Crowdsourcing Climate Data

Multistate Research and Extension Project Coordinates Volunteer Weather Observer Networks

By Sara Delheimer

PRECIPITATION MONITORING

In 1997, a storm hit the city of Fort Collins, Colorado. While some parts of town had modest rainfall, other areas experienced more than one foot of rain over several hours. Five people died in the resulting flash flood, and floodwaters caused an estimated $200 million in damages (Colorado State University, 2012). Events like this are becoming more common. The recent floods in Texas and water restrictions in California due to widespread drought are reminders that precipitation fluctuations and extremes have serious impacts.

Despite advances in tracking precipitation with satellites and radar, on-the-ground measurements are still needed to report and map precipitation. Historical and real-time precipitation data are used every day to help communities prepare for and respond to weather. City planners and engineers rely on precipitation data to design better infrastructure like storm drains, roofs, and bridges. Farmers use past rainfall amounts to choose growing practices, and water providers reference daily precipitation observations to assess supplies for agricultural, industrial, and municipal uses (Doesken & Reges, 2010).

Although the National Weather Service (NWS) maintains one official weather station approximately every 25 miles (NOAA, 2013), the extreme variability of precipitation begs even denser data. To cover more ground and gather more data, weather monitoring programs have tapped into a deep pool of manpower, enlisting volunteers of all ages and backgrounds to record observations right in their backyards. However, counting on citizens to collect data comes with challenges, such as recruiting and retaining regular volunteers and training them to take accurate measurements.

THE MULTISTATE APPROACH

In 2008, scientists and educators from 17 universities and a handful of federal agencies joined forces to improve volunteer weather observer networks. This project, "WERA-1012: Managing and Utilizing Precipitation Observations from Volunteer Networks," is supported in part by USDA-NIFA through the Multistate Research Fund, a national program created to facilitate collaboration on priority issues that no state could address singularly (Doesken et al., 2008). The multistate framework offers a powerful, formal way to leverage additional funds and share resources, enabling project members to conduct innovative research and extend creative, research-based solutions.

From its onset, WERA-1012 has worked primarily with the NWS Cooperative Observer Network (COOP) and the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS). For 125 years, COOP volunteers (based at 8,700 stations) have taken daily climate measurements, providing valuable baseline data for climate modelling (NOAA, 2014). CoCoRaHS volunteers use simpler tools and take fewer measurements, but with more than 19,000 volunteers (Rolston, 2014), the network offers granularity that would not be available otherwise.

RESEARCH AND EXTENSION PROJECT HELPS IMPROVE VOLUNTEER NETWORKS

The WERA-1012 group set out with a long list of issues to tackle, but coordination has made it possible to divide and conquer the necessary work. For example, WERA-1012 researchers in Illinois and South Dakota lead the way in data quality control, while North Dakota is a major hub for training resources (N. Doesken and H. Reges, personal communication, July 30, 2015). These and other subcommittees come together as a cohesive team to generate consensus about the strategies and tools volunteer networks should adopt.

To boost network numbers, the WERA-1012 recruitment subcommittee designed new tactics to attract volunteers, including partnerships with school science programs, media announcements, and recruitment blitzes and contests. Since implementing these new tactics and partnerships, the number of CoCoRaHS volunteers has jumped to almost 20,000, and more than 900 schools have gotten involved (Doesken et al., 2011). Including K-12 schools in the volunteer networks gives students a hands-on opportunity to analyze weather data, use statistical methods, and see real data displayed. Participating in volunteer weather monitoring networks also helps schools meet science, math, and geography standards while teaching the value of community service.

The recruitment subcommittee continues to explore new ways to engage minority and rural populations and encourage regular observations. Recently, WERA-1012 designed a mobile phone app for data entry. The app has enticed young and rural volunteers and has opened the door to volunteers without regular access to a computer or the Internet. French and Spanish versions of the app are being produced to accommodate network expansion to Canada, Puerto Rico, and the Bahamas (Doesken et al., 2013, 2015). Successful expansion is vital to the success of volunteer weather observer networks; more volunteers means broader networks that produce denser data to fill in critical gaps in climate monitoring.

Working as a multistate team has also made it easier to develop and disseminate training materials for diverse, growing networks. Seeking alternatives to in-person workshops and handouts, WERA-1012 developed new online training materials. Online materials are less costly, less labor intensive, easier to update, and more convenient for volunteers. The training subcommittee also replaced older training slide shows with short animated videos that better illustrate complicated scenarios, such as measuring trace amounts of precipitation or large snow cores. Archived on the CoCoRaHS YouTube channel, these videos have higher viewership than the former slide slows. Once a month, WERA-1012 hosts an educational webinar. Webinars give volunteers the opportunity for more in-depth training and a chance to interact with scientists and ask questions. On average, 175 people sign up to take part in each webinar (Doesken et al., 2013). Using these creative, comprehensive, and cost-effective training materials across different networks is making volunteer data more reliable.

In order for volunteer observations to be useful, they must align with state, national, and international quality standards. To bring volunteer measurements up to par, WERA-1012 has issued new protocols for data collection and entry. For example, many volunteer networks now use the same durable, reliable manual rain gauge to collect precipitation. Volunteer networks have also transitioned to paperless systems, streamlining data entry and processing and delivering data faster and with fewer errors (Doesken et al., 2013, 2015).

To further minimize data entry errors, members of the WERA-1012 quality control subcommittee developed software that can flag reports, file tickets for suspicious values, and assign these tickets to the appropriate coordinators for resolution. WERA-1012 also coordinated the compilation and distribution of "Quality Control Tips of the Week" and created a more user-friendly data entry screen for the CoCoRaHS website (Doesken et al., 2011).

As more volunteer networks implement standardized data collection, entry, and quality control methods,

data from different networks can be integrated. For example, because CoCoRaHS now uses the same quality control measures, COOP, the Applied Climate Information System, and NOAA's National Climatic Data Center now incorporate its data (Doesken et al., 2013). Much like boosting the number of volunteers, combining data from different networks makes precipitation data richer and more powerful for those who use it.

IMPLICATIONS

Volunteer weather observer networks provide an invaluable source of data at a low cost, making them an essential component of long-term climate monitoring. As the data produced by volunteer networks improves, more users rely on their data, making these networks more valuable than ever.

Every day, data from both COOP and CoCoRaHS help the National Weather Service issue and verify severe weather watches, warnings, and other special weather statements to give local residents enough time to reach safety (Doesken and Reges, 2010). Combining the networks' datasets also helps scientists analyze significant weather events after they have occurred in order to boost community expectations and preparedness for similar events in the future.

The National Drought Mitigation Center and the U.S. Drought Monitor now routinely use volunteer weather observations to enhance drought depictions and direct water conservation efforts. NOAA's River Forecast Centers also gather daily precipitation data from across the country to predict river water levels and flow rates and assess local water supplies, river navigation, and hydropower production (Colorado Climate Center, 2014a).

Because rainfall measurements from volunteer networks are highly localized, farmers use this data to decide when to plant, fertilize, irrigate, and harvest their crops. Data from nearby volunteer stations can also help farmers anticipate pest outbreaks. Ranchers use the data to evaluate grazing conditions and steer clear of potential weather-related stressors to animals, like flash floods and high temperatures (Doesken and Reges, 2010). Being able to avoid weather-related losses and predict weather-related changes in market prices helps farmers and ranchers run sustainable operations and maintain a steady food supply for a booming world population.

After participating in WERA-1012 workshops, the Federal Emergency Management Agency now has policies for using volunteer data to verify snow disaster declarations (Colorado Climate Center, 2014b). The USDA Risk Management Agency often references volunteer observations to administer federal crop insurance for weather-related damage. Weather can vary dramatically from one side of the street to the other, and using close-set volunteer observations to refine insurance and emergency relief administration could save tens of millions of dollars by helping to identify fraudulent claims.

Over the last seven years, WERA-1012 support and coordination has steered volunteer weather observer networks towards a sustainable future. The continued success of the project and the networks demonstrates the value of collaboration and the importance of championing both technical advances and human resources. Renewed through 2018, WERA-1012 will continue to leverage new funding sources, technologies, and ideas to improve volunteer weather observer networks, painting a vivid picture of the nation's remarkable weather.

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