

## LOUD SEEDING AND THE RAPID CITY FLOOD OF 1972

Arnett Dennis\*

Rapid City, South Dakota

### Summary

Rapid City, South Dakota is built along the banks of Rapid Creek, where it emerges from the eastern side of the Black Hills. In 1972 its population was approximately 60,000. On the night of June 9-10 of that year, torrential rain upstream of Rapid City caused the creek to overflow its banks and devastate adjacent areas of the city.

That summer the Institute of Atmospheric Sciences (IAS) of the South Dakota School of Mines and Technology (Mines) was conducting research into cloud seeding under a contract with the U.S. Bureau of Reclamation (Reclamation), as a part of Reclamation's Project Skywater. The research project, called Cloud Catcher, was directed from a radar site located near the Rapid City Regional Airport. The project was randomized, and used a floating-target design. Each test case consisted of a cluster of convective clouds tracked by radar.

As word got around that the IAS had conducted two experimental cloud seeding flights on June 9, many persons raised the possibility that the seeding might have contributed to the severity of the flood. Others disagreed, arguing that the seeding agent used on that day, which was ordinary table salt, could never have produced such a devastating storm. The controversy was fanned by inflammatory columns in the popular press. An extreme example of such writing was an article in the *National Tattler* of December 24, 1972, titled "Govt. weather tampering is causing world floods." Because of the threat of law suits, IAS personnel were not free to rebut such misleading statements until all legal issues were resolved, which took until 1982.

The present author has written a detailed account of the controversy, which involved the appointment of a Board of Inquiry by the State of South Dakota, newspaper columns, letters to editors, administrative claims against Reclamation, and legal actions that extended to 1982. The detailed account is available

on the web sites of the IAS and of the Weather Modification Association (WMA). <http://www.ias.sdsmt.edu> and [http://www.weathermodification.org/publication\\_repository.htm](http://www.weathermodification.org/publication_repository.htm).

The account provides a brief description of the convective clouds which bring rain to the Black Hills in early summer, and continues with a discussion of the possible effects of seeding clouds with finely powdered sodium chloride (salt). Next comes a description of the weather situation as it developed on that day, which is reproduced here in abbreviated form.

The general weather pattern on June 9 featured a ridge of high pressure aloft over the Great Plains, and an upper low off the West Coast. The Rapid City radiosonde showed a dry layer above a moist layer next to the ground. Winds were light southeasterly near the ground, veering to light southwesterly aloft. Use of a numerical cloud model showed that formation of showers was unlikely as long as the dry layer persisted. However, the 500-mb prognostic charts indicated that a small disturbance approaching from the southwest would likely moisten the air mass enough to allow the formation of showers and thunderstorms by late afternoon.

As showers did develop during the afternoon, two cloud seeding flights were conducted. The first was directed at clouds to the northwest of Rapid City. The cloud-seeding aircraft, which was loaded with about 350 lb of salt, took off at 2:54 pm, and a test case was declared as soon as it reached the shower area. The crew released powdered salt on several seeding passes in updrafts below non-precipitating clouds close to the existing showers until 3:43 pm. The aircraft landed at 3:49 pm (all times MDT).

The second seeding mission was directed at clouds south of Rapid City. The crew seeded non-precipitating clouds close to existing showers between 4:58 and 5:37 pm; the seeding runs began while the test case was centered about 25 miles southeast of Fairburn, and ended close to Fairburn itself. The aircraft landed at 5:53 pm.

\*Corresponding author: Dr. Arnett Dennis, 3931 Ridgemoor Drive, Rapid City, SD 57702; e-mail [ardennis@rushmore.com](mailto:ardennis@rushmore.com)

The radar returns showed the largest cloud in the second test case developing into a tall thunderstorm as it approached the eastern foothills to affect the Battle Creek basin, which is south of the Rapid Creek basin. At 5:45 pm a computerized radar display showed that the strongest cell within the test case was in the vicinity of Fairburn, had an echo top just above 50,000 ft, and showed a maximum reflectivity factor of 68 dbZ, which suggested a rainfall rate of several inches per hour. It was not possible to be precise, because hail shafts can also produce very high reflectivity factors. This group of clouds moved very rapidly northwestward.

Meanwhile, heavy rain had developed over parts of the northern Black Hills, leading to several telephone conversations between Cloud Catcher's operations director at the IAS radar site and National Weather Service (NWS) staff on duty at the Rapid City Regional Airport. At 6:30 pm the operations director described to them a band of heavy rain extending well over 50 miles from north to south along the east side of the Black Hills. The NWS forecasters decided that a flood warning was required for the northern Black Hills. After clearing their decision with a hydrologic center in Sioux City, Iowa, they released the flood warning to the media at 7:15 pm. They soon extended the warning to include the central Black Hills as well, with specific mention of possible flooding on Rapid Creek.

By that time rain had been falling for an hour or so around Pactola Dam, which is on Rapid Creek some 15 miles upstream of Rapid City, but the city, and much of the drainage area between the dam and the city, received only a few sprinkles during the early evening. Shortly after 7 pm a thunderstorm moving northwestward brushed the southwest side of the city, dropping a moderate amount of rain there, and torrential rain in the Rapid Creek basin a few miles upstream. Other large, rapidly moving convective clouds followed it into the hills, and merged into an almost stationary mesoscale convective system (MCS) a few miles to the west. Because most of the clouds joining the MCS dropped little or no rainfall until they had moved beyond the city, most people in town were unaware that places only a few miles to the west were being flooded.

The flood crest reached the west side of Rapid City before 11 pm, and the peak flow in the city occurred about midnight. The U.S. Geological Survey later estimated that it exceeded 50,000 cubic feet per second (cfs), about 100 times the normal flow of the creek, and roughly four times the estimated peak

flow of the second biggest flood on Rapid Creek, which occurred in 1907.

On June 13 the director of the IAS, Dr. Richard Schleusener, made a formal report to the office of the governor of South Dakota through Dr. Harvey Fraser, the president of Mines, denying allegations that cloud seeding had caused or augmented the flood. Schleusener emphasized that the storms around and below Pactola Dam had not been seeded. He also stated that, "... it is ridiculous to think that with a few hundred pounds of finely ground table salt disbursed from a single airplane we could cause twelve inches of rain in a few hours." The governor, Richard Kneip, released a statement in which he quoted some of Schleusener's language, and asked people to avoid spreading rumors. Long-time critics of cloud seeders immediately denounced Schleusener's statement as self-serving.

Interior and Reclamation officials in Washington were concerned with the possibility of legal complications arising from Reclamation's sponsorship of the June 9 cloud seeding flights. Two Reclamation scientists came to Rapid City to interview IAS staff about the events of June 9. IAS personnel involved in the experiments met with them to go over the available data. They looked at time-lapse radar data, logs from the seeding aircraft, and the general weather situation of June 9. They were particularly interested in the estimates of the total rainfall from the test cases, which were already available from the radar data recorded and analyzed by the on-line minicomputer. The first case of June 9 dropped about 1500 acre-feet of rain, and the second case dropped about 4500 acre-feet.

Preliminary estimates of the total rainfall in the Black Hills on June 9 were coming in between 400,000 and 500,000 acre-feet. Therefore the Reclamation scientists concluded that the 6000 acre-feet measured in the two test cases combined did not contribute significantly to the rainfall totals for that day. They also concluded that the seeding did not cause the flooding rains that followed a short time later. Their findings were reported through channels.

State officials in the Division of Weather Modification (DWM) and elsewhere decided soon after Gov. Kneip's press release of June 13 that an outside review was needed. The governor therefore appointed a three-person Board of Inquiry (Board) to review the events of June 9, and submit a report. The Board was chaired by Dr. Pierre St. Amand, a geophysicist of the Naval Ordnance Test Station in California; the

other two members were Robert Elliott, the long-time president of North American Weather Consultants, and Ray Jay Davis, a lawyer who was active in the Weather Modification Association (WMA).

The committee members decided that they should have a report ready to present at the American Meteorological Society's (AMS) Third Conference on Weather Modification, which was set for the last week of June in Rapid City. Following the conclusion of the conference on June 29, many people stayed to hear St. Amand present the preliminary Board report on the impact of cloud seeding on the flood. The report was critical of the decision to launch a second seeding flight on June 9, but concluded that, "In the absence of seeding, the result would have been the same."

The paper covers the events mentioned above in detail, and also reviews the major contributions to the debate by critics. These include letters to the editor of the *Bulletin of the AMS* by Jack Reed; columns in the *Denver Post* and other newspapers by Dr. Peter Metzger, a biochemist from Boulder, Colorado; and an article by David Howell, which was published in *Environmental Action* and introduced into the Congressional Record in 1973.

Two flood survivors, and the heirs of several persons who had died in the flood, filed a total of six administrative claims with the U.S. Dept. of the Interior in 1974 seeking almost \$4,000,000 in damages. The claims erroneously identified the June 9 cloud seeders as Reclamation employees. After the claims were denied, the heirs of five of the victims named in the claims filed a lawsuit (*Lunsford vs. United States*) in Federal court in June 1975 seeking \$1,725,000 in damages. The suit alleged that cloud seeding by a Government contractor on June 9, 1972 had been conducted in a careless and reckless manner, and had contributed to the flooding of Rapid Creek.

Mines had an insurance policy covering damages due to seeding effects up to \$2,000,000, and the U.S. Government was an additional named insured. A law firm in New York City was hired by the insurance company to direct the defense against the suit.

The Federal Tort Claims Act allows suits against the Government for negligence on the part of its employees, but not for negligence on the part of contractor personnel. Recognizing that fact, the plaintiffs alleged that Reclamation's employees had been negligent, in that they failed to supervise the experiments properly. The plaintiffs also sought to have their suit classified as a class action. This move was a great threat to the Government, as it could have opened the door to claims for hundreds of millions of dollars in damages to persons not named in the suit. However, the request for classification as a class action was denied in 1976, and the denial was upheld on appeal. The lawyers defending the government moved for dismissal of the case. Following several court hearings and discovery proceedings regarding the terms of the contract between Reclamation and Mines, the suit was finally dismissed in 1982.

The issue of causation was never argued in court. The detailed account examines several suggested ways that cloud seeding might have influenced the storms of June 9, and finds them wanting. Essentially, the critics hypothesized that seeding intensified the storms, and pointed out that no one can prove otherwise. Their explanations of how salt particles could intensify the storms lack detail, and, in some cases, involve errors about basic cloud physics.

The account concludes with a brief discussion of the problems involved in the forecasting of flash floods in general, and of the Rapid City flood in particular. One source of information that might have proved useful on June 9, if available in real time, was the pibal data collected as a part of Cloud Catcher. These data showed a mid-level jet blowing from the southeast into the southern Black Hills during the afternoon, with peak winds near 75 mph at 15,000 ft above sea level. Such unusual winds are a partial explanation for the record-breaking rainfall rates observed along the east side of the Black Hills. A regional scale atmospheric model has been used to simulate the June 9 storm; the results suggest that such models may eventually prove useful in predicting the onset of flooding rains over mountainous terrain.