PLOS CLIMATE

OPINION

Bridge over changing waters–Citizen science for detecting the impacts of climate change on water

Jan Seibert[1,2]*, **H. J. (Ilja) van Meerveld**[1]

1 Department of Geography, University of Zurich, Zurich, Switzerland, **2** Department of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, Uppsala, Sweden

* jan.seibert@geo.uzh.ch

OPEN ACCESS

Citation: Seibert J, van Meerveld HJ(Ilja) (2022) Bridge over changing waters–Citizen science for detecting the impacts of climate change on water. PLOS Clim 1(11): e0000088. https://doi.org/10.1371/journal.pclm.0000088

Editor: Jamie Males, PLOS Climate, UNITED KINGDOM

Published: November 1, 2022

Funding: This work has been financed by the University of Zurich and support of the Swiss National Science Foundation (SNSF) to the CrowdWater project (Recipients: JS and HJVM). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

Citizen scientists have documented the impacts of climate change by reporting the timing of the cherry blossom [1], the abundance of bird species [2], or the length of flowing streams and stream habitat connectivity [3]. Citizen scientists are also digitizing hand-written observations from the past (e.g., from ship logs or weather data) and are, thus, making these old measurements available to assess climate change. Most of the older observations were not started to document the impacts of climate-change but turn out to be highly informative because they were recorded over a long period. An example from Sweden is the recording of the presence of ice in the harbor of Västerås for transportation planning, which now provides an originally unintended record of changing conditions since 1712 [4].

Hydrology, as a data-limited science, can benefit from new observations or measurements taken by citizen scientists as well [5]. Citizen science data can complement the measurements taken by official agencies and provide valuable spatially distributed data. There is a growing number of water-related citizen science projects, such as CrowdHydrology [6], RinkWatch [7], CoCoRaSH (https://www.cocorahs.org/), Stream Tracker [8] and CrowdWater (https://crowdwater.ch). However, the time series from most projects are still rather short. Here we highlight the potential of citizen science approaches to detect and quantify water-related climate change impacts.

Engaging the help of the public can be useful to obtain a better spatial overage of observations. As water-related climate change impacts will vary and depend on geographic and hydroclimatic conditions, this spatial coverage can be crucial to derive patterns of these changes and increase confidence in the observed trends. But there are various other advantages to using citizen science to document changes as well. People may remember the past, but this memory is likely incomplete and affected by biases. We tend to remember exceptional situations better than usual conditions. For example, we remember the exciting winter days with snow and sun from our childhood better than the grey days without snow. As a result, we may overestimate the number of days in our childhood when it was possible to go sledding or play outdoor ice hockey [9]. Another issue is the shifting baseline syndrome [10,11]. The social perception of the environment changes and adapts to a changing normal. In other words, what we consider as normal now is not the same as for the previous or next generation. This means that we may not notice that typical temperatures or low streamflow conditions are changing, nor that the frequency or magnitude of extreme events is changing. The structured form of citizen science projects is a good way to avoid issues related to memory biases because it provides written documentation, sometimes supported by photographs. Citizen science projects can also motivate people to observe their surroundings more carefully and to look at things that they would otherwise not observe. Citizen science project may, for example, make people more aware of the changing flow state of small streams. Finally, citizen science projects raise awareness about the environment and how climate change affects it [12].

In addition to the direct use of citizen science observations to document changes in the environment, these data are also useful for model calibration and testing. Model simulations of water-related variables are becoming increasingly important because, due to climate change, historical data is less useful as a guide to the future than it was in the past [13]. We may, for instance, prefer to use models to estimate flood probabilities than to base them on estimates from historical time series. In most cases, shorter observation periods are needed to use data for model calibration and testing than for trend analyses. In other words, a few observations can already be informative [e.g., 14,15].

Obviously, it will take a while before long time series are available for new citizen science projects. This is a problem for any type of new measurement and the argument 'we should have started 20 years ago' should not hinder us from starting new measurements or recording observations today. For variables that can easily be observed by the public, such as the presence of water in temporary streams, snow or ice cover, we suggest that citizen science observations should be expanded as soon as possible. Because the projects will need to run long enough to collect sufficient data for trend analyses, a low level of sustained funding and low cost approaches are required for these projects. When starting new projects, one also has to be realistic and recognize the difference in motivation for variables related to topics that people have special interests in (e.g., flowers, birds, ice or snow) and variables where this intrinsic motivation is missing and more efforts are needed to recruit citizens. Sometimes it might be possible to find interesting proxies. People may, for instance, be more motivated to record when they were able to skate or play pond hockey than to record the average winter temperatures. For variables with less personal interests, the motivation can be raised by highlighting the use (and value) of the data. Another strategy may be to focus on the recruitment of 'forced volunteers', i.e., people who report observations as part of their regular job or education. Many variables can easily be observed with low additional cost by, for instance, technicians who travel to the field anyway. For example water level or temporary stream observations can be recorded by technicians on their way to a gauging station or monitoring sites for water quality or ecological assessments.

To conclude, there is great potential in combining traditional scientific methods with citizen science approaches to study water-related climate change impacts. Given the urgency for society to address these significant impacts, it is time to utilize this potential more fully, to strengthen ongoing efforts, and to be creative in developing new citizen science approaches for water-related observations.

References

1. Christidis N, Aono Y, Stott PA. Human influence increases the likelihood of extremely early cherry tree flowering in Kyoto. Environ Res Lett. 2022; 17. https://doi.org/10.1088/1748-9326/ac6bb4
2. Saunders SP, Meehan TD, Michel NL, Bateman BL, DeLuca W, Deppe JL, et al. Unraveling a century of global change impacts on winter bird distributions in the eastern United States. Glob Chang Biol. 2022; 28: 2221–2235. https://doi.org/10.1111/gcb.16063 PMID: 35060249
3. Allen DC, Kopp DA, Costigan KH, Datry T, Hugueny B, Turner DS, et al. Citizen scientists document long-term streamflow declines in intermittent rivers of the desert southwest, USA. Freshw Sci. 2019; 38: 244–256. https://doi.org/10.1086/701483
4. Eklund A. Isläggning och islossning (Freezing and melting of ice in Swedish lakes; in Swedish). SMHI Hydrologi rapport nr. 81, Norrköping, Sweden; 1999.

5. Nardi F., Cudennec C., Abrate T., Allouch C., Annis A., Herman Assumpção T., et al, 2020. Citizens AND HYdrology (CANDHY): conceptualizing a transdisciplinary framework for citizen science addressing hydrological challenges. Hydrol. Sci. J., https://doi.org/10.1080/02626667.2020.1849707
6. Lowry CS, Fienen MN. CrowdHydrology: Crowdsourcing Hydrologic Data and Engaging Citizen Scientists. Ground Water. 2013; 51: 151–156. https://doi.org/10.1111/j.1745-6584.2012.00956.x PMID: 22716075
7. Malik K, McLeman R, Robertson C, Lawrence H. Reconstruction of past backyard skating seasons in the Original Six NHL cities from citizen science data. Can Geogr. 2020; 64: 564–575. https://doi.org/10.1111/cag.12640
8. Kampf S, Strobl B, Hammond J, Annenberg A, Etter S, Martin C, et al. Testing the waters: Mobile apps for crowdsourced streamflow data. Eos (Washington DC). 2018; 99. https://doi.org/10.1029/2018EO096355
9. Hall A, Endfield G. Snow scenes": Exploring the role of memory and place in commemorating extreme winters. Weather Clim Soc. 2016; 8: 5–19. https://doi.org/10.1175/WCAS-D-15-0028.1
10. Pauly D. Anecdotes and the shifting baseline syndrome of fisheries. Trends Ecol Evol. 1995; 10: 430. https://doi.org/10.1016/s0169-5347(00)89171-5 PMID: 21237093
11. Soga M, Gaston KJ. Shifting baseline syndrome: causes, consequences, and implications. Front Ecol Environ. 2018; 16: 222–230. https://doi.org/10.1002/fee.1794
12. Mitchell N, Triska M, Liberatore A, Ashcroft L, Weatherill R, Longnecker N. Benefits and challenges of incorporating citizen science into university education. PLoS One. 2017; 12: 1–15. https://doi.org/10.1371/journal.pone.0186285 PMID: 29091933
13. Milly PCD, Betancourt J, Falkenmark M, Hirsch RM, Zbigniew W, Lettenmaier DP, et al. Stationarity Is Dead: Whither Water Management? 2008; 573–574.
14. Etter S, Strobl B, Seibert J, van Meerveld I, Ilja Van Meerveld HJ, van Meerveld I. Value of uncertain streamflow observations for hydrological modelling. Hydrol Earth Syst Sci. 2018; 22: 5243–5257. https://doi.org/10.5194/hess-2018-355
15. Crumley RL, Hill DF, Wikstrom Jones K, Wolken GJ, Arendt AA, Aragon CM, et al. Assimilation of citizen science data in snowpack modeling using a new snow data set: Community Snow Observations. Hydrol Earth Syst Sci. 2021; 25: 4651–4680. https://doi.org/10.5194/hess-25-4651-2021