4.1 COCO RAHS (COMMUNITY COLLABORATIVE RAIN AND HAIL STUDY) – OBSERVING THE WATER CYCLE IN YOUR OWN COMMUNITY

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1. INTRODUCTION

Precipitation is the most visible, the most talked about, and the most easily measured component of the water cycle. There is no evaporation or transpiration unless there has first been precipitation to provide surface water and soil moisture. There is no runoff, unless precipitation falls. Precipitation, and its curious variability, has direct impacts on our lives and our livelihoods. The watering of our earth by transient clouds and storm systems is something we understand scientifically but is a curious yet beautiful mystery for each young mind willing to contemplate it. Even those of us with older minds, who for many years have observed the water cycle in constant motion, are still amazed.

A thunderstorm just west of Akron, Colorado along U.S. Highway 34 in August 2001. The storm was dumping 1/4 inch hail stones. The bright spot in the image is the sun reflecting off the rain/hail shaft. Photo by CoCo RaHS volunteer.

CoCo RaHS, the Community Collaborative Rain and Hail Study, is a science education project begun in northern Colorado in 1998. Its central focus is the daily measurement of rainfall, snow and hail by large numbers of willing volunteers. CoCo RaHS provides important information about local precipitation to scientists and resource managers while also creating learning opportunities for volunteer participants. It is a simple approach to exploring the water cycle locally.

2. THE HISTORY OF COCO RAHS

CoCo RaHS is the product of adversity. A serious flash flood struck Fort Collins on a July evening in 1997 caused by the heaviest rain ever documented over an urban area in Colorado (Doesken and McKee, 1997). A total of 368 mm (14.5 inches) of rain fell in a little over 24 hours over the highest part of the city with the majority falling in a few hours. This water, helped by gravity, flooded neighborhoods and businesses and surged across the campus of Colorado State University. It washed out roads and derailed a train. As floodwaters peaked, 5 people lost their lives and at least $200 million of damage was left behind.

I live in a part of town hard hit by the flood. Three hours before the worst damage was done and the lives were lost, I walked outside in the storm with my family – soaked to the skin, yet marveling at rising water and the warmth of the rain. (Most Colorado summer rains feel cold – this tipped me off that this was an unusual storm.) By coincidence, at work at the Colorado Climate Center we had just completed a two year project for the State Engineer's Office documenting the worst floods and extreme rains in state history (McKee and Doesken, 1997). This project was conducted to provide essential information to guide plans and policies within the state's Dam Safety Division to assure that structures under their control were built and maintained for the safety and security of Colorado citizens. I had just studied and documented all known flood-producing storms in Colorado. I knew, even without measuring, that we were experiencing one of the storms that engineers and planners would reckon with for years to come. I knew it, but the only people I told were my family. I assumed, like so many others, that in our high-tech electronic information age that everyone knew what a terrible storm we were having so that warnings would be issued and people would take action. I was wrong.

In the weeks that followed, the Colorado Climate Center was responsible for documenting and mapping the rainfall responsible for that flood. It took weeks of surveying, but eventually hundreds of rainfall estimates were gathered, many coming form backyard weather stations. Accuracy of these rainfall reports was sometimes questionable, and many people near the core of the storm using typical low-cost rain gauges could only tell me their gauges were full to the top. Nevertheless, a clear picture of the storm emerged. (Petersen et al., 1999)

We won't go into the details here except to say that the core of heavy rain responsible for most of the damage was only a few square kilometers in area, and the cloud mass that produced it was not impressive when viewed from satellite.

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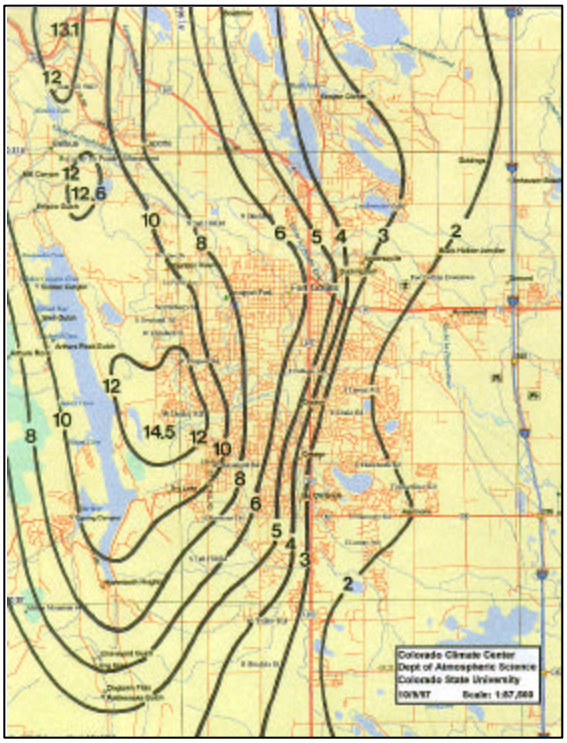


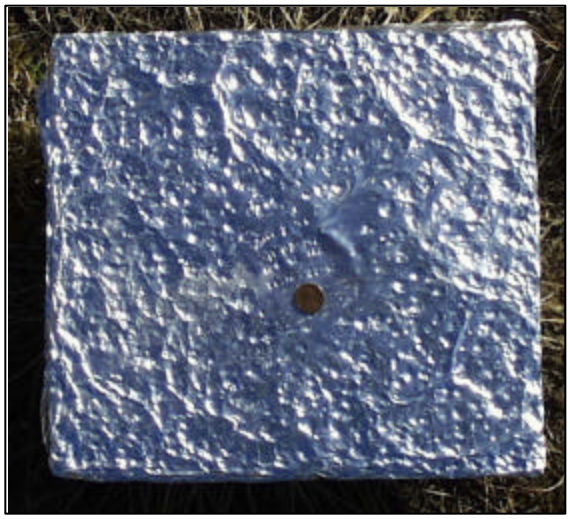
Rainfall (inches) for Fort Collins, Colorado, for 4:00 pm MDT, July 27, 1997 through 11:00 pm MDT for July 28, 1997.

What was impressive was the interest of the local residents to help us study the storm. More than 300 local residents provided data that we used in the research. The result was the most comprehensive local-scale storm analysis ever performed in Colorado.

Before the storm hit, we already had a high school student helping us test the feasibility of utilizing K-12 students to help measure hail stones. The flood changed our priorities to also include local rainfall measurements. It also strengthened our resolve to involve people of all ages – as many as possible. We became committed to starting CoCo RaHS come drought or high water. Both have come, and CoCo RaHS has been launched.

3. COCO RAHS – FIVE YEARS AFTER

The fifth anniversary of the Fort Collins flood has now come and gone. CoCo RaHS continues to grow steadily each year. That first year, the local Fort Collins storm water utility and the Colorado Office of Emergency Management provided seed money that allowed us to hire three local high school students. In a matter of weeks in the spring of 1998 one student developed the CoCo RaHS webpage. A second student learned C++ and began writing computer programs to process, summarize and map daily rain and hail reports from CoCo RaHS volunteers. A third student began recruiting student and adult volunteers, scheduled training sessions and prepared training materials to help teach the basics of installing rain gauges and hail pads and accurately measuring and reporting precipitation. Hail pads, styrofoam covered by extra-heavy-duty aluminum foil, are the low-cost devices used in CoCo RaHS for measuring the number and size of hail stones. While the pads don't tell you the time or duration of the storm, they are extremely effective in documenting hail stone characteristics.



A damaged hail pad shortly after a hail storm. Note the penny in the middle to relate size of hail stones. Photo by Richard Conn.

All participants are asked to use the same type of rain gauge. The 102 mm (4-inch) diameter precipitation gauge can be used for measuring rain or snow (remove funnel and inner tube for operation in cold climates).

Nolan Doesken holding the 4-inch plastic all-weather raingauge and explaining how to read the gauge to a group of school children on tour at the Fort Collins campus weather station. Photo by Chris Moore.

The first data were collected and mapped on June 17, 1998 with more than 50 rainfall reports submitted, all in Larimer County and most from within the city of Fort Collins. All data collected since the project began can all be easily retrieved via the CoCo RaHS webpage at http://www.cocorahs.com

4. NATIONAL SCIENCE FOUNDATION SUPPORT

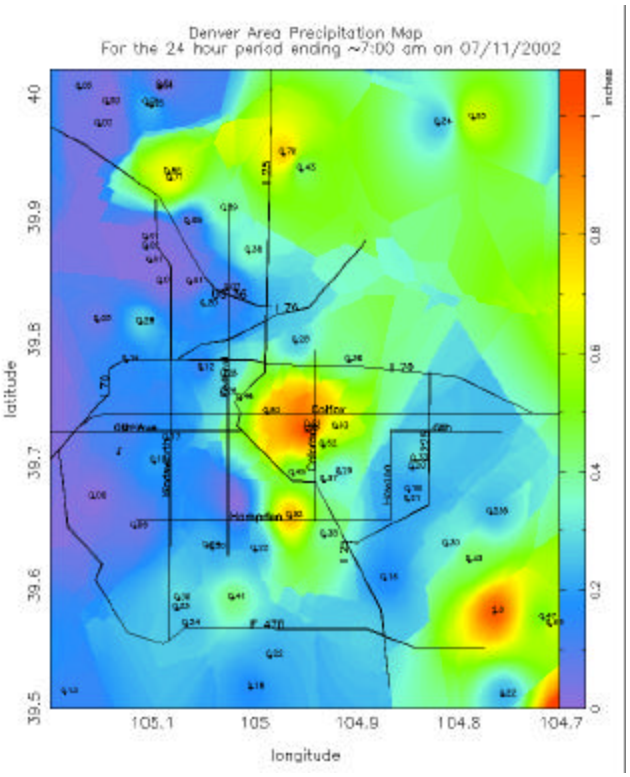
Later in 1999, the National Science Foundation Geoscience Education Program provided support for expanding CoCo RaHS into areas of rural Colorado and to link CoCo RaHS with a large thunderstorm research project conducted in 2000 known as the Severe Thunderstorm Electrification and Precipitation Study (STEPS) (Rutledge et al., 2001). Hundreds of additional volunteers were added, and educational programs including teacher workshops, field trips and community seminars were conducted. Also, the number of local sponsors for the program continued to grow. Support from local sponsors made it possible to distribute hundreds of CoCo RaHS rain gauges and hail pads to students and adults and to hire several high school and college student interns giving them their first opportunity to work with scientists conducting research and doing outreach.

In 2002, CoCo RaHS expanded into the Denver metropolitan area and the nearby mountain communities. By the fall of 2002, nearly 1,200 CoCo RaHS volunteers had been equipped and trained since the project began, with volunteers from 20 counties. In Larimer County, where the project originated, more than 200 volunteers consistently reported rainfall all summer despite prevailing serious drought conditions.

CoCo RaHS is more than science. Each year, with the help of local sponsors, CoCo RaHS volunteers get together, eat, talk and share stories about their favorite storms. With so many participants familiar with the project, it is common to run into folks wearing CoCo RaHS t-shirts at fairs, at school and even at the grocery store.

Demographics include children as young as 6 years old to seniors close to 90. Teachers, preachers, farmers, insurance agents, researchers, resource managers and citizens with disabilities are all equal participants in this grass-roots program.

A wonderful part of CoCo RaHS, and perhaps the main reason that the project has survived for five years and continues to grow, is the simple fact that the rain and hail maps available each day on the WEB are informative and useful. Many organizations use the CoCo RaHS maps and data reports, and many sponsors continue to support the project accordingly. It is very easy to access local precipitation data both current and past, and CoCo RaHS provides the only source of quantitative hail data for this hail-prone area. Users include the U.S. Dept. of Agriculture, the National Weather Service, agribusinesses and Cooperative Extension offices, insurance industry, water, sewer and storm water utilities, emergency managers and even pest management organizations. The Colorado Scientific Society is also pitching in. We have all learned very quickly that no two storms are ever the same. While there are some preferred precipitation patterns, especially near to the Colorado Front Range, each storm is unique, and each precipitation map shows something new.



Example of precipitation contours for a localized storm pattern in Denver, Colorado, for the 24-hour period ending at 7 am on July 11, 2002.

CoCo RaHS data are being used in several research efforts. CoCo RaHS hail data is an essential part of advanced hail research conducted by the Colorado State University CHILL National Radar Facility as they make strides in hail swath mapping in real time (Kennedy et al., 2001). CoCo RaHS rain, hail and snow data are all a key component of a current cooperative research project with the National Weather Service. The Cooperative Institute for Research in the Atmosphere (CIRA) is utilizing CoCo RaHS data in satellite studies. CoCo RaHS is even being considered as a source of information for cloud seeding evaluations planned for 2003.

5. WHAT ABOUT THE WATER CYCLE??

We are not aggressively telling everyone about the water cycle. Rather, we let it speak for itself. Through the measurement of precipitation and awareness in how much precipitation varies from place to place and over time, we are seeing a growing appreciation for the role of water in our communities. This year in times of drought, CoCo RaHS volunteers were among the first to recognize the severity of the situation and were willing and able to carefully conserve water supplies and encourage planning and preparation for the future. But even in a drought year, local downpours occurred providing many opportunities to point out the relationship between total rainfall, rainfall rates, runoff and flooding. A very modest thunderstorm in mid September dumped about 30 mm (1.25 inches) of rain in less than an hour over a portion of Denver. Due to construction work in progress on I-25, Denver's main north-south freeway, debris clogged drains and the entire freeway was flooded and closed for hours. Several similar storms throughout the year had no adverse impact at all. The contrast demonstrated and helped teach how human activities can dramatically influence components of the water cycle.

CoCo RaHS is a small and simple effort to encourage people of all ages to stop for a minute or two each day, measure and report their precipitation, see (if they have time) how their location compared to others around them for one storm, or one month or even longer, and then notice what that means. When does the grass shoot up and grow lush, and when does it dry out and whither? How much rain does it take for the gutters at the side of the street to run full? What does it take to bring the nearby river to the top of its bank? What is different between a year when 635 mm (25 inches) of rain falls in a year compared to 254 mm (10") in terms of vegetation, crop yields, weeds, wild flowers, ground water, stream flow, fishing conditions – even insects and diseases. It may all seem large and overwhelming, but a simple measurement of precipitation taken in your backyard can help you appreciate a little more about how it all fits together.

6. FUTURE PLANS

Our goal is to keep going and keep growing. We plan to dot Colorado cities with as many as 4 volunteer reporting sites for every 10 square kilometers. Over sparsely populated areas of the Central Great Plains we hope to recruit as many volunteers as we can – even encouraging some to measure at several locations. We also plan to involve the residents of our mountain communities where snow is such an important part of the water cycle. Snow is more challenging to measure, but it will be well worth the effort. As we collect more and more data, we also plan to share what we are all learning together through observation and participation. Our website, personalized e-mail messages to our volunteers, and traditional publications like *"Colorado Climate"* (http://climate.atmos.colostate.edu/magazine.shtml) will help us disseminate information. We will also encourage students and teachers to utilize CoCo RaHS to undertake their own studies.

7. ACKNOWLEDGEMENTS

This work has been supported by the National Science Foundation, Geosciences Division under grant number EAR-9907671 and several organizational sponsors – too numerous to mention. A complete list of all sponsors are located at the following web site: http://ccc.atmos.colostate.edu/~hail/about/sponsors.htm

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