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Rescuing Climate Data as a Scientific and Communication Bridge

Citizen science is a broad term, but here I will use it to describe nonprofessional or nonworking scientists taking part in scientific endeavors. Citizen science (using this definition) has been a key component of science for several centuries, but has undergone a resurgence in the last decade or so to become a valuable component of many mainstream research activities.[1] Not only does citizen science make it possible to conduct an investigation well beyond the capabilities of a small research team, it also gives people who do not conduct research in their regular jobs a chance to connect with and feel a sense of ownership of the scientific process and its outcomes.

One form of citizen science in the climate sphere is the rescuing of historical documents and weather observations to improve understanding of past climate variability. Although not as active as recording the weather in the backyard, these "data rescue" projects connect the public with climate research, including retired or remote members of the community who may feel disconnected from mainstream science.

In this essay, I argue that citizen science projects to rescue historical weather observations are an ally of climate communication. Despite Walsh's suggestion (Walsh, this issue, p. 17) of citizen scientists being "free labor" and the potential contradiction associated with exploring the past in order to face a problem of the present and future, I suggest that recovering historical weather data offers a pathway for communication between citizens and researchers that respects the past experience of citizens. Connecting with the weather of the past—and the personalities behind historical observations—provides an accessible way to develop a relationship with climate science and its intricacies.

The Value of the Past

Churchill's famous quote posits that "the longer you can look back, the further you can look forward." This is especially true for climate science. Understanding past climate variability is crucial for separating the natural behavior of our atmospheres and oceans from what is human-induced.

1 Rick Bonney, Jennifer L. Shirk, Tina B. Phillips, Andrea Wiggins, Heidi L. Ballard, Abraham J. Miller-Rushing, and Julia K. Parrish, "Citizen Science: Next Steps for Citizen Science," *Science* 343, no. 6178 (2014): 1436–37, https://doi.org/10.1126/science.1251554.

The primary source of information about regional and global climate is instrumental weather observations. These are our ground truth, the most accurate representations of the atmosphere we have. Most national climate datasets, however, only begin around the start of the twentieth century, and from the mid-twentieth century in many developing countries.[2]

There are many more sources of weather data available from before this time. Colonial observational networks, astronomers, doctors, farmers, and "gentlemen scientists" (the original citizen scientists) have been keeping weather diaries for decades, even centuries.[3] These observations have the potential to put current climate variability in a much longer and more accurate context than is currently possible, but are all too often consigned to archives, lost in a sea of boxes and microfiche. This is particularly the case for observations taken in regional and remote areas of the world, as the focus of past data rescue activities has largely been in capital cities.[4] It would take many scientific lifetimes to find all of these climate treasures, and many more to bring the precious numbers from dusty pages to modern databases.

Many Hands Make for Better Digging

With the help of citizen science, the painstaking work of finding and rescuing weather observations is slowly happening. Whether they are the logbooks of sailors, farmers' diaries, observatory records, or newspaper reports, the scientific community is clamoring for them to be recovered, and begging people to be a part of the recovery effort.[5]

2 Manola Brunet and Phil Jones, "Data Rescue Initiatives: Bringing Historical Climate Data into the 21st Century," *Climate Research* 47, no. 1 (2011): 29–40, https://doi.org/10.3354/cr00960.

3 Georgina H. Endfield and Carol Morris, "Exploring the Role of the Amateur in the Production and Circulation of Meteorological Knowledge," *Climatic Change* 113, no. 1 (2011): 69–89, https://doi.org/10.1007/s10584-012-0415-7.

4 See, for example, Linden Ashcroft, Joëlle Gergis, and David John Karoly, "A Historical Climate Dataset for Southeastern Australia, 1788–1859," *Geoscience Data Journal* 1, no. (2014): 158–78, https://doi.org/10.1002/gdj3.19; David E. Parker, Tim P. Legg, and Chris K. Folland, "A New Daily Central England Temperature Series, 1772–1991," *International Journal of Climatology* 12, no. 4 (1992): 317–42, https://doi.org/10.1002/joc.3370120402; and Victoria C. Slonosky, "Wet Winters, Dry Summers? Three Centuries of Precipitation Data from Paris," *Geophysical Research Letters* 29, no. 19 (2002): 34-1–34-4, https://doi.org/10.1029/2001GL014302.

5 P. W Thorne, R. J. Allan, L. Ashcroft, P. Brohan, R. J. H. Dunn, M. J. Menne, P. R. Pearce, et al., "Toward an Integrated Set of Surface Meteorological Observations for Climate Science and Applications," *Bulletin of the American Meteorological Society* 98, (2017): 2689–2702, https://doi.org/10.1175/BAMS-D-16-0165.1; Alexandra Eveleigh, Charlene Jennett, Stuart Lynn, and Anna L. Cox, "'I Want to Be a Captain! I Want to Be a Captain!': Gamification in the Old Weather Citizen Science Project," *Gamification '13 Proceedings of the First International Conference on Gameful Design, Research, and Applications*, (2013): 79–82, https://doi.org/10.1145/2583008.2583019.

The typical structure of a citizen science project is that professional scientists coordinate an activity, under the umbrella of a larger research project. Having professional scientists organize the project this way ensures that the methodology is rigorous[6] and that the questions being asked are connected to current leading edges of scientific research. Connecting the activities with a larger project is also motivating for many, and makes people feel like they are contributing to the public good.[7]

There are many citizen science projects that don't fit this typical structure, and climate data rescue projects are no exception. Some are global in nature, calling on participants to follow ships across the oceans and recover the weather records taken onboard through sophisticated online interfaces.[8] Others are smaller in scale, with Excel spreadsheets and Dropbox links being emailed back and forth between a handful of team members.[9]

The climate data rescue projects I am involved in do include professional scientists, but they are often just consultants, advisers in what are really volunteer-led initiatives. The projects are coordinated by volunteer groups and typically led by retired professionals from a range of backgrounds. They are the ones who have found the data, and embarked on a journey to recover a slice of history. Engaging professional scientists is in some ways an afterthought, to see if their work would be useful to anyone else.

The Benefits of Connecting to the Past

These kinds of rescue activities connect people with data— the basis of so much climate science. Rescuing historical observations shows people how complicated it can be to work with the raw instrumental record. Handwriting that is hard to read, along with changes in units, instruments, formats, and variables, are all common obstacles in data rescue efforts.[10] Not only that, but recovering the weather records of a farmer, explorer, or notable personality may make those in nearby communities appreciate that observa-

6 See, for example, World Meteorological Organization, "Guidelines on Best Practices for Climate Data Rescue 2016," https://library.wmo.int/opac/doc_num.php?explnum_id=3318.
7 Carol Morris and Georgina Endfield, "Exploring Contemporary Amateur Meteorology through an Historical Lens," *Weather* 67, no. 1 (2012): 4–8, https://doi.org/10.1002/wea.800.
8 For example, Eveleigh et al., "'I Want to Be a Captain!'"
9 Linden Ashcroft, Rob Allan, Howard Bridgman, Joëlle Gergis, Christa Pudmenzky, and Ken Thornton, "Current Climate Data Rescue Activities in Australia," *Advances in Atmospheric Sciences* 33, no. 12 (2016): 1323–24. https://doi.org/10.1007/s00376-016-6189-5.
10 S. Brönnimann, J. Annis, W. Dann, T. Ewen, A. N. Grant, T. Griesser, S. Krähenmann, C. Mohr, M. Scherer, and C. Vogler, "A Guide for Digitising Manuscript Climate Data," *Climate of the Past* 2, no. 2 (2006): 137–44, https://doi.org/10.5194/cp-2-137-2006.

tions made by people on the land are important, leading to an empowering sense of connection with the science being undertaken.

In turn, citizen science activities that connect people with historical data may offer a way to build a personal sense of ownership of modern climate-change research. Getting "up close and personal" with one of the many different sources that contribute to climate science can only improve engagement with the field, particularly if one is familiar with the history or the geographical region represented by the data.

A Conversation between Local and Professional Knowledge

The idea of becoming immersed in the weather of the past may seem like a great way to learn firsthand how much things have already changed. However, while rescuing old data is valuable, the process of transcribing observations from page to screen can be tedious and far removed from the weather outside. Climate change is not a linear beast either; there were hot days in the past too. The location of historical instruments, particularly thermometers, has often been suboptimal, and can lead to temperature recordings that are anomalously high or low. Untangling the impact of historical instrument placement on a measurement is a fundamental part of tracing the fingerprint of climate change, and is not a trivial task.[11] This process can, however, cause people to claim that data manipulation has occurred if it is not communicated clearly.

The fact that temperature observations were taken in Fahrenheit until relatively recently can also make things more confusing outside the US when comparing past to present, as people have to convert values from Fahrenheit to Celsius. However, historical mentions of snowfall in an area where snowfall no longer occurs can be a powerful emotional discovery as well as a scientific one.

Finally, if these activities, whether led by volunteers or by professional scientists, occur without engaging outside of their own community, then opportunities are lost for building positive change. A historical group in regional Australia, for example, might transcribe an entire weather diary and share it with their community. It would likely be a boon for the town to uncover this slice of history and science, and an enjoyable exercise

11 Blair Trewin, "Exposure, Instrumentation, and Observing Practice Effects on Land Temperature Measurements," *Wiley Interdisciplinary Reviews: Climate Change* 1, no. 4 (2010): 490–506, https://doi.org/10.1002/wcc.46.

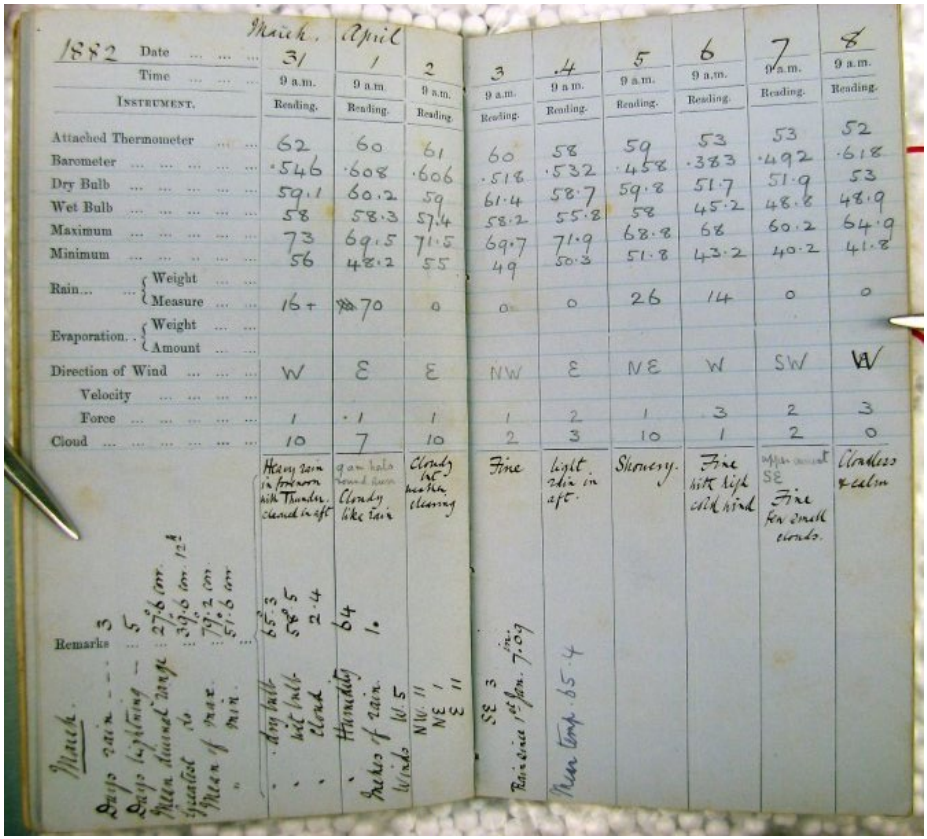

Figure 1:
Page from the journal of Algernon Henry Belfield, a grazier from New South Wales who diligently recorded the weather at his farm near Armidale from 1877 until shortly before he died in 1922. His diaries were donated to research by his descendants, and the digitization and study of this valuable set of observations has been primarily conducted by volunteers, or citizen scientists. Image source: Cultural Collections, The University of Newcastle.

for the volunteers involved. However, including historical climate experts in the team would open up many more doors for sharing knowledge in both directions, enriching scientific research while enabling the community to have a true sense of ownership of the study of climate in their town. Similarly, a scientist setting up an online data rescue portal without close and regular contact with those who are engaging with the data is not a successful enterprise from a scientific or communication point of view.

Conclusions

Citizen science activities offer a way for the public and academia to work together. As Walsh's argument suggests (Walsh, this issue), a successful citizen science endeavor is one where both the professional scientist and citizen scientist respect and learn from each other. I posit that weather data rescue activities have great potential to fit this definition. Communication between professional scientists and those actively seeking to recover historical information leads to greater scientific and historical discoveries, an increased mutual respect between citizens and the scientific community, and a chance for citizens to feel ownership of the research being conducted on a small and large scale. It is the combined work of both sets of "experts" that will result in the greatest benefits for knowledge and society.

Further reading

Ashcroft, Linden, Rob Allan, Howard Bridgman, Joëlle Gergis, Christa Pudmenzky, and Ken Thornton. "Current Climate Data Rescue Activities in Australia." *Advances in Atmospheric Sciences* 33, no. 12. (2016): 1323–24. https://doi.org/10.1007/s00376-016-6189-5.

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