

LENA GULCH EVACUATION:
AN EXAMINATION OF WARNING
AND RESPONSE

LENA
GULCH
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AN EXAMINATION OF WARNING
AND RESPONSE

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PREFACE

This study was commissioned by the Urban Drainage and Flood Control District of Denver, Colorado to examine a particular instance of flood hazard warning and response.

The author acknowledges the helpful information provided by Mr. Brian Nielson and Sgt. Gary Harper of the City of Lakewood, Colorado, Mr. Gary Lewman, Chairman of the Review and Study Committee of Flood of Maple Grove Reservoir/Lena Gulch, and Mr. Bill DeGroot of the District for making the study possible and providing helpful inputs. None of the above are responsible for any conclusions reached in the report or for any errors it may contain.

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I. BACKGROUND

On the evening of March 17, 1979 a minor flooding event took place in Wheat Ridge, Colorado, a community located northwest of Denver. The flooding was caused by vandalism to a rubberized dam located upstream of the community at Maple Grove Reservoir. Approximately 100 acre feet (32 million gallons) of water were lost over a period of two and one-half to three hours. The situation necessitated the evacuation of nearly 2,000 residents who live in the area of Lena Gulch which flows from the Maple Grove Reservoir through Wheat Ridge to Clear Creek.

Wheat Ridge police were notified of the situation at approximately 11:30 p.m. by residents calling in with reports of rising water in Lena Gulch and some water in the streets. At this point, patrol cars were dispatched to the area to verify the residents' observations, and representatives of the Consolidated Mutual Water Company (which maintains the Maple Grove Reservoir and dam) were contacted. Once the reports of potential flooding were confirmed, and the severity of the situation was assessed, a decision to evacuate residents was arrived at by the Mayor, City Administrator, and Director of Public Works for the City of Wheat Ridge. Officials from the cities of Golden, Arvada, Wheat Ridge, and from Jefferson County were called in to assist in the evacuation effort which would be concentrated in the

area bordering on Lena Gulch.

A year previous to the present study, research had been conducted by the author in the Lena Gulch area to determine the effectiveness (in terms of heightening awareness of potential flood hazards and/or motivating protective behavior in the event of flooding) of a flood hazard brochure then being produced and disseminated by the Urban Drainage and Flood Control District (UDFCD) of Denver. In that study 83 residents of the Lena Gulch one percent flood plain (in conjunction with 166 residents of a comparable flood hazard area) were interviewed by telephone to ascertain information in five general areas: 1) flood hazard awareness; 2) prior hazard experience; 3) demographic factors (e.g., age, type of residence, property value, etc.); 4) mitigation action behavior; and 5) knowledge of the UDFCD brochure. Given the fact that information concerning mitigation action was, for the most part, hypothetical (i.e., respondents were asked what they would do in case of a flood), the present situation (the March 17 flood) seemed to present an excellent opportunity for identifying what residents did in an actual flood.

II. PURPOSE OF THE STUDY

Since a great deal of information had previously been collected about residents of the Lena Gulch flood plain, the opportunity to correlate those data with actual behavior seemed one worth investigating. The primary purpose of the present study, therefore, was to ascertain how residents were apprised of the situation, how they responded, and what they would do in similar circumstances in the future. It was thought that differences in response to the flooding could be explained by data previously collected (including, but not limited to, the effects of the UDFCD brochure).

III. METHODOLOGY

Residents of the Lena Gulch area were interviewed by telephone to elicit information in several general areas (the entire interview schedule with a summary of responses is reproduced in Appendix I): 1) their recollections regarding a warning to evacuate (including the source, the delivery mode, and the message content); 2) any confirmation actions taken; 3) their behavioral response; 4) their level of flood preparedness before and after March 17; 5) their feelings regarding the necessity of the evacuation; and 6) whether they sustained any damage from the flood. A sampling frame of 83 residents (those interviewed in the earlier study) was utilized to obtain respondents, and of these, 53 interviews were completed. Of the 30 interviews which were not completed, approximately 65 percent were because the respondent had moved, or the phone number had been changed and a new number could not be obtained. An additional 25 percent of the interviews could not be completed because no adult members of the household were at home on the evening of March 17. The other ten percent of those called could not be reached at all.

IV. FINDINGS

The responses to the interview were analyzed and the results are presented here by general area. Comments obtained through less formal interviews with officials involved in the evaluation effort will be inserted as appropriate. Finally, several analyses were undertaken to correlate response behavior reported in the present study with data obtained about these respondents in the previous study. The implications of the findings will be discussed in the next section.

The Warning

Several factors related to the warning itself have often been postulated as being important for motivating appropriate response behavior. These include the way in which the warning is given, by whom, and finally the actual content of the warning message. The interview addressed each of these factors. Of the 53 respondents, 34 (64%) had received a warning of some sort to evacuate their residence because of possible flooding. For those receiving a warning, the most common method (47%) was a knock on the door. Other warning modes included telephone calls (15%), bullhorns or sirens (9%), and multiple methods (bullhorns, lights, sirens, loudspeakers, etc. - 6%). A number of respondents (17%) did not mention a specific warning mechanism. Several officials¹

¹ Mr. Gary Lewman, Chairman, Review and Study Committee of

cited the complication with the door-to-door method of unduly frightening residents. Some residents thought the officials were prowlers, which resulted in a large number of calls to the police department and clogged communication channels.

The sources of the warnings were also varied. The largest percentage of respondents received a warning either from fire department personnel (32%), or from a friend or neighbor (also 32%). An additional group (21%) received a warning from police officials. A final group of respondents (15%) did not specifically mention the source of the warning.

Finally, respondents were asked (in an open-ended manner) to recall as closely as they could the actual content of the message they had received. By far the most common response (53%) included a reference to the dam breaking. Usually this was in conjunction with the phrase, "evacuate immediately." The second most frequently reported message type (21%) was one with several factors usually including "there is water coming, we expect flooding in the area, please evacuate immediately." Other respondents (15%) reported the message as simply saying "evacuate immediately." The remaining respondents (11%) were unable to recall the message clearly, or felt that there had not been a very

Maple Grove Reservoir/Lena Gulch, Personal Communication, July 13, 1979; Sgt. Gary Harper, Lakewood Department of Public Safety, Personal Communication, July 15, 1979.

specific type of message given. Although officials² reported that the message included a suggestion of where residents could go for shelter, very few of the respondents included this factor in their reports of the message.

Confirmation Behavior

Another factor which has been mentioned in the literature³ as being influential in determining response to disaster warnings relates to the types of actions (if any) which people take to confirm the warning which they receive. In the present study a very large proportion (76%) of those who received a warning confirmed its accuracy in some way. Most of these respondents (73% of the 76%) confirmed the warning through environmental cues (i.e., they could see the water for themselves, either rising in the creek or in the street). Others (12%) confirmed the warning by contacting officials (either from the police or fire departments). A third group (again 12%) tried to confirm the warning by watching television or listening to the radio. Finally, four percent of the respondents tried to confirm the warning by talking to friends or neighbors.

A small proportion (24%) of those respondents who

² Mr. Brian Nielson, Emergency Preparedness Coordinator, City of Lakewood, Personal Communication, May 9, 1979; Sgt. Gary Harper, Lakewood Department of Public Safety, Personal Communication, July 15, 1979.

³ Dennis S. Mileti, Natural Hazard Warning Systems in the United States: A Research Assessment. Boulder: University of Colorado, Institute of Behavioral Science, Monograph #NSF-RA-E-75-013, 1975, p. 19.

received a warning did not attempt to confirm its accuracy. Of these, most (63%) did not do so because they believed the warning source to be credible. Other reasons given for not confirming were having previously experienced floods in the area, and being too frightened to stay and confirm the warning.

Behavioral Response

The next series of questions were aimed at identifying what the respondents did after receiving the warning. First respondents were asked to describe their actions immediately following the warning. Most (59%) responded that they left immediately. (Since most confirmation behavior consisted of observing rising water, the confirmation took very little time and did not interfere with immediate evacuation.) Other respondents (15%) took some time to warn other friends or neighbors before evacuating. Several (9%) monitored the situation (i.e., continued to watch the water) before deciding to leave or stay. Some respondents (9%) gathered personal possessions (e.g., important papers, valuables, pets, etc.) before evacuating. Finally, one group of respondents (9%) prepared their home in some way (e.g., turned off electricity, or moved valuables to higher positions) before evacuating.

Respondents (including those who had not received a warning) were then asked if they had indeed evacuated their residences. Of the 53 persons interviewed, 33 (62%) responded that they had evacuated. Since this number closely

approximates the number of respondents who had received a warning (34), a chi-square analysis was performed to ascertain whether these were the same respondents. The analysis disclosed that although the two groups (those who received a warning and those who subsequently evacuated) were not identical, 90 percent of those who had evacuated had received a warning. Conversely, of the group who had not received a warning, 84 percent did not evacuate. Although these findings may seem obvious, these figures (particularly for the group which did evacuate) are larger than might ordinarily be expected. A possible explanation for these results is presented below. It is also interesting to note that of the respondents who evacuated, nine percent of them did so without receiving a warning. When questioned further, these respondents stated that they had been aware of a general commotion in the area, and upon further investigation (either by contacting friends or neighbors, or officials), had been apprised of the situation. So that although they had not received a formal warning, they did receive sufficient information to motivate their evacuation.

A substantial proportion (38%) of the respondents interviewed stated that they had not evacuated, and these people were then asked why they had not left their homes. The majority (55%) stated that they had known nothing about the flood until after it was over. In other words, they had simply slept through the entire event. An additional 35 percent of those respondents stated that they were

observing the situation, and never felt sufficiently threatened to leave their homes. Other reasons for not leaving included a desire to stay available in case officials needed assistance, and one case in which police decided that evacuation would not be necessary.

Finally, respondents were asked several questions regarding their own evacuation. The first of these concerned where people went after leaving their homes. The largest percentage (42%) went to the home of a relative. Other places mentioned were friends' or neighbors' homes (21%), Wheat Ridge High School (the officially designated shelter--15%), a local shopping center (9%), and other assorted places (12%). People were then asked why they had chosen their particular destination. The predominant response (30%) was that it was close and/or safe. Other responses (each given by 15 percent of those interviewed) included that the destination was on higher ground, that it was the only known choice, or that officials had suggested this particular location. One group of respondents (12%) stated that they had chosen a specific destination because they had gone there during previous floods. The last question in this area concerned the length of time residents were out of their homes. Here responses varied from less than two hours to over eight hours, with more than half of those interviewed (54%) stating they had been out of their homes four hours or more.

Preparation for Flood Hazard

Another series of questions was aimed at illuminating

the level of flood hazard preparedness of the residents before and after the flood of March 17. Respondents were first asked if they felt they were prepared for a flooding event before that night. A majority (57%) felt that they were not prepared. These respondents were then asked why they were not prepared, and a significant proportion (33%) replied that one cannot really prepare for a flood, but can only evacuate if a flood occurs. An equal proportion (33%) stated that they had not believed the possibility of a flood occurring was real. A third group (20%) stated they knew nothing of the possible danger before that evening. (This group is distinguished from the previous one in that the former had heard about the possibility of flooding and had discounted that possibility, while the latter had never been informed about such a possibility.) A final segment (13%) responded that they did not know (did not have enough information) how to prepare themselves for this type of eventuality.

Respondents who answered that they were prepared before March 17 (43%) were then asked in what ways they felt they were prepared. Here, the most frequent response (35%) was a general awareness of the possibility of flooding (which, as identified in the previous study, may be directly attributable to the UDFCD brochure). Another frequently mentioned preparation (26%) was the establishment of an emergency strategy, including an evacuation plan. (Again this may be due to the influence of the brochure which specifically recommends this type of self-protection.) Other preparations

include flood insurance (17%), and psychological preparedness (17%).

A series of questions analogous to the foregoing were then posed, but now focusing on whether respondents felt they were more prepared, than before the March 17 flood. The majority (60%) felt they were not more prepared. The major reason given (by 30 percent of the respondents), as before, was that there is no way to prepare for a flood. Other reasons given were a lack of concern (fostered, no doubt, by having just "survived" a minor flooding event, and not realizing that much larger magnitude floods could occur in the area), and no knowledge of how to prepare (12%). Another group of these respondents (33%) stated that their level of preparation was the same as it had been prior to March 17 (i.e., they were not now more prepared).

Those respondents who stated they were more prepared now (40%) were asked in what ways they felt themselves to be more prepared. A large majority (61%) responded that they were now much more aware of the possibility of flooding. A second response to this question (which was given by the other 39 percent of those interviewed) was that these residents had now taken specific steps either to prepare their household, or to lay out an evacuation strategy, for use in another flood situation.

Future Evacuation Behavior

In order to evaluate whether residents thought the evacuation had been worthwhile, they were asked if they

would evacuate in the future under similar circumstances. A significant proportion (36%) reported that they would not evacuate their residence in a similar situation. When asked why not, many respondents (37% of the 36%) stated that the March 17 flood had not presented a real threat, but that they would evacuate in a larger flood. Another group (37%) responded that they were not concerned, and would therefore not evacuate. Several respondents (11%) felt that the flooding situation had now been remedied (either through personal actions taken to prepare their home, or through actions taken by officials to secure the dam) and evacuation would not be necessary in the future.

Damage

Very few (11%) of the respondents had suffered any damage as a result of the March 17 flooding, and this was limited to lawns and shrubbery, basements, and small items in homes or garages.

V. SUMMARY AND CONCLUSIONS

Warning and Response

The evacuation effort of March 17 was extremely successful in terms of producing the desired response from citizens. Nearly everyone who received a warning evacuated, and evacuated quickly. Several interesting findings may be utilized to explain this high degree of response. First, a large proportion of the respondents who received a warning stated that the message contained a reference to a dam breaking. This kind of message, delivered as it was between 11:30 p.m. and sometime after midnight, apparently is quite effective in arousing people to an immediate reaction. Second, in conjunction with the highly emotional nature of the message, people were able to confirm the warning for themselves quite readily by observing the rising water both in Lena Gulch and in the streets outside their homes. This factor seems to have played a vital role in citizens' decisions to evacuate. The sight of the water actually rising reduced the uncertainty of the situation to a great degree in the sense that it was unnecessary to speculate about whether a flood was going to occur. The only uncertainty left for residents was how large the flooding event was likely to be. The reduced ambiguity in the first question allowed a quick and positive reaction (i.e., evacuation).

From another perspective, however, there was a major

difficulty with the effort. While it is true that virtually all of the residents who were warned subsequently evacuated, 36 percent of those interviewed did not receive a warning. Several analyses were performed to identify any systematic reasons for this group not receiving a warning. For example, one analysis examined whether those who did not receive a warning lived further away from Lena Gulch (data gathered in the previous study). A second analysis was conducted to ascertain whether those who did not receive a warning were predominantly in one age group. Neither of these hypotheses were borne out by the analyses. Most of those who did not receive a warning simply slept through all efforts to rouse them.

Other difficulties with the evacuation effort included the previously mentioned problem with the door-to-door method of warning, difficulties in intergovernmental communication and coordination, and a lack of directions for those evacuating (particularly relating to where they should go).

Preparedness and Future Behavior

One striking finding in this area is the large percentage of respondents who felt that nothing could be done to prepare for a flood, or who felt they did not have enough knowledge to undertake preparations. Such feelings of ineffectiveness could have serious consequences, particularly in the event of larger magnitude floods, when preparedness could be crucial for appropriate response.

A second important piece of information relates to the

large numbers of respondents who stated they would not evacuate in similar circumstances in the future. Having experienced a minor flood seems to have created a false sense of security regarding future flooding. Again, in the face of a larger event, such attitudes may prove disastrous.

Recommendations

Several recommendations emerge from the foregoing. A more strenuous effort must be put forth in future events to ensure that citizens receive an adequate warning. Given the fact that once a warning is received and confirmed a large number of people respond appropriately, it is vital that the warning be delivered. Alternatives to external warning mechanisms (e.g., tone activated in-home radios) should be fully explored. The warning message should state the conditions which exist, where people should go, and how to get there.

In conjunction with this point, city officials should designate shelter areas ahead of time, and these locations (along with recommended routes) should then be delineated on the UDFCD brochure. It might also be helpful if the map in the brochure would indicate a number of areas of high ground which could be reached quickly by persons without sufficient time to reach the designated shelter.

In another area it seems that the District must make a more concerted effort in its brochure to point out the kinds of preparatory actions residents may take. People must be convinced that some actions (e.g., the establishment

of an emergency plan) could be invaluable in the event of major flooding. This leads to one final recommendation. The brochure must emphasize the fact, even more strongly than at present, that large magnitude floods can occur. As residents experience a number of small events with very little effect, their sense of complacency grows, and this false sense of security must be dispelled.

Conclusion

The March 17, 1979 flood provided an opportunity to examine some of the processes related to natural hazard warning and response mechanisms. By and large, the effort to evacuate citizens was highly successful, but because of several circumstances (i.e., the small magnitude of the flood, the message contained the phrase "the dam is breaking," and the fact that confirmation was possible immediately), the success may have been partly luck. The fact that most people felt, and still feel, unprepared for this type of situation must be overcome if future efforts are expected to be as successful. Finally, the difficulties involved with warning the entire population-at-risk must be addressed in an effective manner in order to ensure the continuing public safety.

APPENDIX I
SUMMARY OF RESPONSES

1. Interview possible?

a. Yes	53 - 64%
b. No	30 - 36%

2. Did you receive a warning, of any type, to evacuate your residence because of potential flooding?

a. Yes	34 - 64%
b. No	19 - 36%

3. How were you given this warning?

Mode

a. Knock on door	16 - 47%
b. Telephone call	5 - 15%
c. Siren	3 - 9%
d. Bullhorn, loudspeakers	1 - 3%
e. Multiple modes	2 - 6%
f. Unknown or not mentioned	6 - 17%
g. Other (e.g., radio)	1 - 3%

Source

a. Police Department	7 - 21%
b. Fire Department	11 - 32%
c. Friends, neighbors	11 - 32%
d. Unknown or not mentioned	5 - 14%

4. As closely as you can recall, what was the content of the warning message?

a. Evacuate immediately	5 - 15%
b. Dam is breaking (had broken), evacuate	18 - 53%
c. Water coming	1 - 3%
d. Multiple message (water coming, evacuate)	7 - 21%
e. Other	2 - 5%
f. Could not recall	1 - 3%

5. Did you try to confirm the accuracy of the message?
- | | |
|--------|----------|
| a. Yes | 26 - 76% |
| b. No | 8 - 24% |
6. How did you try to confirm the warning (those who did)?
- | | |
|--------------------------------------|----------|
| a. Talked to friends
or neighbors | 1 - 3% |
| b. Talked to officials | 3 - 12% |
| c. Environmental cues | 19 - 73% |
| d. Radio or TV monitoring | 3 - 12% |
| e. Other | 0 - 0% |
7. Why didn't you try to confirm the warning (those who did not)?
- | | |
|---------------------------------|---------|
| a. Believed warning source | 5 - 61% |
| b. Previous flood
experience | 1 - 13% |
| c. Too frightened | 1 - 13% |
| d. Other | 1 - 13% |
8. What did you do immediately following the warning?
- | | |
|---|----------|
| a. Left | 20 - 59% |
| b. Monitored situation | 3 - 9% |
| c. Called to warn friends
or neighbors | 5 - 14% |
| d. Gathered possessions | 3 - 9% |
| e. Prepared home or self
in some way | 1 - 3% |
| f. d and e | 2 - 6% |
9. Did you evacuate your residence?
- | | |
|--------|----------|
| a. Yes | 33 - 62% |
| b. No | 20 - 38% |
10. Did you evacuate immediately?
- | | |
|--------|----------|
| a. Yes | 29 - 56% |
| b. No | 23 - 44% |
11. Why didn't you evacuate (those who did not)?
- | | |
|---------------------------|----------|
| a. Did not know of danger | 11 - 55% |
| b. Not concerned | 7 - 35% |
| c. Other | 2 - 10% |

12. Where did you go?
- | | |
|--------------------------------|----------|
| a. Relatives' home | 14 - 42% |
| b. Friends' or neighbors' home | 7 - 21% |
| c. High School | 5 - 15% |
| d. Shopping Center | 3 - 9% |
| e. Other | 4 - 12% |
13. Why did you choose this place?
- | | |
|------------------------|----------|
| a. Close and/or safe | 10 - 30% |
| b. Higher ground | 5 - 15% |
| c. Only known choice | 5 - 15% |
| d. Officials advised | 5 - 15% |
| e. Previous experience | 4 - 12% |
| f. Other | 4 - 12% |
14. How long were you out of your home?
- | | |
|--------------------------|---------|
| a. Less than 2 hours | 3 - 8% |
| b. 2 - less than 3 hours | 7 - 21% |
| c. 3 - less than 4 hours | 5 - 15% |
| d. 4 - less than 5 hours | 5 - 15% |
| e. 5 - less than 6 hours | 7 - 21% |
| f. More than 6 hours | 7 - 21% |
15. Before the night of March 17, 1979 do you feel you were prepared for a possible flood?
- | | |
|--------|----------|
| a. Yes | 23 - 43% |
| b. No | 30 - 57% |
16. In what ways were you prepared (for those that were)?
- | | |
|-----------------------------|---------|
| a. Flood insurance | 4 - 17% |
| b. Psychologically prepared | 4 - 17% |
| c. Evacuation plan | 6 - 26% |
| d. Aware of hazard | 8 - 35% |
| e. Other | 1 - 4% |
17. Why were you not prepared (those that were not)?
- | | |
|--------------------------------------|----------|
| a. Can't prepare | 10 - 33% |
| b. Did not know of danger | 6 - 20% |
| c. Did not believe flooding possible | 10 - 33% |
| d. Did not know how to prepare | 4 - 13% |

18. Do you feel that you are more prepared now?
- | | |
|--------|----------|
| a. Yes | 21 - 40% |
| b. No | 32 - 60% |
19. In what ways are you more prepared (those that are)?
- | | |
|---|----------|
| a. More aware of possibility | 11 - 61% |
| b. Specific household (or evacuation) preparation | 7 - 39% |
20. Why are you not more prepared (those that are not)?
- | | |
|--|----------|
| a. Can't prepare | 10 - 30% |
| b. No knowledge of how to prepare | 4 - 12% |
| c. Not concerned | 7 - 21% |
| d. Same level of preparation as before | 11 - 33% |
| e. Other | 1 - 3% |
21. In a similar situation, would you evacuate residence?
- | | |
|--------|----------|
| a. Yes | 34 - 64% |
| b. No | 19 - 36% |
22. Why would you not evacuate (those that would not)?
- | | |
|---|---------|
| a. No danger, but would if higher water | 7 - 37% |
| b. Not concerned | 7 - 37% |
| c. Not much damage | 1 - 5% |
| d. Believe situation remedied | 2 - 10% |
| e. Other | 2 - 10% |
23. Did you suffer any damage from the flooding of March 17, 1979?
- | | |
|--------|----------|
| a. Yes | 6 - 11% |
| b. No | 47 - 89% |
24. How much (those who did)?
- | | |
|--|---------|
| a. Lawn washed away (or other yard damage) | 2 - 33% |
| b. Furnace damaged | 1 - 17% |
| c. Small items damaged | 1 - 17% |
| d. Other (can't estimate) | 2 - 33% |