Precipitation Stations in the Missionary Ridge Burn Area, Southwestern Colorado

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INTRODUCTION

From June 9 to July 15, 2002, the Missionary Ridge and Valley Fire complexes burned 70,485 acres. Of this acreage, 31 percent (22,542 acres) was considered severely burned with the majority of this area on steep slopes at the head of small tributaries. The Burned Area Emergency Rehabilitation (BAER) team and the local Office of Emergency Response (OEM) recognized the potential for flooding and debris flows from these areas. In response to this issue, the BAER team requested that the USGS install and operate 12 rain gages with satellite telemetry as an early warning system. Of the 12 sites, 10 were only accessible by helicopter for maintenance and installation. The first gage was installed and began operating on July 11, and the remaining gages were installed and operational by July 20. The data from the sites were available to the public on the Web at *http://co.water.usgs.gov* by July 22. The data were used extensively by the OEM and National Weather Service through the remainder of the first season.

LOGISTICS

Installation of the rain gages with telemetry involves two processes: (1) Apply for and receive National Environmental Satellite Data and Information Service (NESDIS) identification numbers and windows for the satellite Data Collection Platforms (DCP), create station identification numbers and data descriptors within USGS National Water Information System (USGS-NWIS), and program Device Conversion and Delivery System (DECODES) to interpret the transmitted data; and (2) Design a deployable unit, acquire the hardware, and program and install the DCP's. A random channel, 100-baud rate is preferred because the DCP's can transmit based on events and users can receive the information within a few minutes of a rain event. However, NESDIS windows were assigned for 300-baud high data rate (HDR) transmitters that do not have the random channel capability. Special hardware requirements included software that the field office is familiar with, a modular set-up so the components are interchangeable for ease in repair and troubleshooting, structures that have as low a profile and use as little metal as possible to avoid lightning strikes, and a quick and simple base/leg system for installation. They also would to be lightweight and compact for helicopter deployment.

NESDIS Communications

Because NESDIS assigned the 300-baud rate windows, and we could not use these windows for the random channel requirements, the 300-baud rate windows were exchanged for other surface-water transmitters. By the time the equipment and windows were exchanged, a number of 100-baud windows became available from NESDIS for the network. The equipment exchanges amounted to a man-day for each site to include travel, hardware exchange, and programming and decoding changes.

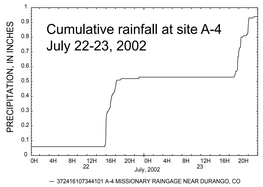
Software and Programming

The "trigger" for the random transmissions needed to be very small; therefore, the DCP's were programmed to send random transmissions every time that there was 0.02 inch or more rain within a minute. Self-timed transmissions containing 15-minute data were sent every 4 hours. Once locations were chosen for the sites, the latitude/longitude was used to develop USGS-NWIS identification numbers and the station information was entered into the system. DECODES was updated; when the stations began transmitting, the data were ready to be served to the Web. The sites were then created on the Web and the data were served to the public. The computer section in the USGS Colorado District developed an interactive Web page that showed the general area with the outline of the burn area and the rain gage locations.

Hardware

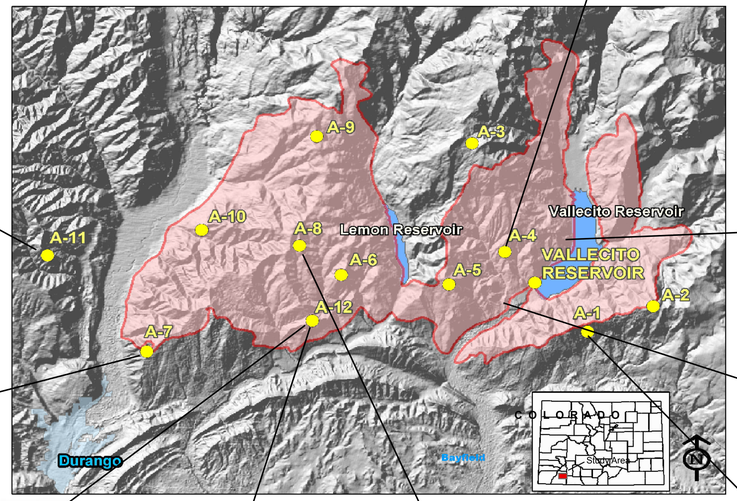
Development of modular gages that could be transported easily using helicopters that met the other requirements involved a process of assembling several versions of a "mock" gage. Once such a system was developed, all of the components were ordered with high shipping priority. Within 2 days, new equipment began to arrive and the system was fine-tuned to fit the actual components as they arrived. The components of the modular units are housed in 18"x18"x24" plastic shipping containers. The legs are galvanized steel pipe that can be buried in a relatively shallow trench to provide stability to the gage. The antennae and rain-gage masts and DCP antennae are made from plastic to cut down on the exposed metal surfaces protruding above the structure. The rain-gage units are tipping bucket gages that signal each 0.01 inch of rain. 12-volt batteries charged by solar cells power the units. The field office took an initial set of equipment and installed the first gage before the arrival of the modular units. It was installed at a location with vehicle access and was housed in a metal box (the potential for vandalism is the greatest at this site) near an array of communication towers that would draw any lightning strikes. The remaining sites were installed using two-person crews--one in the field installing and another at the office, assembling the modular gages.

Modular gage installed in moderate burn area.



Helicopter at site A-11.

A-7 Rain gage installed July 11, 2002.



USGS Precipitation Gages in the Missionary Ridge Fire Area

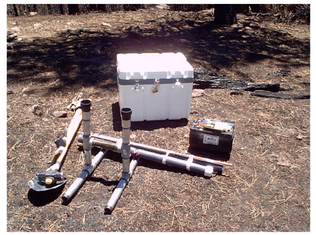
Scour effects from rain on July 22-23, 2002.

Debris flow on CR 501 from rain on July 22-23, 2002.

Helipad for precipitation station A-12.

Helicopter on helipad at A-12.

Modular gage installed in severe burn area.



Modular rain gage packed for transport.

Operation and Maintenance

Once the network was in place, the field office and key computer personnel in the District office monitored the gages twice a day, each day of the week. In the event any of the gages would not be updated on the public web site, the field office and computer personnel would go through diagnostics to determine where the failure was occurring. If the problem could not be repaired immediately, the OEM in La Plata County and National Weather Service would be notified of the problem. Then the appropriate steps would be taken to arrange to repair the problem. Both the field office and District computer sections rotated the weekend watches to ease the load.

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Lessons Learned

The logistical problems could be alleviated if there was a central location where modular units could be stored. In addition, there would need to be a sufficient stockpile of NESDIS identification windows to cover the stored modular units. NESDIS and the USGS are currently working on the addition of random channels for the HDR identification windows. Some modifications to the modular units may be needed, such as vandal-proof units that have greater public exposure. It would also be beneficial to have a select set of experienced personnel to act as advisors to the BAER teams, assisting in the selection of sites for early warning networks and assisting field offices with the programming of the units as well as installation. Staff in field offices is minimal and the burden of installation and operation of an early warning network may not be possible without additional experienced help.

Durango Herald, July 15, 2002

Early warning system for weather on the way, By Jim Greenhill, Herald Staff Writer

Most of the ash flows, mudslides and flash floods that will follow the Missionary Ridge Fire can't be prevented - but they can be forecast. When members of the Missionary Ridge Complex Burned Area Emergency Rehabilitation team returned last week from their first flights over the fire, they were alarmed. Rain falling on the ridges would rush through denuded watersheds and narrow canyons, bringing ash, mud and debris to the floor of the Animas Valley, to the road along the west side of Vallecito Reservoir and to other areas on the fire perimeter, they said. "It's the summer thunderstorms that are the most concern," said Mark Story, a hydrologist with the BAER team. Given the topography, scale, and forces involved, little can be done to stop or soften these events, expected to peak during the summer monsoon season. But the BAER team realized something could be done: La Plata County residents could be warned. People could be evacuated. The team arranged for a state-of-the-art early warning system to be installed throughout the fire area. One of the monitors will alert Durango water officials when rain threatens to wash debris into the city's water intake, south of Lemon Dam on the Florida River. Parts of the early warning system are already in place. "The thing should all be done within a week and hopefully (will) be operating pretty quickly," Story said. When rain falls in the mountains, the system will send real-time data to the National Weather Service in Grand Junction, alerting dispatchers at the Durango-La Plata Emergency Communications Center in Bodo Park. Butch Knowlton, director of emergency preparedness for La Plata County, has said that the early-warning system and a reverse 911 system that automatically calls homes to tell people to evacuate both have the potential to save lives.

Courtesy Missionary Ridge BAER Team

The Forest Service and the U.S. Geological Survey are installing 12 automated weather stations, one of which is shown here, within the area burned by the Missionary Ridge Fire to alert local authorities to potential flash floods and mudslides.

Durango Herald, August 28, 2002

Answers to burning questions, By Jim Greenhill, Herald Staff Writer

Technology is proving an invaluable weapon in the war to deal with the aftermath of the Missionary Ridge Fire. First the federal Burned Area Emergency Response team that evaluated the likely impact of the fire arranged for a weather early warning system. The system of rain gages in the burned area helps local emergency managers anticipate mudslides. Butch Knowlton, La Plata County's director of emergency preparedness, needs to know when it rains in those drainages and canyons on Missionary Ridge that are particularly vulnerable to ash, mud and debris flows. "Five, eight years ago, it would have been different," Knowlton said. "The mere fact that we have these rain gage monitors, and they can talk to a satellite and send information back down to someone on the ground is a tremendous step into the future for us." Last Wednesday, Knowlton and Warren Holland, a member of the emergency management team with expertise in gadgetry, clustered around a computer monitor in Knowlton's walk-in closet-sized office in the basement of the La Plata County Courthouse.

Dustin Bradford/Herald

Butch Knowlton, director of emergency preparedness for La Plata County, standing, and emergency management assistant Warren Holland look at a live Doppler image at the Courthouse Emergency Operations Center in the La Plata County Courthouse.