

WARNING AND RESPONSE TO
THE MOUNT ST. HELENS ERUPTION

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The amount of foreknowledge and warning for Mount St. Helens was probably greater than for any previous geologic hazard in United States history. The public, and/or responsible officials had a series of warnings, as information on this volcano passed through successive stages from a routine research publication to the issuing of a potential hazard notification, and still later, the initiation of a hazard watch. These warnings, and the regulations developed as a result of them, did probably cut down on the death toll of the eruption. However, many people remained unwarned, or unconvinced of the danger in spite of the great amount of information disseminated to the public through government channels as well as intensive media coverage.

The abstract in the slim informative "blue book" of Dwight Crandell and Donald Mullineaux [1978] opens with the statement: "Mount St. Helens has been more active and more explosive during the last 4,500 years than any other volcano in the conterminous United States." In the publication the past behavior and future probabilities of volcanic eruptions are succinctly outlined and the areas likely to be affected clearly marked on maps. In addition, the bulletin includes step-by-step instructions for identifying the warning signs of an eruption, monitoring the premonitory events, and actions which should be taken to inform both governmental agencies and private companies. This publication was a product of an ongoing United States Geological Survey (henceforth U.S.G.S.) research program which has focused on hazards appraisals for the volcanos in the United States portion of the Cascade Range. A report discussing the Mount St. Helens hazard appraisal appeared in Science as early as 1975 [Crandall, Mullineaux, and Meyer, 1975], and geologists and some U.S. Forest Service personnel were aware of the work one or two years earlier.

In recent years as reports on various volcanos reached publication stage they were forwarded to the Hazards Information Coordinator, and after evaluation, warnings of potential hazards were issued. This is in keeping with U.S.G.S. responsibility to provide timely and effective warnings with respect to geological hazards. It has been doing so since 1977.

Mount St. Helens was the eighth hazard warning of the new U.S.G.S. hazard warning system. On December 20, 1978, a letter was sent to the governor's representative from the U.S.G.S. notifying federal, state, and local officials of the potential hazard. The Governor's representative misinterpreted the notification thinking the eruption was imminent, and a special meeting involving representatives of many State of Washington Government departments and U.S.G.S. officials was called in January, 1979, to clarify the situation. Although at the time this was regarded as an over-reaction, the meeting might, in retrospect, be seen as useful in alerting state officials to the potential problem. On the other hand, the U.S.G.S. sprinkling of cold water on the initial reaction may have tempered the later reaction to the Mount St. Helens eruption.

On March 20, 1980, the first of a series of moderate earthquakes, measuring about Magnitude 4 on the Richter scale was detected on seismographs operated by the University of Washington in cooperation with the U.S.G.S.'s earthquake studies program. The seismic activity beneath and within Mount St. Helens led to further monitoring and the decision to initiate a hazard watch for the volcano. Since then the volcanic activity has stimulated great interest which extends far beyond the area affected as may be seen in the extensive and continuous coverage in local, national, and international news. Mount St. Helens clearly qualifies as a major media event.

Within the State of Washington and the immediate vicinity of the volcano, major efforts were made once again to inform responsible officials of the potential hazard after the hazard watch was initiated. The U.S.G.S. shipped 200 copies of the Crandell and Mullineaux report to Vancouver, Washington, for distribution to appropriate persons. By then the interest level was so high that thousands of copies of the report could have been given away had they been available. Many of the U.S.G.S. geologists were now headquartered in the U.S. Forest Service offices for the Gifford Pinchot National Forest which covers a major portion of the park. Thus Vancouver, Washington, became the main information center for the developing events.

As the monitoring activity for the volcano watch continued, daily news conferences were provided under the leadership of the U.S. Forest Service. In the immediate aftermath of the eruption these news conferences were held three times a day and were scenes of great intensity as the radio, T.V., and press personnel, who had converged on Vancouver, grilled the spokesman for the U.S.G.S., the U.S. Forest Service, the State Department of Emergency Services, and the sheriffs of the local counties, demanding clarifications of statements, explanations of discrepancies, and occasionally answers to unanswerable or embarrassing questions.

The leadership of the U.S. Forest Service in organizing the daily press conferences is to be commended. These press conferences saved harassed officials, responding to the disaster, from the necessity of confronting each of the reporters separately, and it provided the media people with a single centralized source for news so they could gain an overall perspective on the most recent developments. It also helped keep

rumors to a minimum level. U.S.G.S. officials were kept busy not only in explaining probable risks but in discounting imaginary ones such as fears that watermelon-sized bombs would destroy Morton, that a new bulge was developing on the south side of the mountain, that the dam of debris at Spirit Lake might break, that a lava flow might reach the Kelso-Longview area, or that Mount Margaret is a volcano. Sometimes rumors began with amateur radio operators who picked up reports from the field and drew their own conclusions before the data were analyzed and evaluated by scientists.

The U.S. Forest Service (U.S.F.S.) also took the initiative in organizing many of the local officials to cooperate in developing the Mount St. Helens Contingency Plan which laid out the steps to be taken by each official in the event of an eruption [Osmund, 1980]. Several other agencies developed contingency plans before the major eruption of May 18th. These included the Washington State Dept. of Emergency Services, 9th Army Division, Federal Aviation Administration, and the Washington National Guard.

In addition, as significant changes were noted in the monitoring, the U.S.G.S. sent letters to the directors of the Department of Emergency Services. This was done when harmonic earthquake tremors appeared and when the bulge on the north flank of the mountain developed.

From the foregoing, it is clear that there was a great deal of warning and discussion about the activity of Mount St. Helens prior to the major eruption which began at 8:32 a.m. on Sunday, May 18, 1980. This eruption consisted of a number of components. According to the U.S.G.S. information update 09:00, Tuesday, May 20, 1980:

The first was an initial blast that totally devastated the forest over a wide swath arcing from the northwest to the north or northeast side of the volcano and extending up to 15 miles from its former summit. The blast covered the devastated area with ash that swept the ridges, collected in valleys, and flowed down the local drainages. Although the blast was hot, its temperature was not high enough to char the fallen or buried trees. The second component of the event was a combined pyroclastic flow and landslide that carried material released by catastrophic failure of the volcano's north flank across its lower slope and about 18 miles down the Toutle River Valley, burying it to depths as great as 200 feet. The third component was a pumiceous pyroclastic flow that funnelled northward through the breach in the crater formed by the north slope failure. This deposit raised the outlet of Spirit Lake by about 200 feet and raised the water level by 100-150 feet. The lake continues to rise behind the debris dam.

After the initial rapid series of events, the volcano continued to erupt an ash column to altitudes of

50,000 to 60,000 feet and greater for several hours, generating a plume at high levels in the atmosphere that has deposited ash more than several inches thick as far east as central Montana and continues to deposit detectable amounts of ash into the central United States.

This dramatic sequence of events was exceedingly destructive. The symmetrical beauty of Mount St. Helens, sometimes referred to as the "Fuji of America" was marred by a black gaping crater and the peak was 400 meters shorter.

Preliminary estimates of \$2.5 billion damage [Ranier National Bank, 1980] have more recently been succeeded by estimates of short term losses to the economy of Washington State on the order of \$860 million Hunt and MacCready, 1980. Over half was forest damage (\$450 million) in the blast zone where some 229.2 square miles were either laid bare, left with fallen timber marking the direction of the blast, or merely singed. Next in amount of losses were clean-up costs (\$274 million), damaged or destroyed property (\$85 million) mainly roads, bridges, and other federal and state property in the blasted and flooded areas, and agricultural losses (\$39 million).

Two-thirds of the clean-up costs were concentrated in the immediate area of the volcano. A major portion was due to the need of dredging of the Toutle, Cowlitz, and even the Columbia River. On the Columbia River ocean-going traffic was stopped for about a week. The channels of the Toutle and Cowlitz Rivers were filled with mud and debris which greatly limited their capacity and increased the risk of floods.

East of the Cascades the clean-up problem was ash removal. Appreciable amounts of ash fell on four states with the greatest concentration in certain Eastern Washington counties where expenses involved in ash removal exceeded the local ability to pay. In these same areas were concentrated most of the damages to agriculture as well [Cook, et al., 1981]. The major losses were to the hay crop. Wheat, apple, and potato crops were normal or above normal. Although the wheat crop was good, the ash's abrasive qualities caused damage to the mechanical equipment used in harvesting.

In assessing the preparation for and reaction to these damaging events, only the most beneficial and worst aspects of the warning system will be discussed. The major benefits were derived from the establishment of a restricted zone which cut down on the fatalities, due to the eruption, which were the first ever on the continental United States due to a volcanic eruption. In contrast, the major oversight in the warning system was the failure to effectively warn the people in the ashfall areas. In describing these events some of the flavor of the public reactions will emerge as well as the importance of the perceptions of the various people in affecting the decisions made.

As a result of the many earthquakes and other physical indications that Mount St. Helens was building toward an eruption, restricted zones

were set up around the mountain. As early as March 25 the U.S. Forest Service set up a red zone closing off the whole mountain above the timberline. From the moment the road blocks were set up to prevent people from entering the area, the officials experienced great difficulty in enforcing them. On April 3, Washington State Governor Dixie Lee Ray declared a state of emergency which allowed National Guard units to aid local law officials in keeping the public out. Running the road blocks became a game. It was easy to find alternative routes in, especially when enterprising local people began selling maps of the many logging roads in the area. This same public discounting of the hazard was documented by Green, Perry, and Lindell [1980] who interviewed residents of Toutle/Silverlake and Woodland, small communities close to the volcano.

It was not only the public which discounted the hazards. The major lumber companies did as well and were capable of exerting strong political pressure. When the red and blue zones were finally made official on April 30th, portions of the red zone boundaries bore a closer resemblance to divisions between public lands and lumber company property than to defined geologic hazard zones. All activities were to be banned from the red zone. Certain activities were allowed in the blue zone during daylight hours and access there was possible with permission. The result was that lumbering could continue very close to the western side of the volcano.

In spite of all these problems, the establishment of restricted zones did prevent greater loss of life than the 60 or so who are assumed to have perished as a result of the blast. Even so a bit of luck was involved, for the death toll would surely have been higher if the major eruption had occurred on a weekday when lumbering was in full swing rather than a Sunday. Estimates of how many lives were saved as a result of the warnings and restrictions vary from a few hundred, the number who might normally be there on a weekend in May, to as high as 100,000. The size of these estimates depends on the assumptions of the estimator as to how many people would have converged on the area to see the volcanic activity if free access had been allowed.

The interest level was high and remains so as may be seen in the growth of a thriving souvenir industry at main roadside sites from which the mountain is visible. T-shirts, ash, volcanic rock, postcards, picturebooks, refreshments, and a variety of items made from ash or volcanic rock were all available. On the first anniversary of the destructive eruption, celebrations in Toutle, Castle Rock, Silverlake, and other nearby small towns commemorated the event with parades, prayers for the dead, and sale of souvenirs [Arizona Daily Star, 1981].

The major oversight of the warning system was the failure to inform adequately the people in the ashfall areas about the problems they could face. The U.S.G.S. described them clearly in their report but did not follow through to be sure that the public east of the Cascades was aware that:

Tephra eruptions can also result in psychological stress by blocking roads and causing people to be isolated, by causing darkness during daylight hours, by increasing acidity and turbidity in exposed water supplies, and by interrupting telephone, radio, and electrical services. Exposure to one or more of these stresses may lead to panic even though an individual's health or life is not directly endangered. Damage to property results largely from the weight of tephra, especially if it becomes water soaked, from its smothering effect, from abrasion, and from corrosion. Machinery is especially susceptible to the last two effects. [Crandell and Mullineaux, 1978, p. C11]

The U.S.G.S. scientists, with little experience in direct communication with the public, saw themselves as technical advisors. They perhaps assumed that their report would be read and people would act accordingly. The report was sent to key public officials, but there was little follow-up to see that it had reached all those likely to be affected. One might argue that people who got the information might not use it anyway, but our results plainly indicate that those who received the "blue book" were more likely to make some adjustment to the volcanic hazard than those who did not.

The U.S.G.S. scientists were not at all reluctant to relinquish the public information role to the U.S. Forest Service officials, who became heavily involved, since Mount St. Helens was within their jurisdiction. After the hazard watch was declared, the U.S.G.S. representatives were kept too busy responding to local demands for information and assessing the physical nature of the hazard to follow up on warning the public. The intensity of the demands on them during this period of high excitement forced them to work up to 20 hours a day for several weeks. Even with such long hours, they were unable to attend to all the legitimate requests for their time with which they were inundated.

The U.S. Forest Service had many members who were aware of the hazard, and they very quickly responded to the increased seismic activity by closing off the area, setting up a public information office at their headquarters in Vancouver, Washington, and developing a contingency plan for an eruption. Their main responsibility was for the forest areas. These and the areas immediately adjacent corresponded closely to the most serious geologic hazard zones identified by the U.S.G.S. Thus, they concentrated their main efforts on what were perceived to be the areas of most serious danger to life and property, essentially the areas immediately adjacent to the mountain and those in the valleys down which mud flows and floods were likely to descend. Only two of the some 66 key contacts among public officials and private industry representatives in their contingency plan were from the areas east of the Cascades, which later were covered with ash. Both of these were from Yakima.

The State of Washington Department of Emergency Services was the agency with the responsibility of warning the public. Unfortunately, it was a neglected, underfunded agency directed by an inexperienced

political appointee rather than a hazards professional. It had been rated as having one of the worst disaster response programs in the country [The Oregonian, 1980]. As a result it did not have the personnel to conduct independent geological assessments. Rather than take the initiative, it followed the lead of the Vancouver headquarters. Although the department sent out information on the volcano's activities to all its county offices, it did not specify how this information was relevant to Eastern Washington. When the major eruption took place on May 18th, the county offices were still in such a state of disarray that their warning to the local communities was delayed almost two hours.

The local officials in Eastern Washington who received the reports on the increasing activity of Mount St. Helens tended to regard them as irrelevant to their activities. After all, Mount St. Helens was a distant Cascade peak. As a result the information was not acted upon. As the ash cloud approached, many people thought it was a thundercloud or dust storm and were completely unprepared for a heavy ashfall. (This is evident in eyewitness accounts from Pullman and Ellensburg, Washington [Dillman, 1980] [Ressler].) Thus, roads were soon closed, motorists stranded, and normal activity came to a standstill. Each community tended to improvise on its own in handling the emergency situation and in at least one case all emergency vehicles were soon out of commission due to dust clogging up the engines. Later as the clean-up began, problems arose related to how to handle the ash. The ash clean-up was complicated by variations in the physical properties of the ash from place to place so that it could not be handled in a uniform manner.

Questions and fears developed about medical effects. Children enjoyed the ease with which they could stir up a dust cloud, but parents worried about the potential health effects. Similar concerns arose related to the effects of the ash on vehicles or mechanical equipment or on crops. The Federal Emergency Management Agency (F.E.M.A.), which became involved when the federal disaster declaration was made official, soon developed a series of technical bulletins to answer some of these questions, but such information would have been even more useful a few weeks or months earlier.

After the May 18th eruption, people's perceptions of volcanos changed considerably. The warning system is also more effective than before. From the predictions based on physical measurements to the dissemination of data to the public, there is a much improved system. Lumbering is once more taking place, though restricted zones are still in force. Crews have emergency evaluation plans and are in direct contact with the headquarters from which warnings are issued. For some of the latest eruptions predictions were made several hours in advance, and people were evacuated efficiently. The major hazard at present is that of floods for the capacity of the river channels is much less than normal, and they could become even more clogged as loose ash is carried down by winter rains.

On a broader level one might hope that the eruption of Mount St. Helens was useful in dramatizing the fact that Cascade volcanos are active and could erupt at any time. This could encourage state and local

communities close to other volcanos to develop contingency plans to improve the response to the next eruption.

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