section.

L336-339 Again this is introduction, not discussion.

We have revised the introduction and discussion sections appropriately.

L341-350 This raises a quality control issue that has not been addressed - why was all of this potentially fantastic data not quality controlled or checked regularly?

That is a great question. As independent scientists working with data from the citizen science program at WEN, we had no control with respect to data quality control. Our conversations with WEN suggest that cross sections may not have been as high of a priority on Stream Team outings for early analysis, which may explain why this error on data collection sheets was not caught during earlier years. Earlier versions of the data entry sheets in the field did not have clear spots to record all the data (i.e. distance along the cross section). This is also one of our take home messages from this paper: citizen scientists do a great job on what they are instructed to do, but if they are not instructed to do something and/or if there are not places in datasheets to record data, citizen scientists likely will not know to collect those data.

Anonymous Referee #2

This paper is a useful exposition of the potential and challenges of using crowdsourcing techniques to gather a timeseries of scientific data over several years with changing teams. The information presented

is valuable, but requires more context, organization, analysis, visualization, and reflection to be useful to other readers of the journal.

We agree, and have addressed these concerns in our revision following the specific comments from the first reviewer.

CONTEXTUAL:

Dam removal is gaining traction primarily in the US and Europe in recent years. The authors note correctly that research on this is primarily on larger dams although smaller dams and barrages may be more common. Even in the larger dam cases, often little is known about the before and after timeseries of critical stream physical and ecosystem changes because of the dam removal. The case that is made here that in the smaller dams/barrages, it may be useful to have more citizen science use as they have shown in this case to do such analysis.

We agree!

The lack of any discernable changes in stream due to this small dam removal could perhaps be a function of not only the size of the dam, but also the hydrology (including intra and inter-annual variability), river and floodplain cross section, sediment load and characteristics, flora and fauna, history, and use trends in the area. The relative amount of live and dead storage in the dam that was removed is unclear and could have played a significant part in the results – since the live storage was already removed for this dam since 2012 when the gates were removed – so the changes in 2020 would just be the removal of the dead storage.

That makes sense.

The relative sizes of the 7 dams (major?) of which one was recently removed would be useful to indicate along with their locations. Even for the site of interest, some characteristics of the dam that was studied (even basics like a name/codename if any, height of sluices, live/dead storage, catchment area, inundation area on the map, rainfall, flows, original operations, etc.) and the characteristics of the u/s and d/s monitored areas (incl. some visualization of the cross sections and other information) would be useful to include. A timeline of the events on the dam would be a great graphic to include.

We have edited Figure 1 to include additional information including a timeline relevant to the dam, all the upstream wilderness dams and lakes, and the stream gages. We have also created a new figure for the supplemental information that includes photos of the stream monitoring methods.

Such approaches could actually also be useful to understand changes when dams are first constructed if there is a good baseline for a few years before the dam is constructed.

The description mentioned that one concern that may have led to dam removal was the spring fish migration problems during high flow – did this change after the full dam removal?

We have added to this part of section 2.2 to provide the information that is known from Trout Unlimited report regarding fish migration.

METHODS:

The primary thrust of the paper is to showcase how crowdsourcing methods could be standardized and used to collect useful information using simple tools and techniques. It does seem like these can not only be a great way to teach students and get them more connected to the nature around them, but also provide some data for insights even with the quality concerns.

A challenge indeed is that 3 years data on either side of a dam removal may not give enough time for the geomorphological and ecological processes to change and may just reflect the variability in the streamflows and sampling. The use of basic data quality management is also highlighted (e.g. missing data and not knowing which cross section measurement was from which site). The websites for sharing the data and code should be checked as they do not exist as included.

We have added to and edited the supplemental files, including the data and code, and new weblinks are provided with the revision.

The use of simple tools and simplified standard operating procedures and their description is useful. Some of these techniques may also be modernized over time – e.g. writing on paper pads in such an environment and then digitizing into spreadsheets for analysis can perhaps be replaced by using smartphone tools (online spreadsheets or even simple apps that can have built-in error checking upon entry and also record locations, etc.). Simple probes/sensors that are getting increasingly cheaper could be utilized. Some of the lidar scanners built into some smartphones and tablets could also be great for cross sections that seems to have been a weak spot in this analysis due to unusable data from traditional methods.

WEN did start using an app and tablets to record field data the year after our analysis, which was designed to ensure all data was collected in the field (users cannot click off a page until all fields are completed). We have added this information in the conclusions and future work section of the manuscript.

Overall, it looks like this study can provide pointers for both what to do and certainly on what not to do in the case of crowdsourcing such data. It also points to perhaps moving towards a more standardized approach ensuring better data quality that can provide crowdsourced harmonized data for every stream based on the work of nearby educational institutions that facilitate crowdsourcing. This could provide a great way to just look at stream physical and ecological changes over time whether dams are involved or not. It may be useful to also explore strengthening some national knowledge network for crowdsourced stream monitoring that can also develop simple online ways to organizing, analyzing, visualizing, and disseminating these kinds of open-source data for open science. This may be a great approach to be further adapted to encourage open science especially for the developing world where even less is often known about local streams or rivers.

Thank you! We completely agree and we very much hope that this paper can serve as a guideline for other citizen science monitoring projects