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THE WARNING SYSTEM IN DISASTER SITUATIONS:
A SELECTIVE ANALYSIS

Benjamin F. McLuckie

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Abstract

In many ways warning can be the most important phase of the disaster response. Warning is thought of not just in terms of mechanical devices but in terms of psychological and sociological structures and processes. Warning is not only advance notification of the existence of danger but also information about what can be done to prevent, avoid, or minimize the danger. The characteristics of the disaster agent -- frequency, speed of onset, scope of impact, destructive potential, etc. -- affect the warning process. Before a warning message can be issued, threat data must be collected, collated, and evaluated. This report examines what is involved in these processes. Multiple organizations are frequently involved in collecting data; thus it must be compiled. In order for this information to be useful it must be evaluated. The decision to warn and the dissemination of the message are discussed: who is to be warned, when, how, what the message includes. The response to warnings of danger is also considered. Included among the factors influencing response are the socio-cultural framework, the historical setting, and the immediate ongoing social situation. The report concludes with a discussion of implications for nuclear catastrophe.

FORWARD

This report was originally printed in 1970. Because of numerous requests for the report in the ensuing years, there are no longer any original copies available. The report was, therefore, reprinted in 1980.

This reprint is identical to the original one with the exception of a new title page and the elimination of several pages at the end of the report which refer to technical matters and the funding source.

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CHAPTER I

THE NATURE OF WARNING

Why still another discussion of warning in disaster situations? This topic is one of the very few in the disaster area on which there exists more than a handful of references.¹ One of the major reasons for this is the fairly obvious importance of warning in preparing for response to disasters. This is part of our reason for adding to the literature. However, it is equally clear to anyone with some acquaintance with the theoretical analyses and empirical studies of warning that the topic has not yet been quite satisfactorily handled. Another part of our reason for adding to the literature, therefore, is the hope that our discussion will help to clarify some outstanding issues and questions.

As a contribution to this clarification we treat warning as a system. Such a focus is neither original nor unique to us, but we attempt to carry the formulation further along this line than have others so far. The incompleteness and inadequacy of many discussions and analyses of warning, theoretical as well as practical, we believe partly rests on a failure to see warning in system terms.

In the rest of this chapter we attempt to specify the systematic nature of warning, after noting that warning in many ways can be the most important phase of many disaster responses. In the chapters that follow, our treatment is rather selective. In part, this is because a later report in this series will deal rather comprehensively with the larger topic of communications in disasters, and little purpose would be served by any great overlap in the discussions.² In other respects, the analysis is selective because, as just indicated, some aspects of warning have been treated so often in the literature that little would be accomplished by further detailed, extended reiteration of commonly accepted points (e.g., that community officials are reluctant to give warning signals unless they are rather sure that a danger is highly likely, or that there is a tendency at the individual level to avoid readily accepting cues that suggest threat to self). Those aspects of warning on which there is high consensus or much discussion in the prior literature, we will simply and briefly state, and go on to other matters.

In the chapter that follows we analyze the dimensions of disaster agents. This is necessary since the consequences of warning will differ depending upon the dimensions involved. Chapter 3 discusses the collection, collation, and evaluation of threat data. Warnings do not come out of a vacuum; they are usually the result of a filtering process, especially by certain key community organizations. In chapter 4, we examine the dissemination of warning messages as the result of decisions made earlier in the process. Included here will be a discussion of the content of warning messages. Chapter 5 deals with the responses and feedback to warnings of danger and includes an analysis of some factors affecting the public reaction. The

report concludes with a chapter on the implications for nuclear catastrophe that might be drawn from the prior analysis of warning. An appendix is also included that is a case study of actual warnings in a major disaster; this is primarily for readers who are not too familiar with the actual operations of warning systems in natural disasters. With this preview, we now turn to the importance of warning in community crises.

The Importance of Warning

Some disasters, such as explosions and earthquakes, do not allow for much if any warning. However, most dangerous situations do not occur without some prior indication of impending trouble. In these situations, warning can be the most important phase of any disaster response in certain major respects. It may be the difference -- at an individual or group level -- between avoiding a disaster and falling victim to the catastrophe.

At the personal level, the individual if properly warned turns his attention from whatever he is doing, scans the environment for further cues about threats, and generally assumes a posture of vigilance. This may allow either eliminating the threat by taking appropriate actions, or adaptive behavior which will lessen the chances of death and damage even if the danger can not be avoided.

At the community level, warning can be a step in the control of the disaster agent or in the orderly and systematic organizational preparation for impact. With warning, dikes can be reinforced, flood dams opened, clouds seeded, or whatever other steps are technologically feasible. At the very least, activities for reducing the potential consequences of the disaster can be undertaken: groups can be evacuated from endangered areas, advance preparations for speedy search-and-rescue activities can be made. With warning, planning can be directed to the post-impact need for coordination of relief efforts. Overall, warning is the process that activates other parts of the disaster response system.

This also suggests that the important aspect of warning lies in its social or human component, rather than in any technological or engineering feature. There is sometimes a tendency to think of warning in terms of mechanical devices such as sirens or radios. But these are merely means at best. Their activation, use, and functions are determined by the behavior of people and the actions of organizations. As such, warning should be thought of primarily in terms of psychological and sociological structures and processes, a position which we take in the rest of this report.

A Definition of Warning

Much has been written about warning in connection with natural disasters, but there is lack of agreement on how to conceptualize the phenomena and what

sort of framework to use to analyze warning-associated activities. The issue involves more than semantic differences or theoretical preferences. The position that is taken has implications for both basic research and practical applications.

For example, some authors, such as Williams, define warning as "the transmission to individuals, groups, or populations of messages which provide them with information about (1) the existence of danger, and (2) what can be done to prevent, avoid, or minimize the danger."³ It clearly follows as Williams himself notes that any activity which does not include the second component is not warning, whatever the implicit intentions of the communicator. Yet it would appear that most persons use the term only in the sense of advance notification of danger. This is seen in those writers who draw a distinction between alert and warning. The former term in this kind of discussion usually refers to an attention-getting signal that is intended to advise the recipient to prepare for action. Warning on the other hand is seen as not only advance notification but provision of meaningful data about the nature, extent, and imminence of the disaster agent. Nothing is implied in this formulation about the transmission of information on what to do about the danger. Weather Bureau advisories about tornadoes and hurricanes almost always take this form. The second part of the definition cited above, i.e., "what can be done to prevent, avoid, or minimize the danger," emphasizes the point that to affect the consequences of a disaster, the warning message must evoke some appropriate behavior on the part of the receiver of the message. A warning message should give information about both the existence of danger and appropriate action to be taken. Fritz has indicated that a warning should be "a call to action".⁴ Or as Beach notes, "if it does not have this function, it might as well not have occurred."⁵ Partly for this reason, we will use the formulation by Williams in this report.

When warning is equated simply with information about a danger agent, it is of course being seen primarily as some sort of discrete message or act. This in turn is related to another distinction in the literature on the framework to be used to analyze the phenomena. Warning can be visualized as a process or a system. Here again the difference is more than a verbal one or a matter of scholarly preference. It makes a significant difference as to which position is taken.

Most writers tend to view warning as a process, the essence of which is the transmission of a message from a source to a recipient in a somewhat linear fashion. Thus, Moore and others have suggested different phases or steps in the warning process.⁶ A typical formulation is to think of such stages or steps as: (1) detection, (2) prediction, (3) dissemination, (4) reception, (5) evaluation, (6) reinforcement, and (7) recall of the warning. This is a framework indicating a sequence from the first detection of cues about possible environmental threats to the phase when people decide on the basis of information, valid or otherwise, that the danger is over. Here again Williams takes a somewhat different position. He advocates a somewhat broader viewpoint that enables one to take into account feedback and to go beyond the linear transmission of a message. Warning from this point of view is best visualized as a system.⁷

Warning, however, can be viewed as a process that is the product of a system. One may speak, then, of the warning system and of its input and output -- the warning process. The component parts of the system, e.g., police and civil defense organizations, are viewed not as discrete entities so much as interrelated parts of a system. The input and outputs of the system are seen less as accomplished acts than as parts of an ongoing process. This essentially will be the point of view taken in this report. We conceive of warning as involving both the transmission of information about a threat and what should be done about the danger. We take the position that this can be visualized in system terms or as it has been stated:

It is useful to analyze warning as a system involving all the components, relationships, and processes which affect the determination and estimation of danger, the formulation or selection and transmission of warning messages, the way people interpret and act upon warning messages, and the effect which public responses to a warning have upon (1) the next warnings issued, (2) the systems which issued the warnings, and (3) the public itself.⁸

Thus, in considering the warning system we are concerned with not only the units that comprise the system, but also with their interrelatedness and with the larger system of which warning is a part.

Visualized in system terms, the warning processes can then be said to include the following:

1. The collection, collation, and evaluation of threat data. This includes the detection and measurement or estimation of changes in the environment which could result in some sort of threat, as well as the compilation of information from various input sources about threat cues and an assessment of their implications.
2. The decision to warn, and the dissemination of warning messages. This includes the different decisions that must be made before warnings can be issued, and the activities involved in preparing the content of warning messages and transmitting them to the public.
3. The responses to warnings and feedback to warning sources of new or old warnings about danger. This includes interpretations of the warning message by those exposed to the content, as well as actions of the persons interpreting the warnings.

In summary, then, we may say that warning is a process that begins with detection of a threat and is completed with action on the part of recipients of the message and feedback. When we analyze warning systems it is important to keep in mind that the system is comprised of smaller units and is itself a part of a larger system. In a similar manner the warning process is composed of a number of stages and is itself a stage in the larger process of response to disaster.⁹

FOOTNOTES: Chapter I

1. There are numerous references but among the best are Raymond W. Mack and George W. Baker, The Occasion Instant: The Structure of Social Responses to Unanticipated Air Raid Warnings, Publication 945 (Washington: National Academy of Sciences -- National Research Council, 1961); George H. Grosser et al., eds., The Threat of Impending Disasters: Contributions to the Psychology of Stress (Cambridge, Mass.: MIT Press, 1964); Harry Estill Moore et al., Before the Wind: A Study of the Response to Hurricane Carla, Publication 1095 (Washington: National Academy of Sciences -- National Research Council, 1963); Roy Lachman et al, "Human Behavior During the Tsunami of May 1960," Science 103 (May 1961): 1405-1409.
2. "Communications in Disasters: Intra and Interorganizational Aspects," forthcoming.
3. Harry B. Williams, "Human Factors in Warning-and-Response Systems," in The Threat of Impending Disasters, ed. by Growwer, p. 80.
4. Charles E. Fritz, "Disaster," Contemporary Social Problems: An Introduction to the Sociology of Deviant Behavior and Social Disorganization, ed. by Robert K. Merton and Robert A. Nisbet (New York: Harcourt, Brace and World, 1961), pp. 663-668.
5. Horace D. Beach, Management of Human Behaviour in Disaster (Ottawa, Canada: Department of National Health and Welfare, 1967).
6. Moore, Before the Wind, p. 15.
7. Williams, "Human Factors", pp. 79-83.
8. Ibid., p. 82.
9. For a discussion of disaster stages and phases see the January 1970 issue of The American Behavioral Scientist which is exclusively devoted to articles reporting findings and observations on natural disasters.

CHAPTER II

DIMENSIONS OF DISASTER AGENTS: CONSEQUENCES FOR WARNING

In this chapter we discuss the characteristics of disaster agents and their implications for the warning process and system. This is a generalized discussion; specific points will be examined in more detail in later chapters.

Disaster Agent Characteristics

Since the kind of disaster agent that poses a threat is of crucial importance to warning processes, it is necessary to analyze briefly the dimensions along which disaster agents can differ. Using such characteristics, it is possible to develop a typology of disasters along key dimensions and thus avoid the necessity of talking about particular kinds of disaster agents, i.e., tornado funnels, flood surges, hurricane clouds and winds, and so on. However, our aim here is much more modest. It is merely to list the key dimensions of disaster agents and to indicate in general terms how they may have a bearing on warning. As has been detailed elsewhere, there are at least nine major characteristics or dimensions along which disaster agents may differ.¹ These are: frequency, physical consequences, speed of onset, length of possible forewarning, duration, scope of impact, destructive potential, gross predictability and gross controllability. We shall discuss each one separately as their implications for warning range from very important to relatively minor.

Frequency

Hundreds of disasters occur every year but disaster agents differ considerably in their probability of frequently hitting a given locale. An earthquake may strike a particular area only once in recorded history, or the region may experience periodic earthquakes such as well-known regions in Italy, Japan, and some places in the western United States. Communities in certain sections of midwest America are often threatened by tornadoes. In fact, at least several dozen American cities have been struck two or more times by a tornado funnel. Certain river communities in the upper midwest have come to expect floods annually at given times of the year. Although irregular, seismic waves are periodically anticipated at particular points around the rim of the Pacific Ocean and the islands therein.

The importance of frequency in relation to warning is that the number of times an area has been impacted, or at least threatened, affects whether people and organizations become sensitive to threat cues, the warning systems organizations develop, and the general response that might be anticipated to

a warning of danger. In general, the frequency with which a disaster agent strikes or threatens a particular community affects the way that community responds. Thus, hurricane-prone cities such as Miami or New Orleans are especially alert to cues of such a potential threat; have elaborate warning procedures to alert their residents; and have developed a complex organizational structure to collect and collate threat cues, to disseminate warning messages, and to evoke public community responses to warnings of hurricane danger.²

Physical Consequences

Disaster agents inherently differ as to their physical consequences. The water involved in a flood creates a different kind of task problem than the wind of a tornado. Boats are needed in a flood situation where they would not normally be required in a tornado disaster. An epidemic likewise has different physical consequences than an explosion.

There are some implications for warning in the inherent physical consequences of a disaster agent if warning is thought of as involving an indication of the course of action to be followed. This is particularly true if the physical consequences of the disaster agent are not "self-evident." In an explosion in the atomic plant in San Antonio in 1963 that was studied by DRC, there was lack of clarity as to the consequences of the explosion and, therefore, what warnings were to be issued to the surrounding area.

Sometimes, the physical consequences of even a relatively familiar disaster agent may not be fully understood with unfortunate results. When Hurricane Audrey struck lower Louisiana, over 400 lives were lost. A great number of the dead seem to have been the inhabitants of one parish in the state who thought the rising waters accompanying the hurricane would not reach the ridges on which they were located. That the warning messages issued failed to make absolutely clear that one physical consequence of such a storm would be such very high waters, contributed in part to the heavy loss of life.³

Speed of Onset

The onset of disaster agents can vary widely but it is possible and useful to think of three types of onset: rapid, gradual, and repetitive. In the case of rapid onset, the length of time between the pre-impact phase and the beginning of the emergency period is very short because the agent strikes very rapidly (we ignore here those cases where there is no time at all as in the instance of most earthquakes). The flash floods which struck central and south Colorado including Denver in 1965 are examples of this type of onset.⁴ Gradual onset refers to those situations in which the effect of the agent on the populace is very gradual but ever-increasing in intensity until the emergency period is reached. Thus, in contrast with those disaster agents

that suddenly and unexpectedly appear, there are others, such as the rising rivers in the upper midwest in 1969 as a result of heavy winter snows, that literally were weeks in appearing. However, there are other types of disaster agents that do not strike with a single impact. They may be repetitive over a period of time, but are not so far apart that one would refer to them as separate disaster agents. For example, a series of seismic waves struck Crescent City, California in 1964 as a result of the shock waves set up by the Alaskan earthquake.

The speed of onset is an extremely important dimension in relation to warning. When the speed of onset is rapid, the warning period is necessarily short, and there is a probability that fewer people will receive the message about the danger. Even for those who do receive the message, there is less time to take protective action. Consequently, some protective actions that might have been possible given a longer period of time, as in situations of gradual onset, are not possible when onset is rapid, e.g., pre-impact evacuation.

However, it should not be assumed that the slower the speed of onset, the more effective will be the warning. Too long a period of forewarning without any immediate danger is more likely to create an apathetic reaction on the part of both individuals and groups, rather than an active response to a warning of threat. In other words, if the speed of onset is too slow, it will diminish the probability of the warning being taken seriously (everything else being equal). While the availability of a time period to give warnings is more desirable than no time at all, too much time in a sense is a mixed blessing.

Length of Possible Forewarning

There is a difference, not always recognized, between the speed of onset and the length of forewarning of a given disaster agent. The two are not necessarily related; it is possible to have either a long period of forewarning or no forewarning associated with each of the three modes of onset we discussed -- rapid, gradual, and repetitive. For example, there was a correct forewarning of almost an hour as to when the first seismic wave was to reach Crescent City, California, yet the impact was very rapid.⁵

The length of forewarning is, of course, important because it allows the opportunity for protective action. The degree of community disorganization may be inversely proportional to the length of forewarning in disasters with rapid onset. Problems of communication and coordinated response are heightened in such situations. This seems to result because without forewarning and with rapid onset, organizational activities are inhibited and the predominant adaptive response comes from individuals. Isolated individuals tend to operate within their own limited sphere of action. There is a tendency to react to the needs of the immediate situation, with little communication of needs and knowledge to others. Even possible warning messages about the danger may not be passed on.

Duration

Disaster agents may be grossly conceptualized as being of limited duration or of prolonged duration. Limited duration would be illustrated by an explosion such as the Indianapolis Coliseum explosion, where (with no secondary threats) the impact was over almost as soon as it occurred.⁶ On the other hand, certain disaster agents, such as floods or forest fires, may extend over several days or weeks, or in something like an epidemic possibly several months.

The duration is related to warning in at least two ways. Warning information about how to protect oneself from a disaster agent of long duration will obviously be different from that concerning preparations necessary for a short duration agent. Some of the difficulties that occurred in New Orleans as a result of Hurricane Betsy were the result of the fact that people had been warned about, prepared for, and responded to a hurricane; however, what they actually were faced with was a disaster agent of a much longer duration -- a flood. In other words, the content of warning messages and the protective actions taken as a result will necessarily be affected by the duration of disaster agents.

In addition, the period of time a disaster agent stays in a community will influence the issuing of warnings, particularly of new threats. In some respects, because of the disruption of community life occasioned by an initial disaster agent, it is sometimes difficult to transmit effective warnings about secondary sources of danger, e.g., about polluted water or food as in the Alaskan earthquake of 1964. In the Fairbanks flood of 1967, the amount of time the waters remained in the city meant that certain areas were not readily accessible to any kind of communication, and it was not easy to disseminate warnings about secondary threats.

Scope of Impact

The area that a disaster agent strikes may be localized or diffuse. A disaster whose scope is more diffuse throughout the total community tends to be more serious than one which is localized within the community. A localized disaster may leave the rest of the area around a neighborhood or segment of a community almost totally unaffected. When there was a gas main explosion in Jamaica, New York in 1967 only a few blocks were affected; the rest of the metropolitan area was totally uninvolved. A diffuse disaster would tend to be more disruptive. When Hurricane Beulah hit southern Texas in late 1967 it affected thousands of square miles and hundreds of communities in varying degrees.

Here again there are some possible consequences for warning, especially of secondary threats. In a localized disaster, communication equipment and manpower might be almost all intact, and since relatively few persons might

be directly involved, additional warnings might be easy to disseminate. In contrast, in the Easter Sunday tornadoes that cut across Illinois, Indiana, Michigan, and Ohio, the diffuseness of the impacted area (among other reasons) made it difficult for the earlier struck localities in the west to warn the eastern areas hit later.

Destructive Potential

Disaster agents differ as to their destructive potential, an obvious fact that is often forgotten by many within and outside the impacted area. This potential has two aspects to it. One, there is no necessary correlation between personal loss and property damage. A disaster agent may have tremendous potential for killing or incapacitating people, but it may have no consequences for damaging or destroying property. An epidemic is an obvious example of this, but a nerve gas "fall-out" accident as recently happened in Utah also illustrates the point. The converse of course can also be true -- that is, there may be considerable property damage and yet the disaster agent may have little direct consequence for persons, as in the instance of crop diseases or sudden freezing spells in Florida or California citrus fruit areas.

In addition, of course, disaster agents will differ in the extent of the destructiveness they may cause. When the Vaiont Dam overflowed in Italy as a result of a mountain top sliding into it, there was almost total obliteration of the people and property in its path. From a maximum of total personal and material losses in such situations, disaster agents diminish in their destructive capability.

The destructive potential of a disaster agent is important to warning in several ways. Prior to impact, it is not always easy to gauge the potential impact of a disaster agent and thus to evaluate the kind of warning that should be issued. Many factors may affect the potential destructiveness of a tornado funnel or hurricane cloud, for example, even if they do hit a particular locality. In part, because of the particular way Hurricane Betsy hit New Orleans, it was far more destructive than otherwise would have been the case. In some kinds of natural disasters such as hurricanes, the nature of the secondary threats that may be associated with it, such as the lines of tornadoes that are frequently spawned, are all but impossible to ascertain prior to impact.

After impact, the consequences of great intensity or great destructiveness, have many of the same implications for warning as a diffuse disaster agent. Greater damage and loss of life and general community disruptions may make it difficult to learn about and inform communities of secondary threats. The Alaskan coastal villages in the 1964 earthquake were in poor positions to be informed about and to respond to the seismic wave warnings that were issued in connection with the quake.

Gross Predictability

Disaster agents differ considerably in their predictability. Some disaster agents, such as those involved in explosions and earthquakes, are outside any current forecasting methodology. Some others, such as floods, hurricanes, and tornadoes can be predicted within a certain range. That is, gross predictions can be made of the probability of their appearance or nonappearance, the general paths the disaster agents are likely to take, and some estimates of their possible intensity. More specific details are currently unpredictable although recent advances in meteorology have considerably narrowed the area of the unknown.

Obviously the predictability of a disaster agent as a threat determines, to a considerable extent, the length and kind of warning possible. This, in turn, has consequences for the whole process of disaster response. The accuracy with which a disaster agent may be anticipated also has important consequences for response. In general, the more accurate the prediction as to the location of the threat, the more effective the response may be by the population affected.

Perhaps the most classic case of accurate prediction and effective response on a large scale, in a natural disaster occurred in connection with Hurricane Carla in September 1961. This hurricane of considerable magnitude, was spotted about a week before it reached the Texas-Louisiana coastline. Tracked by the weather bureau, it was possible to give rather extensive warnings. As a consequence, it is estimated that somewhat over half a million residents of coastal Louisiana and Texas evacuated their homes, with perhaps 200,000 of them spending at least part of their time at one of the more than 650 inland shelters that had been set up.⁷

Gross Controllability

Although the range is not as wide as in the case of predictability, disaster agents also differ somewhat in their controllability. Some kinds of disaster agents lend themselves to control, e.g., floods or forest fires. At least in the long run if not the short run it is possible to take actions which will neutralize the disaster agents involved. In the case of floods, dams can be built over the long run and spill-off procedures and raising of levees can be undertaken over a shorter period of time. In the instance of forest fires or mud slides, engineering activities can be undertaken that will prevent such events from occurring or at least will confine them to a very narrow area if they do occur. Other disaster agents, of course, are much less controllable, e.g., tornadoes, severe storms, and earthquakes. Even some of these agents, through such procedures as cloud seeding, might eventually be brought under some degree of gross control although at present that is outside of the limits of man's current knowledge and technology.

The degree of gross controllability that is visualized will have some effect on the warning that is possible and probable. For example, if it is thought that the disaster agent is potentially controllable in a given situation, there may be a reluctance to warn and alarm people. In some flood cases studied by DRC an element of this probability seems to have been operative and affected warning that was issued. In other instances, it is the matter of the possibility of control rather than probability that influences what occurs. If no control is thought possible, then it is very likely that warning messages will be issued or residents of an area will pick up threat cues on their own and act accordingly. Thus, when the largest dam in the area was thought to have broken, about a quarter of the city residents of Port Jervis, New York went to high ground.⁸

In a highly truncated fashion we have tried to indicate what dimensions of disaster agents are likely to be most salient in warning. We have treated each of the characteristics of disaster agents separately and individually. However, it is necessary to note that they may have different effects when taken cumulatively or in conjunction with one another. Insofar as warning is concerned, certain aspects may be magnified when they occur together, or in some cases they may actually neutralize one another. For example, it might be hypothesized for reasons implied in the last few pages that warning would be most difficult and ineffective if the disaster agent were infrequent, had non-obvious physical consequences, was rapid in onset, involved a short period of forewarning, was of lengthy duration, had very wide scope of impact, extremely high destructive potential, and both little gross predictability and gross controllability. Fortunately, it would appear that at a given time not many natural disaster agents incorporate all of these characteristics. However, in the last chapter of this report we will note that nuclear weapons have many of these characteristics to a considerable degree and this has obvious consequences for warning.

FOOTNOTES: Chapter II

1. For more detailed discussion of some of these dimensions see Russell R. Dynes, Organized Behavior in Disaster: Analysis and Conceptualization, Disaster Research Center Monograph Series (Columbus: Disaster Research Center, The Ohio State University, 1969).
2. This will be detailed in a forthcoming DRC monograph on the impact of Hurricane Betsy in New Orleans.
3. For description of the Colorado floods see Thomas E. Drabek, "Social Processes in Disaster: Family Evacuation," Social Problems 16 (Winter 1969): 336-349, and Drabek and Keith Boggs, "Families in Disaster: Reactions and Relatives," Journal of Marriage and the Family 30 (1968): 443-451.
4. F. L. Bates et al., The Social and Psychological Consequences of a Natural Disaster: A Longitudinal Study of Hurricane Audrey (Washington: National Academy of Sciences - National Research Council, 1963), p. 13.
5. William A. Anderson, "Disaster Warning and Communication Processes in Two Communities," Journal of Communication 19 (June 1969): 92-104.
6. Thomas E. Drabek, Disaster in Aisle 13: A Case Study of the Coliseum Explosion at the Indiana State Fairgrounds, October 31, 1963, Disaster Research Center Monograph Series (Columbus: College of Administrative Science, The Ohio State University, 1968).
7. Harry E. Moore et al., Before the Wind: A Study of the Response to Hurricane Carla (Washington: National Academy of Sciences - National Research Council, 1963).
8. Elliot Danzig, Paul Thayer, and Lila Galanter, The Effects of a Threatening Rumor on a Disaster Stricken Community (Washington: National Academy of Sciences - National Research Council, 1958).

CHAPTER III

COLLECTION, COLLATION AND EVALUATION OF THREAT DATA

In this chapter we consider what is involved in the collection, collation, and evaluation of the threat data that is necessary before a warning message can be issued in American society. We proceed by first discussing in general terms the overall and continual search for information that is usually triggered when an initial indication of a threat is deemed serious. In the later parts of the chapter we examine in more detail the specific processes that are involved in this search. Thus, we look at the collection of threat data and what affects that process. This is followed by a consideration of what influences the collation of the incoming data. We conclude this first section with an examination of what enters into the evaluation of warning data. The threefold distinction we make, of course, is for analytical purposes; in the reality of actual disaster situations the three processes are indistinguishably intermixed although there is a rough order with collection of threat data occurring first, followed by its collation, and ending in some sort of evaluation.

Continuing Search for Information

Without prior processing of threat cues there cannot be any warning. Even a single individual has to collect, collate, and evaluate cues before he can arrive at a judgement that he is in danger. At the collective or community level, the same things have to occur before a warning message can be transmitted. In some situations this is doubly important because there may be time for only one warning.

In emergency situations where there is the possibility of a series of warnings, there is often an attempt to continue to receive information about the impending disaster agent. Up-to-the-minute information concerning the type of agent, time of impact, its possible scope, duration, and other characteristics is needed by organizations and individuals in the community if there is going to be an adaptive response. One warning message may be all that is transmitted, but if there is more time, an effort is made to increase information inputs about threat cues.

Often the organizations who initially detected and disseminated the warning continue to search for information concerning the agent. While additional information may come from varied sources -- such as individual sightings of a funnel cloud, high sea waves, or approaching high water -- usually it is collected by "environmentally attuned" organizations such as the weather bureau. Also, organizations who have communication facilities of their own and are in contact with their own personnel and other organizations, such as police and fire departments, radio and television stations,

public works departments, etc., are often involved in gathering and disseminating this additional information.¹

For example, in flood situations the weather bureau constantly surveys the approaching flood waters and provides information on the impending disaster. This literally went on for months prior to the upper midwest floods in 1969 since extremely heavy snowfalls the previous winter indicated that there would be serious rises in river waters as the snow melted with the warmth of spring. During the Great Falls, Montana flood of 1964 the weather bureau issued the following bulletin at 11:00 a.m. on Monday:

Due to heavy rains over the head waters area of the Sun River during the past two days some flooding has already developed in the area above Fort Shaw. It will not reach the Great Falls area until about noon Tuesday. Further bulletins will be issued as soon as definite information from Givson and Diversion Dams become available.

One hour later, at 12:00 noon, a second, more specific bulletin was issued:

The overflow over Diversion Dam is now considerably higher than was ever previously recorded. Serious major flooding will occur at all points downstream to Great Falls. Overflow will begin in the Great Falls area about noon Tuesday, reaching levels higher than the 1953 flood Tuesday night or Wednesday morning. Further bulletins will be issued as additional information becomes available.

As noted, organizations which are normally involved in receiving and disseminating information and have normal day-to-day relationships with other groups and agencies may also provide information regarding the disaster agent. The following example illustrates how one radio station provided this information during a tornado. This excerpt from their broadcast in which two telephone messages are employed to pinpoint the location and direction of one tornado shows what are apparently typical sources of this information and the use to which this information can be put:

Radio: This gentleman on the other telephone line, you say that you have sighted the tornado?

Caller: Yes, about one and a half miles north of Wayzata on 101. We were down in our basement when the twister went over. Three windows were broken.

Radio: About a minute and half ago?

Caller: Yes.

Radio: We can add Hamel to our take-cover right now?

Caller: Yes, you should.

.....

Radio: We have a report from a sheriff. Where are you, sir? You want to give us your location?

Sheriff: 101. It just went through going north about two minues ago.

Radio: Give us that location again.

Sheriff: County Road 8 and State Highway 101, about a mile north of Wayzata.

Radio: Okay, and do you see any damage at all?

Sheriff: No, sir. We do not. There was quite a bit of fire from power lines in the sky. However, we did not see it touch down. This was a funnel at approximately 4 to 500 feet in the air, moving in a northerly direction. Very high wind.

Radio: That more or less puts it in a line towards Maple Grove and Anoka. Is that right?...That's the same one that went past...the north end of Minnetonka there and also the gentleman who called in north of Wayzata. I'm looking at a map that puts it in the vicinity of -- perhaps dead even with Hamel, but not as far west as Hamel.

During this stage of gathering further information on the disaster agent, various communication channels are utilized in order to disseminate it to community organizations and individuals. Some of these channels are pre-existent to the emergency; others may develop "on-the-spot." Many organizations with disaster-relevant tasks, such as police, fire, and public work departments, public utilities, civil defense, and city government agencies, the Red Cross and the Salvation Army, and so on, develop interorganizational relationships for the exchange of vital information about danger cues during this period. These communication channels may take various forms ranging from the installation of telephone "hot lines" to the placement of liaison officials with other organizations.

To further aid the coordination of the community response, ad hoc meetings are often held at which representatives from organizations such as those listed above gather, exchange information and evaluate it.² For example, in the Great Falls, Montana flood alluded to above, three top-level meetings were called before the flood crest arrived in the city at midnight on Tuesday. The first meeting, at the request of the city engineer, occurred at 4:00 p.m.

on Monday. Present were the acting mayor, county commissioners, county surveyor, county sheriff, and city department heads, as well as representatives of the local civil defense, Malmstrom Air Force Base, and the Montana National Guard. Here the ground work was laid for the response to the initial warning: that is, the gathering of further warning information, the evacuation that was probably necessary, the sandbagging of the river in order to counter the rising waters, and the dissemination of information about the threat and the steps being taken to the general public.

Tuesday morning there was another meeting of state, county, city, and military officials in the area to further outline the scope of the approaching danger and to evaluate further what needed to be done. The Corps of Engineers, the Red Cross, and state civil defense, who were not present at the first meeting on Monday, all had representatives at this meeting. Again information about the danger was exchanged, and problems of authority, evacuation and shelter taking, and interorganizational communications were discussed. At nightfall, with news that the rate of rise in the Sun River was increasing rapidly, another top-level meeting was held. Present at the third meeting were the acting mayor, the county sheriff, and the city engineer, state and local civil defense officials, liaison men from the National Guard, and representatives from the Air Force disaster control group, the Red Cross, and city police, as well as members from boat clubs in Great Falls. Once more, the main subjects of discussion were the exchange of information about the impending danger and how the different groups were going to maintain contact with one another during the emergency.

The above example illustrates very well how in those situations where extended forewarning is possible, the warning system may expand almost indefinitely. In a continuing search for information about the disaster agent, more and more groups and agencies are involved. Consequently, by time of impact, almost every relevant community organization has been incorporated in a network of contacts to collect, collate, and evaluate information about the threat. This response does not happen in all cases, but often enough to characterize it as typical.

Collection of Threat Data

Of the many things that could be said about the collection of threat data in American society, there are perhaps five points that should be emphasized. First, information about danger cues in the environment is overwhelmingly gathered by organizations rather than individuals. Second, many organizations are involved in varying degrees in obtaining such information. Third, not all groups and agencies involved in the collection of threat data are equally active in seeking cues. Fourth, organizations differ markedly in their ability to detect and understand indicators about possible disaster agents. And fifth, American community organizations do not always seem to cover the full range of potential danger cues. These five aspects are not all that is involved in the collection of threat data, but they are among the most important to note.

(1) Cues and signs regarding potential dangers can be spotted by various groups, agencies, and individuals in a community -- and have been at times. However, the complexity of the process and the technology necessary to detect indicators of threats in modern societies means that this activity comes to be borne by those organizations with collective skills and pooled resources equal to the task. Without discounting the value of visual observations by isolated amateurs, the "Paul Revere" image of the alerting process has been replaced by bureaucratic professionals handling radar, computers, microscopic slides, and helicopters. In fact, in an urbanized and mass society, it is doubtful that most individuals have the personal knowledge and familiarity necessary to recognize weather or medical signs indicating a possible threat.

In most disasters, certain community organizations are more involved than others in detecting changes in the environment which indicate a threat of some kind. In general, the weather bureau, public health services, local and state police agencies, civil defense groups, the utilities, and radio and television stations are often crucially involved in collecting threat data. The most elaborate of these organizations is the Environmental Science Service Administration under whose auspices the weather bureau collects information about tornadoes, hurricanes, blizzards, and floods.³ There are in fact a number of special centers to deal with specific disaster agents such as the National Hurricane Center in Miami, Florida, and SELS (Severe Local Storm Unit of the Weather Bureau) located in Kansas City, and responsible for paying particular attention to those meteorological conditions which suggest the possibility of tornadoes. The United States Coast and Geodetic Service operates an extensive seismic wave detection and measurement system. Besides the weather organizations there are special agencies to deal with possible epidemics and other medically-related disasters, and other groups to deal with water and air pollution. The detection of the potential threat of radioactivity, of course, has been primarily assumed by civil defense agencies.

(2) Depending upon the type of disaster agent involved, various community organizations may be involved in the detection of threat cues. In those disasters in which the length of possible forewarning is more than minimal, inputs to the warning system usually come to those organizations which are attuned to the environment. As indicated before, there may be a number of these, some within and some outside the possibly affected communities.

In fact, it is not rare for environmentally attuned agencies quite outside the local community to be the initiators of the first input of threat data into the warning system. For example, SELS is charged with the responsibility of forecasting severe storm activities for all parts of the United States. Particular attention is paid to those meteorological conditions which contain the potentials for spawning tornadoes. Thus, SELS each morning issues an "outlook" which covers the subsequent twenty-four-hour period. In addition, SELS continues its watch of these conditions. When weather data and radar information suggest more definite evidence for the

build-up of such storms, severe weather forecasts are issued to local weather bureaus in areas likely to be effected by these storms. SELS attempts to allow approximately six hours of lead time for such forecasts. The average lead time is actually about an hour and a half. The areas normally included in these forecasts vary in size from 20,000 to 30,000 square miles. The picture is quite similar for alerts for hurricanes and to some extent for floods.

Often local organizations may also detect threat cues more directly on their own. But here again it is the relatively rare situation where only one agency collects the threat data. A local weather bureau with radar may pick up strong echoes or hooks on the screen and from this detection, combined with such varied reports as airline weather messages and observations of security forces such as the local sheriff, become highly alert to the possible threat of a severe storm or tornado. The local fire prevention bureau may note that the weather has been extremely hot, dry, and windy, and coupling these with reports from the U.S. Forest Service, may become rather sensitive to the fact that these are the ideal conditions for widespread brush fires. In essence, it seldom occurs that only one organization is involved in gathering information about danger cues in the environment. This as we shall see later, however, creates problem in the collation of all of the threat data.

(3) Not all of the groups and agencies involved in the collection of threat data are equally active in seeking cues. Some organizations such as the weather bureau are accustomed to monitoring regularly environmental data as part of their day-to-day functions, including those that might involve some disaster agent. In fact, since one of the primary objectives of such organizations is to be alert to environmental changes of a certain kind, they are characterized by activity rather than passivity in seeking out threat cues. Other groups and agencies, however, are far more passive in collecting threat data. The mass media agencies of communication, the utilities, and even the police and fire departments have many functions of a daily if not hourly nature. They tend to become active in looking for danger cues only when they have already been alerted for possible trouble by the more "environmentally attuned" organizations.

However, there are some situations where almost all of the relevant organizations may be collecting threat data. Usually there are at least three factors at play to create this kind of situation. One, the speed of onset of the disaster agent is gradual and the length of the possible forewarning period is relatively long. Two, the organizations involved either as a result of prior disaster planning, or because of the existence of a disaster subculture, are accustomed to collecting threat data. And three, the potential threat is defined as probably a serious one for the community in which the organizations are located. Flood disasters, such as the almost yearly spring floodings of many communities in Iowa or the Dakotas, well illustrate this kind of situation. In those localities, practically every group in and around the possibly affected community can be found collecting information about the probable threat.

(4) The fact that organizational rather than individual sentinels are on the alert for danger cues means that the task is generally in the hands of trained personnel. Nevertheless, organizations can and do differ considerably in their ability to detect and understand indicators about possible disaster agents. This difference exists both between different communities, and among different organizations in the same locality. That is, some communities, either as a result of prior experience and/or training seem to be much more attuned to detecting threat cues than other towns and cities. Most emergency-relevant organizations in Los Angeles for example, seem rather responsive to collecting threat data, at least compared with the sensitivity to danger cues exhibited in some other metropolitan areas around the country.

Likewise, there is a range of capability among the different groups and agencies in a community. Some tend to be more professional than others. They simply have more trained personnel and specialized equipment which can be used to detect threat cues. However, sometimes even a fairly well professionalized organization may be called upon in an emergency to seek for unfamiliar danger cues. A police department searching for signs of gas leaks, whatever its professional capability, may be operating in an area relatively far from its general, routine competence.

(5) In most American communities, the full range of potential danger cues in the environment is not always completely covered. There are several reasons for this. Most of the environmentally-attuned groups and agencies we talked of before, tend to specialize in a sense in certain kinds of potential disaster agents. Accordingly, they pay little attention to threat signs outside of their organizational domain, and it is therefore possible that sensitivity to certain disaster agents may not be the specific daily responsibility of any group.

Other disaster agents are so infrequent in a particular community that they are not visualized as something to be watched for even on an irregular basis. The July 4 floods in northern Ohio caught some communities unaware because such disaster agents were not seen as potential threats in those localities. No one watched for them. Finally, diffuse threats with very slow periods of onset, such as are involved in water and air pollution, again tend to be generally ignored (at least until the last year or so with the increased emphasis on environmental quality).

Collation of Incoming Data

The collection and collation of incoming threat data might be thought of as a rather inseparable process. However, there is a difference, and often a marked one in actual disaster situations because of the fact as indicated earlier, that multiple organizations in American society are frequently involved in collecting threat data. Consequently, the various inputs of information have to be collated or compiled somewhere if they are to be of maximum usefulness. The process of collecting threat data would serve little

purpose if the information were not assembled some place at some time for eventual evaluation and later incorporation into a warning message.

There are three important aspects to note about the organizational collation of incoming data. First, there generally does not exist one central location or point for the assembling of information about dangers that might be threatening a community. Second, collation of threat data has to occur within as well as between organizations involved in the detection of danger cues. Third, the compiling of such information is peculiarly a collective process and thus subject to all the problems that befall anything that is collectively processed. Here again, these are not the only aspects involved in the collation of incoming threat data, but they are among the most important to note.

(1) It is characteristic of American society that there exists no one central location for the collation of incoming information about threat cues in the total environment. No such central point or pivotal organization exists at the national level, at the state level, and except in certain emergencies, at the local community level. There are instead multiple groups and points involved as can be seen in the matter of detecting threat cues even in meteorological associated matters; thus not only are there the subcenters of the Environmental Science Service Administration, but different centers exist for seismic wave sightings and the collection of information with regard to air and water pollution. In addition, of course, there exist a variety of places where information is collected by many groups for the detection of cues for disaster agents other than "Acts of God" and for other threats to the society, such as civil disturbances. There is no one major data monitoring organization that collects and collates incoming danger signs so as to obtain an overall picture of the total security stance of the system.

At times, the situation is somewhat better at the local community level. We gave an example of this earlier in the chapter when we briefly described what occurred during the Great Falls, Montana floods. While no one organization took over a collating function, the frequent meetings of organizational representatives served somewhat the same function. The threat information available to all groups was exchanged at the meetings. This kind of situation however can only develop when there is enough of a time period between the first indicator of a threat and the actual impact of a disaster agent. Also, as illustrated in the example given, it is typical that the collation of incoming data is handled in a somewhat informal manner. The only places where one finds a more formalized arrangement is where a strong disaster subculture exists. Thus, when Hurricane Camille approached New Orleans, dozens of organizational representatives were assembled under civil defense guidance in the emergency operating center of the city and considerable collation of information about danger signs occurred. However, this is a relatively atypical kind of situation, and not found even in all disaster subculture areas.

(2) Given the complexity of some of the large agencies and groups involved in the detection of disaster agents, there frequently is a need for

collation of information within as well as between organizations. There is considerable room for slippage of information within an organization during a period of stress. In fact, DRC has found that in general the problem is less the absence of important information in a disaster situation than it is that relevant information gets segregated or is confined to a particular subunit or segment of an organization.⁴ There is no reason to think that this general principal is not equally applicable to organizations involved in the detection of threat cues. If so, the necessity for collation of information within a given organization is clearly important.

(3) The collation of incoming data, processed as it is by a variety of organizations and subunits therein, is subject to the same problems likely to occur with any collective product. For example, there are difficulties sometimes just in the language used by different agencies and groups. Most organization language is rather specialized. The weather bureau, for example, make a very definite distinction between a hurricane or tornado "watch" and a "warning." "Watch" means a storm has formed and might appear in a particular locality. "Warning" means that the storm is imminent and protective steps ought to be instituted immediately. This distinction is perfectly clear to weather bureau personnel, but it is not always understood by other organizations leading to misunderstandings when information is being collated by one group or another.

Evaluation of Danger Cues

Whatever the amount of threat data gathered, no matter how carefully the information is collated, it is useless unless it is evaluated by some organization in some meaningful way. The chief problems at this point are those of evaluating the reliability of the information; estimating the precise implications of the data with a view to deciding whether a warning message should be issued, to whom, how, and at what time; and resolving the differences and contradictions between several sources of information. In other words, responsible organizational personnel must find answers to such questions as the following: Are the sources reliable? What does the data imply in terms of specific dangers to specific places at specific times? What about incompatible information? We shall discuss the matter of evaluation in terms of factors that enter into (1) an assessment of the reliability of sources of threat; (2) the perceived meaning of the information; and (3) the resolution of conflicting data. Again we make no pretense that this covers all aspects of the evaluating process; but these three aspects are rather crucial in the process.

(1) As is true of many other communication situations, those involved in the evaluation of threat data respond as much to the sources as they do to the content of whatever information they receive. That is, judgment of reliability is frequently made on the basis of what is known about the provider of the information; the message itself is less crucial. If the source is a known one, judged as having competence with regard to the disaster agent

supposedly involved, and has proved to be accurate in warning forecasts in the past, the chances are very high that any information of danger will be seen as reliable. The converse, of course, is also true. The more the source is unfamiliar, believed not to have much competence with regard to a possible threat, and has been incorrect in the past, the less likely will any threat data be evaluated as reliable.

Thus, a local weather bureau which has been rather correct in earlier situations is very likely to have its threat data accepted without question. An unfamiliar city group, a civil defense agency, or a county sheriff's office that has in previous times reported funnel clouds no one else saw, would have little chance of having its information viewed as reliable. However, it is important to note that it is not the nature of the organization per se that is crucial, but whether the group has the three characteristics just noted. For example, in some localities in midwestern states, the local civil defense office, on the basis of having the three characteristics would have its information about a tornado threat evaluated as reliable.

(2) While the meaning of the information about a threat appears to be less crucial than the source, it is not altogether an insignificant matter. It makes a difference at the evaluation point if the threat information is: (a) clear enough and (b) is detailed enough for the organization and community who might have to make some sort of evaluation of incoming data about a possible danger. Thus, low reliability in general tends to be placed on unclear or global statements about threat cues (assuming the disaster agent is not directly visible to the evaluating group).

In fact, the reliability of the information seems to be partly judged on the basis of what the receiving group needs to know. If the information is not detailed enough for its purposes, it may not be seen as too reliable. For example, the city of Chicago has for some time felt that the snow forecasts provided for them by the weather bureau are not detailed enough for the needs of different organizations in the city. The city requires quite specific, detailed information so they can determine whether or not they should undertake such actions as alerting all crews, placing crews on stand-by, preparing crews for plowing, preparing crews for spreading, watching traffic icing at intersections, watching for alternate thaw and freeze, or mounting plows. Consequently, for this purpose, both the Bureau of Sanitation and the Chicago Transit Authority have hired a private consulting firm specializing in meteorological services. This firm provides such information as (a) source of trouble, (b) specific time of beginning, (c) specific duration, (d) type of snow, (e) snowfall accumulation, (f) rain/ice time type, (g) air temperatures, (h) specific wind, (i) comments -- i.e., no rush-hour trouble, traffic icing at intersections, or icing due to cold pavement, (j) recommendations, (k) weather following storm, and (l) shower details. Clearly, given the needs of the city and the detailed information that is required, any kind of global statement that there is a 60 percent chance of snow in Chicago on a given day, is not going to be evaluated too highly.

(3) However, what is possibly the most damaging factor with regard to acceptance of information about danger cues, is inconsistent data. It is a

well established social psychological principle that individuals in the face of conflicting statements, some of whom are less threatening to their self-esteem, will almost invariably accept those statements as being more true, valid, etc.⁵ The same principle appears to be operative in the case of groups and organizations. If an evaluation group is faced with a series of inconsistent, ambiguous, or conflicting reports about danger cues, the strong tendency is to accept the weaker of the reports. That is, conflicting data is resolved in favor of that which supports the contention that there probably is no problem. There can of course be elements in a given situation which could override all of this (e.g. belief in an "impeachable source", one's own direct visual observation, a highly consistent pattern by one of the reporting sources of incorrect information, etc.). But generally the evaluation of inconsistent danger cues is along the line just indicated.

In this chapter we have briefly and selectively examined some aspects of what is involved in the processes of collecting, collating, and evaluating threat data. These processes provide the initial inputs into the warning system. What happens after that is discussed in the next chapter.

FOOTNOTES: Chapter III

1. For a discussion of police department activities in disasters see Will C. Kennedy, "Police Departments: Organization and Tasks in Disaster," American Behavioral Scientist 13, No. 3 (January-February 1970): 354-361.
2. An examination of the conditions leading to the emergence of such groups is presented in Arnold R. Parr, "Group Emergency Under Stress: A Study of Collective Behavior During the Emergency Period of Community Crises" (Ph.D. dissertation, The Ohio State University, 1969).
3. The various activities of this organization are detailed in Roy Popkin, The Environment Science Services Administration (New York: Praeger, 1967).
4. E. L. Quarantelli, "Some Observations on Organizational Problems in Disaster," Disaster Research Center Working Paper No. 20, mimeographed (Columbus: Disaster Research Center, The Ohio State University, 1969).
5. This point is discussed many places in the literature. For a general textbook discussion see John McDavid and Herbert Harari, Social Psychology (New York: Harper and Row, 1968), pp. 220-223.

CHAPTER IV

WARNING DECISIONS AND THE DISSEMINATION OF WARNING MESSAGES

The collection of threat cues, the collation of them, and an evaluation of their reliability, forces organizational officials involved to make a number of crucial decisions. They must decide if the general public and other organizations are to be warned; if so, how it should be done, and what specific information should be transmitted. Thus, in the pages that follow we first consider the decision to warn, then dissemination of warnings, and conclude with an examination of warning messages.

The Decision to Warn

Of the many aspects involved in the decision to warn, we will consider but three. (1) Either way the organizational decision is made in a potentially dangerous situation, the consequences can be very serious and will almost certainly affect warnings in the future. (2) Major responsibility for warning messages is seldom in practice, if not formally, the sole responsibility of one organization. (3) There are many factors at work, which can combine in a variety of ways, which affect a decision to transmit warning messages.

(1) The decision to issue a warning of impending disaster involves serious consequences. If the decision is made not to issue any message about a potential threat and the disaster agent strikes, the impact may be much more destructive of life and property than otherwise would have been the case. In some instances, responsible officials have delayed or have failed to alert the population to a threat. When the disaster then occurred, possible preventive or protective actions had not been taken.

On the other hand, a decision may be made to issue a warning message and then nothing occurs. In those cases, the population may be put to a great deal of inconvenience, loss of time and money, and will be subject to needless fear and anxiety. Perhaps more important, future warning activities will be affected. Officials who are subject to sometimes bitter criticism will hesitate more than usual in any future situation about issuing a warning message of a later danger. Persons who have gone through what they consider a false alarm, in turn, are not as likely to heed as seriously any later warning messages.

Officials in organizations that are normally involved in collecting, collating, and evaluating threat data seem acutely aware of the dilemma involved. They often express concern about the possibly disastrous consequences of a failure to warn; yet, they also indicate that they do not want to place themselves in a position of issuing needless calls about possible dangers. There does not seem to be any obvious, overall pattern to how the

problem is solved (although we will later discuss some of the factors that may affect a decision to transmit a warning message).

(2) The major responsibility for issuing warning messages seldom falls to one organization. This is so in two senses. One, sometimes there may be clear-cut responsibility for the issuance of the first or even later alerts that something may be amiss, but the warning message may not clearly indicate what should be done. The course of action, in other words, is left unclear and is not the prime responsibility of any group. The weather bureau activity generally falls into this category. This agency is charged with monitoring for certain danger signs regarding a range of meteorological phenomena, and for general notification that such signs have been noted. In this, its role and responsibility is clear cut. But if warning is also thought of as involving an indication of what should be done, the position is less clear. The weather bureau really has no formal responsibility on this score, and seldom, even at the local level, takes it upon itself to suggest protective or preventive actions.

In a second sense, particularly with regard to nonweather kinds of threats, there is often far less clear-cut understanding of who is responsible for what, insofar as warning messages are concerned. The mass media agencies, especially radio and television stations, have generally assumed the responsibility of passing on warning messages, but they rarely initiate them. In most ambiguous nonweather cases, the local police department typically takes on a warning function. This seems to be because of all community organizations, the police are almost inevitably one of the first groups to become aware that something is amiss. But even the police seldom issue warning messages unless the impact of the disaster agent is believed rather imminent; long-range and diffuse threats are left to whatever other (usually governmental) agency is willing to take on the function.

This is well illustrated in the DRC study of warning responsibility during the Easter Sunday series of tornadoes that hit about five upper central midwestern states. When asked what was their organization's role and responsibility in alerting the general public to the fact that tornadoes had been sighted, officials from different state police organizations, sheriff's offices, city police departments, and civil defense agencies, typically replied that they had only an indirect role in the warning process. They said it was the responsibility of radio and television stations to pass on such information. No member of any organization interviewed saw it as the responsibility of his group to initiate or to supplement the tornado forecasts that had been made and that were being broadcast by some of the mass media organizations. As one police chief said: "I never felt that it was our primary duty to inform the public because usually the radio has the information even before we get it."

The responsibility for issuing warning messages is further complicated by the fact that whole formal responsibility may be delegated to some particular organization and specific officials, the actual decision to warn sometimes proceeds in other ways. Certain organizations do have definite provisions as to who is responsible for making the decisions to issue and

disseminate a warning message to other organizations and the general public. However, even when there is a definite formal procedure and clear-cut positions with the authority to make decisions, the actual decisions are at times made on the basis of informal consensus. One DRC study of a tornado situation in a midwestern state showed that while a formally organized authority structure existed for decision making as to sounding an alarm, the decision to warn was actually made on the basis of informal discussions.

(3) A great number of factors operate in a variety of ways to influence a decision to issue a warning message. Among them are the following (not listed in any necessary order of importance): The decision makers have to make a judgment on the basis of the available information about whether a danger is really going to materialize at a certain place. Obviously all sorts of elements enter into such a consideration, from the technical knowledge or expertise of the decision makers to their past experiences with such kinds of information. Another factor is the estimation of the time thought necessary after warning to take preventive or protective actions. Again considerable variation is possible for one might be dealing with a "disaster-wise" population, or the warning message may be going to a community which has neither knowledge of the disaster agent or what actions can be taken to reduce the possible impact of the agent. Still another factor that enters into the decision making is the gross predictability of the disaster agent. As was discussed in chapter 2, there can be considerable variation in this and it can affect both if and how a warning message will be issued.¹

But probably the most important factor in the decision-making process is the consequences visualized. As noted earlier, decision makers generally see themselves faced with a basic dilemma. Too many false warnings might make persons insensitive to future messages about danger. On the other hand, many responsible officials -- especially in areas not generally subject to disasters -- are concerned with the problem of initiating a panic if it is indicated a disaster might be at hand. The problem of panic, as is documented elsewhere, is essentially a mythological one; nevertheless, to the extent it is believed to be true, it tends to inhibit officials from issuing warning messages.²

The Dissemination of Warnings

Of the many aspects of dissemination of warning messages that might be examined, we will consider only two. There are a variety of means or modes by which a warning signal can be sent. We will look at some of the means used and what affects their usages. There are different segments of a population and a community to which a warning message could be sent. In a way, different warning subsystems can be activated. The last part of this section very briefly examines three such subsystems.

The mode of communication of a warning message may range from verbal, face-to-face communication to the near ultimate in impersonality, strictly

mechanical devices such as sirens or bells. Taken on a sort of personal-impersonal continuum, mode might be visualized in the following manner:

Figure 1: Mode of Communication

<u>Personal</u>	<u>Impersonal</u>
face-to-face telephone	loudspeaker . . mass media . . mechanical (sirens, etc.)

An obvious parallel exists between source and mode, although this is only a very rough correlation. Sources utilizing the more impersonal modes of communication would tend to possess a higher degree of authority, simply because some authority is required for access to mass media facilities or mechanical warning systems. While the parallel should not be stretched to include credibility, it is apparent that individuals will tend to utilize the more personal modes of warning, with formal organizations tending toward the opposite of the continuum.

While any particular means of disseminating warning messages may have problems, the polar extremes on the continuum can especially generate difficulties if used for warning. Those warning messages that are handled solely on a personal basis take a long time to disseminate, often get distorted badly in the transmission, and may not reach the more isolated people in the population. The more impersonal means such as sirens, often can not be heard in "dead spots" in a community. They can readily be misinterpreted as ordinary day-to-day sounds. More important, they generally do not convey a message to most people other than to alert them to the fact that something, somewhere is wrong. When sirens were used in a Minneapolis tornado, they really did not communicate any forewarning of danger, but they did provoke many persons to turn on their radios to find out why the sirens were sounding.

Any number of devices have been used in different disasters to attempt to alert the general public. Among them have been sirens, lights, church bells, car horns, public address systems, etc. Short wave radios, both amateur and official -- fire, hospital, police, civil defense, and others -- have also been used; they have proved particularly valuable when electric power has failed and when telephone service has been disrupted or overloaded. Of the two major means typically used in American society, radio clearly seems superior to television. Because of the difficulty in making immediate and major program changes, not very mobile equipment and facilities, and the power failure problem in homes receiving telecasts, television is not as well suited as radio for short run emergency communication.³

The time when the disaster agent appears often dictates what particular means can be used or at least affects considerably their effectiveness. In the Minneapolis tornado of 1965 a communication about the tornado was given by the weather bureau to the radio and television stations in the area in time to be included on the regular 6:00 p.m. newscasts. Thus, large audiences

were tuned in and heard about the tornado. A completely different set of circumstances occurred in a few towns in Colorado during the flooding of 1965. News of the rising waters came late at night, and some of the radio stations -- not licensed to operate on a twenty-four hour basis -- were not on the air. The population besides was not accustomed to tuning in to these stations at a very late hour. Other means of warning, such as police sirens had to be used.

With the decision to warn a community of an impending disaster agent, three community subsystems may be set in motion: an interorganizational subsystem, an intraorganizational subsystem, and a general public alert subsystem. Such subsystems are more likely to exist in some localities than others, e.g., where there is a disaster subculture. But in a rudimentary form, they can probably be said to exist in any American community of at least moderate size.

The Interorganizational Subsystem. In most communities, certain organizations typically have contact with one another. For various reasons there tends to be close links between organizations that are particularly vulnerable to the damaging effects of disaster agents due to the nature and concentration of people they involve (e.g., schools and hospitals) or which have important functions in emergency situations (e.g., police and fire departments, sheriff's offices, civil defense agencies, public utilities, etc.) Directly or indirectly, warning messages usually get transmitted to these organizations.⁴ These organizations may be warned via teletype networks, telephone "hot lines", telephone fan-out chains, monitored radio reports, special sirens, bells, lights, buzzers, etc., and whatever other communication channels that exist as a result of nearly daily relationships between organizations.

The Intraorganizational Subsystem. Most organizations have means and channels for communicating with their own members. These channels and means, or others instituted as a result of disaster planning, can be used to inform organizational members of the presence and progress of a disaster agent. In fact, as was indicated earlier, some organizations stop to warn only their own staffs and make no attempt to warn others, especially the general public. In the Easter Sunday tornadoes, a number of sheriff's departments and some state highway patrol organizations learned of the oncoming tornadoes. They did issue a warning message to their own members but made no attempt to notify anyone else.

The General Public Alert Subsystem. This is the least likely of the subsystems to exist. In fact, they probably exist in any major way only in areas with definitive disaster subcultures. Since we consider the responses of the public to warning messages in considerable detail in the next chapter, further discussion of this subsystem is postponed until then.

Warning Messages

Our discussion of warning messages or content will consider four aspects. The first of these will be degree of specificity or focus of the

message. We will then consider the degree of urgency in the warning message. Third, will be an examination of the projected consequences of the threat conveyed in the message. We conclude with a consideration of the probability of occurrence implied in the message.

The degree of specificity of a warning message may be examined from two viewpoints. First, at whom is the message seemingly directed? Second, what is the nature of the threat set forth in the message?

Messages are frequently nonspecific as to their audience and are received and acted upon by recipients for whom they were not intended, or are not even received by their intended audience. This problem is vividly illustrated in the messages issued prior to the impact of Hurricane Carla in Lower Cameron Parish, Louisiana in 1957. In that instance, radio broadcasts from Lake Charles, Louisiana stated that there was no cause for alarm on the night of the disaster. These messages were heard by residents of Lower Cameron Parish who consequently took no action to protect themselves while, in fact, they were in grave danger. The messages were intended only for people in Lake Charles some sixty miles away.⁵

Other warning messages may be very focused with respect to their audience. In the flood which struck Denver in 1965, messages were very specific as to which blocks should be evacuated. While other factors confounded the process, both radio-television and face-to-face warnings were quite explicit about areas which were endangered. For example, messages were relayed urging residents living in areas bounded by Santa Fe Drive and the Platte River to evacuate. More specific direction could hardly be envisioned.

The other aspect about specificity of the message concerns the information as to the nature of the threat itself. An air-raid siren may well serve as an alerting message, but it is totally nonspecific unless those who hear it have received prior instruction as to its meaning. It may, in fact, not even serve as a warning message in many instances. Two researchers, in a summary and comparison of three studies, demonstrated that over 56 percent of the people hearing air-raid sirens did not believe them to be actual warnings of imminent danger.⁶ By way of contrast, sirens sounded in Topeka, Kansas, before the 1966 tornado stimulated a very high degree of protective action. While no precise quantitative data can be given, the low ratio of personal injuries to property damage and qualitative interviews both indicate widespread acceptance of the sirens as tornado warning messages. The basis of this different response is immediately obvious to anyone familiar with the city of Topeka. It is situated squarely in the midwestern "tornado belt" and the inhabitants had experienced a number of previous alerts, "near misses" in other storms, and much informational material had been circulated by community organizations. All of this worked together to provide a "meaning" for the sirens, nearly as specific as would have been the case had a radio broadcast been used.

To carry this illustration to the near ultimate, one might look at the messages utilized with great regularity in many river valley floods, especially along the Mississippi and Ohio rivers. These warning messages frequently

include very precise information of estimated time of arrival of the flood crest and its projected height and volume. These provide those threatened with a wealth of very specific information about the threat.

The degree of urgency in the warning message may be either explicit or implicit. Urgency is the extent to which a warning message communicates a need for immediate action. A good example of a message with a very low degree of urgency is the fairly standard weather bureau "forecast" messages utilized to announce a tornado watch. This normally is along the lines of "scattered severe thunderstorms and possibly tornado activity expected until 9:00 p.m. EST west and southwest of Sandusky." This type of message communicates very little urgency to the average listener, implying that there is no immediate need for action, that if such should become necessary, additional warnings would be issued. This particular message, it might be noted, is also very nonspecific and projects a very low probability of occurrence.

Messages which do convey a sense of urgency to the listener may do this in several ways. The most obvious way is by explicitly stating the urgency of the situation: "A flood of major proportions is sweeping into the city. All valley residents should evacuate their homes immediately and go to high ground." Descriptive information may also convey urgency, although less explicitly: "I've never seen anything like it, it's sweeping everything before it. A wall of water twenty feet high and about one-half mile wide is moving fast. There are trailers in it, houses, cows, trees. Bridges are mapping from the dikes. It's going to hit Denver and it's bad. My God!"⁷

The projected consequences of the threat conveyed in a warning might be called the "so what?" aspect of the warning message. Just what are the probable consequences of the threat? Does a flood warning simply mean that belongings should be moved to the second floor, or is the whole house apt to be swept away by a raging torrent? A hurricane warning may mean that high winds and heavy rain are due, or it may mean that the whole city might be destroyed. Behavioral reactions may be quite different, depending upon the consequences which the warning message projects.

This element, like degree of urgency, may be explicit or implicit. A message to project dire consequences need not explicitly state that a seismic wave will completely destroy all buildings within 5 blocks of the harbor. A statement that waves 50-75 feet in height moving at tremendous speeds will strike, portrays much the same image to a listener.

As others have pointed out before, the degree of urgency communicated by a message is a result of the composition of the entire message. The classic example of conflicting information destroying the urgency of a warning is the following:

In Piedras Negras (a Mexican town threatened by the rising Rio Grande) two loudspeaker cars "drafted" from the local theatre supplemented the four official units. It has been said that one of these cars cruised through the streets for a few minutes repeating "An all-time record flood is going to inundate the city.

You must evacuate immediately. (Pause) The _____ theatre is presenting two exciting features tonight. Be sure to see these pictures at the _____ theatre tonight."⁸

A similar problem exists when radio and television stations insert warning messages into their regular programming, but immediately return to normal broadcasting. In both of these cases the juxtaposition of warning and "normal" information or entertainment seems to imply that the warning is not really all that urgent.

The probability of occurrence presented by a warning message is also another important element. Weather bureau tornado messages here again provide an illustration. During the "forecast" or watch phase, the weather bureau issues very general kinds of information which alludes to large areas, frequently as much as a two-to-three state area. These messages indicate that a tornado is possible. As was noted earlier, these kinds of warnings convey little urgency. They also convey a very low probability of occurrence to the listener, for most people are aware of the fact that a tornado covers a very small area when it does touch ground. Secondly, many areas of the country undergo periodic forecast or watch periods with never a sign of a tornado. As a result, people recognize these as low probability statements. The more specific weather bureau "warnings,"⁹ on the other hand, are very high probability messages, stating that a specific tornado has been spotted at a certain location and is moving in a definite direction. If properly issued, these warnings convey the idea that the storm is virtually certain to strike the group of listeners at whom it is directed.

If both the warning source and the intended group to be warned attach very little probability of occurrence to the threat agent, the result can be truly disastrous. The DRC study of the 1964 seismic wave warnings in Crescent City, California demonstrated this. Crescent City is a coastal community which experiences "tidal wave" warnings with some regularity. On March 27, a seismic wave did strike the city, killing at least eleven residents and damaging property over a twenty-nine block area. Studies disclosed that the first warning had been received in the city some fifty-two minutes before the first, gentle wave washed in and better than two and a half hours before the fourth -- and destructive -- wave struck. The basis for the lack of (or inadequacy of) the response to this warning may be traced directly to the fact that the individuals involved, both local officials and inhabitants, felt there was a low probability of the waves actually striking. Considerable past experience had taught the local people that a "probable" seismic wave (as the warnings were worded) had, in fact, a very low chance of occurring. Also, cities farther north on the coast (thus, presumably to be stricken earlier) reported that no waves materialized when expected. All of these facts combined to produce an assessment to the effect that the waves would probably not strike. No evacuations were ordered by local officials, although residents were alerted that a wave was expected. As the number of deaths indicates, residents shared officials' disbelief in the probability of occurrence and took little protective action.

In this chapter we have considered aspects involved in warning decisions and the dissemination of warning messages. However, in a basic sense, unless there are some actual individual and group responses to such messages, the transmission of such information is useless. We turn therefore in the next chapter to an examination of response and feedback to warnings of danger.

FOOTNOTES: Chapter IV

1. For a discussion of different factors see Harry B. Williams, "Human Factors in Warning-and-Response Systems," in The Threat of Impending Disaster: Contributions to the Psychology of Stress, ed. by George H. Grosser et al. (Cambridge, Mass.: MIT Press, 1964), pp. 87-88.
2. E. L. Quarantelli, "Images of Withdrawal Behavior in Disasters: Some Basic Misconceptions," Social Problems 8, no. 1 (1960): 68-78.
3. A differential response to radio as compared with television was found by Harry E. Moore et al., Before the Wind: A Study of the Response to Hurricane Carla (Washington: National Academy of Sciences -- National Research Council, 1963), pp. 34-37.
4. See the appendix of this report for an elaborate description of such a warning subsystem in Topeka, Kansas.
5. Williams, "Human Factors," p. 80.
6. Raymond W. Mack and George W. Baker, The Occasion Instant: The Structure of Social Responses to Unanticipated Air Raid Warnings (Washington: National Academy of Sciences -- National Research Council, 1961), p. 38.
7. This is taken from an unpublished document issued by a radio station in the Denver area.
8. Roy A. Clifford, Informal Group Actions in the Rio Grande Disaster (Washington: National Academy of Sciences -- National Research Council, 1955), p. 27.
9. The weather bureau terminology has changed from time to time. Such words as "forecast," "alert," "watch," "warning," etc., have been used but a partial consequence is considerable lack of clarity on the part of most people and community officials with regard to which term means what situation. The term "warning" is here used in the more specific sense of current weather bureau usage, i.e. that danger is imminent.

CHAPTER V

RESPONSE TO WARNINGS OF DANGER

In this chapter we consider response to warnings of danger. We do so by first examining some of the general factors that influence individual and group responses. Among the factors examined are the sociocultural framework, the historical setting, and the immediate ongoing social situation. We then turn to a consideration of individual reactions to warning messages. This is followed by a discussion of group or organizational reactions. The chapter concludes with a look at the pattern of responses to later warnings necessary in a disaster and how they are affected by the earlier experience with the disaster agent.

General Factors

It is often assumed that information is information and that signs and signals convey what they are intended to mean. This assumption is often wrong, as one can confirm by recalling the frequent misinterpretations of cues and words which occur during courtship and other personal interactions as well as by observing what goes on in diplomatic exchanges and other interactions between different societies and nations. The assumption is a particularly dangerous one with respect to warnings of impending danger. Not only are the stakes often a matter of life and death, but a warning message may be interpreted in different ways by different people and groups, so that the community in question "gets" different "messages." A warning message is seldom a unique input of information which results in a specific and predictable output of behavior. It is but one of many inputs which the individual and group is receiving at a given time, within a context of particular circumstances.

There are many specific circumstances or factors that influence the response to warning messages. In any given situation, there are very intricate combinations of elements that affect how specific individuals and groups may react. Nevertheless, it is possible to depict certain general categories of factors that play a part in the general response of persons and organizations to warnings of danger.

The general factors may be divided in different ways, but for our purposes, a threefold distinction seems sufficient. We will look at: 1) the sociocultural framework, 2) the historical setting, and 3) the immediate ongoing social situation. Our examination of these will be relatively brief but will attempt to highlight why they are important and in what ways.

Sociocultural Framework

Among the factors that influence the interpretation of warning messages is the sociocultural framework in which the communication takes place. The sociocultural framework is something that develops over time and is "peculiar" to a specific group, organization, community, or society. It is this framework that lends an individualistic or distinctive tone to the response; it is this which primarily differentiates an organization's or a community's response from that of other organizations or communities under similar conditions.

One of the most vivid examples of a sociocultural framework is the phenomena of a "disaster subculture" to which we have already made a number of references.¹ The DRC studies of several river valley and coastal cities have discovered that a number of communities in those areas have developed distinctive "profiles" or "personalities." They are characterized by rather distinct sociocultural patterns geared towards the solution of problems involved in recurrent natural disasters such as floods and hurricanes. Regularized methods and procedures for coping with certain kinds of disaster agents have been developed in such localities. Part of the pattern is a somewhat standardized response to warning messages. Residents of the area and warning sources have both had so much experience with a certain type of threat that warning procedures and messages have become standardized. Receivers of warning messages have developed a standard interpretation and subsequent response, a fact which occasionally causes considerable difficulty when the standard response is not adequate.

Somewhat the same phenomenon, but working in the opposite direction, has been observed in areas which have undergone numerous false alarms. As well as eroding the credibility of warning sources, this type of experience may also engender a sort of "false-alarm subculture" in which warning messages elicit a standard interpretation, in this case a negative one. During the warning period in Ocean City, Maryland prior to Hurricane Barbara, residents of the city evidenced strong resistance to evacuation warnings. This stemmed from the fact that Ocean City had previously experienced the fringes of four hurricanes and thus "storms are part of the cultural environment of the population, and, though carefully watched, are not regarded as dangerous."²

Prior disaster experience, involving either direct impact or consistent "misses" may simply produce a different basis for evaluation of warning messages. If a community has heard numerous warnings over a five year period, it then has quite a different basis for evaluating the urgency and the projected consequences of a warning message than does a population which has not encountered disaster threats for a number of years. Lubbock, Texas, for example, is so used to having tornadoes hit all around it, that it does not sound its sirens (used as part of the warning message) unless impact is fairly obvious. This city simply has a different sociocultural framework for interpreting disaster agent cues as well as warning messages.

However, the dimensions of sociocultural framework involved in the warning system are not just confined to the possible existence of a disaster subculture. Although still poorly understood insofar as disaster responses are concerned, there are substantial socioculturally based differences within and between communities along class, ethnic, and religious lines to mention a few that can affect warning. For example, different classes or ethnic groups have varying conceptions of what constitutes a threat, or the credibility of community organizations that might be involved in issuing warning messages. It is not very realistic to believe that residents of an upper class suburban area and of a ghetto area in a metropolis will see dangers in the same light or accept warning messages via mass media agencies, the police, or certain other community groups in the same fashion.

Especially important in warning would be the credibility given to the warning. It has been said:

The extent to which warning will be taken seriously is strongly influenced by the credibility of the source or official from which the warning is issued. Does he have the position and status which evoke respect? . . . It has been found that even a mild fear message can produce a strong response if it comes from a credible source. On the other hand, a strong fear message has very little effect if it comes from a low credibility source or individual. It is probably the factor of credibility that makes people turn to friends and to selected officials when they are apprehensive.³

Credibility of the source can and does differ from authority. The police may possess a high degree of authority, but may for various reasons lack credibility. There is no escaping the fact that in certain communities they are viewed as something less than dependable protectors of all the public, and this view is especially noticeable in ethnic subgroups (black or Puerto Rican subcommunities, for example). In these instances the lack of credibility is a result of nondisaster-related conditions, but they are bound to affect responses to warning messages, if such kinds of warning sources and warned populations are involved.

It should also be pointed out that few things increase the credibility of a source as does a confirmed warning. Persons who earlier have had direct experience with a disaster agent become hypersensitive to signs of its reappearance, and warning under these conditions usually ensures adequate protective actions. This observation was validated by DRC studies in Crescent City, California in 1964 and 1965. In 1964, a tsunami struck the harbor area, doing considerable damage. This disaster was preceded by several false alerts, and when warnings were issued for the tsunami which did strike the city, response was very deliberate. The warnings issued in 1965 serve as vivid contrast, however, as the 1964 disaster lent the warning sources involved a good deal more credibility, and response was much more uniform and prompt.

Historical Setting

A disaster agent threatens an area at a particular time. Therefore, warning must necessarily occur in a particular historical setting. There are at least two aspects to this. Communities operate on social time. Communities react in terms of the "spirit of the times."

Social time is most important in understanding those disaster agents characterized by rapid onset and little forewarning. It is important because the activities of every community vary during the day, the week, the month, and the year. Such patterned activities have important implications for the warning system and processes.

For example, the reception of warning messages may vary according to time. Word-of-mouth communication of threat is difficult to accomplish during the privacy of the night hours. Mass media exposure also varies greatly with time. Audits of routine programming show great variations in the size and nature of the audience at various times of the day and week. Many people "abstain" from television on Sunday mornings and afternoons in general; on the other hand, Sunday evening tends to be a peak time for large audiences. Radio has a different audience pattern from television. Also, different times and programs are selective in their audience appeal. There are women's programs and children's programs during certain portions of the day. These all make a difference in how many persons are likely to be exposed to warning messages.

Social time is also important in whether individuals and groups can, for example, visually check the information in warning messages. Certain disaster agents or the conditions creating them can be seen visually by even relatively untrained observers. But such observations usually can not be made at night. Social time, in many cases, precludes the possibility of direct confirmation.

The other aspect of the historical setting that may be operative is what we have called the "spirit of the times." At certain times, there are widespread expectations and anticipations. Any cue indicating that such anticipations and expectations are at hand is likely to be accepted. What is involved here is the belief by the individual or the group, that there is a strong likelihood of the appearance of the disaster agent in question. Thus, studies of false air raid alerts in Chicago, Washington, D.C., and Oakland, California revealed that those people who believed war was imminent, that the international situation was tense, or that a war might be set off by mistake, were much more likely to interpret the sirens as signaling a real alert.⁴ Similarly, organizations and communities in the upper midwest in the spring of 1969, anticipating floods from the heavy winter snows, were very sensitive to accepting both short-run and long-run warning messages about possible dangers.

In the past air raid sirens have always sounded for tests and drills; this experience becomes part of the historical setting. It provides reason to believe that a present alarm is also a test or a drill. In a tornado in Minneapolis, this was the case; the air raid sirens had never been used to alert the population of an actual emergency. Of course, no factor works in isolation. Thus, in the Minneapolis case, the past experience and present were inconsistent in day and hour. One alternative interpretation as a result had to be questioned if not rejected. Air raid sirens on the wrong day and at the wrong time for a test are difficult to define as just another test.

Social Situation

Sometimes, individuals pay quick heed to warning messages. At other times, even though officially warned time and time again, people refuse to leave their homes or otherwise take protective action. In 1964 when the Sun River flooded the city of Great Falls, Montana, warning was possible. However, despite repeated official warning messages and weather bulletins, many residents in west Great Falls, the area which was threatened, remained in their homes until the last minute.

On the other hand, opposite responses can be just as easily cited. In Hilo, Hawaii in March 1964 mild seismic sea waves generated by the Alaskan earthquake struck the community but resulted in little property damage and loss of life. While the waves were not strong, evidence, however, suggests that residents would have suffered only slight losses even if a powerful wave had hit. The residents were warned and immediately took appropriate action by evacuating endangered areas. There was little hesitation on the part of responsible local officials to suggest that evacuation and other protective measures be taken by the public when news of the threat was received. Correspondingly, there was little resistance on the part of residents in complying with such suggestions.

What factors might explain why the population of a community may correctly interpret a warning message and take functional action in one instance, while in other cases not only is no action (or dysfunctional) action taken, but there is even incorrect interpretation of warning cues? As previously mentioned, warning is a communicative process taking place in an ongoing social situation. As such, it is affected by the social and psychological factors that are always operative in such situations.

Most persons would prefer to believe that they are safe rather than in danger and also that despite the sounding and reception of a warning cue or alert signal nothing bad will happen. This generalization is probably valid for most persons in most warning situations, with the exception of a few individuals who are psychologically set to believe the worst in any situation or those who have recently experienced a "near miss" disaster. Thus the initial interpretation of an alert signal is likely to be the most unalarming

of the available alternative interpretations. An air raid siren indicates first another test, drill, or a mistake; only when these unthreatening definitions are proven untenable are other less acceptable interpretations considered. Any ambiguity or apparent contradictions in the warning message and environment will typically be seized upon as evidence not for the worst but for the best. Therefore, successful warning depends upon the amount of information to be contradicted.

The information to be contradicted if the warning message is to be successful derives to a considerable extent from the ongoing social situation. In any given social situation, the persons in the situation are usually engaged in playing some kind of social role, interacting with others, and are differentially involved in the situation. All of these matters can drastically affect the response to warning messages. The influence may range from a total dismissal of the idea that there is any threat, to complete acceptance of the notion of immediate danger even though indicators of trouble may be rather minimal.

Any given individual fills multiple social roles and his interpretation of the same warning message may be expected to vary somewhat depending upon which role he is enacting at the time of reception. He may, for example, be a father, a salesman, and a Red Cross volunteer. Given these varying roles, one would expect greater credence given to a warning message received while the person is acting as a father or Red Cross worker, than one obtained while in the role of salesman. Still less credence might be given if this same individual were to be with a group of male companions spending a "night on the town." Different forms of social behavior are appropriate for different roles, and what might be appropriate for a father to do would cause a drinking companion to be ridiculed. Thus, interpretation of and response to warning may vary depending upon social roles.

Persons not only play social roles, but in almost all cases they are in interaction with others when they do so. As Williams has noted:

Except where action must be taken very quickly, the interpretation of warning and the decision on how to act usually involve seeking additional information from . . . other sources. . . . Where it is possible, a decision may involve the actual testing of possible courses of action. In short, interpretation of and reaction to warning is not a simple or automatic process, except in those situations where reflexive action, or at least very rapid action, is required. It is a complex and, if time and a group of people are involved, usually a highly social process.⁵

The interaction that goes on greatly aids individuals in defining the situation as threatening or not threatening. It is of interest that persons who are in the company of others, but not directly interacting with them, appear to have the greatest difficulty in interpreting the situation as a dangerous one, because the failure of others to respond in an alarmed manner leads the individual to assume that the information is of no great importance.⁶

The degree of personal involvement is also a factor that sensitizes persons to the content and significance of warning messages. Those individuals who have family members or close friends or relatives in a danger area appear to be more aware of warning messages. In the already mentioned studies of the false air raid alarms, it was found that persons whose families were in the potential danger zone were more likely to interpret the sirens as a real alert. This was the case whether they were separated from their families or not.⁷

Individual Reactions

Viewed from the simplest possible perspective, warning messages may have one of two results: either the recipients of the warning act with reference to the warnings, or they do not. If the recipients do act with reference to the warning message, this means the warning process has had some effect. Whether this effect is that desired by the warning sources, or whether it is sufficient to protect the recipients from the threat, is another matter. Simply to assume (as some warning sources have done in the past) that warning receipt can be equated with adequate response to warning is definitely an unsafe assumption.

If there is reaction to warning messages, it may take, in general, one of two forms: investigative or protective. It should be observed that these two forms are those which the actors themselves interpret their behavior as being. Objective circumstances may be such that the end result of a warning recipient's attempt at protective behavior is to increase his vulnerability to the threat, or they may cause attempted investigation to be actually protective action. We will here look at behavior as the actor himself sees it.

Protective behavior is that in which the actor takes one of many available measures to attempt to protect himself or others from a threat. It may be self-protective, other-protective, or both. Individuals attempting to take protective action usually resort either to flight or to taking some sort of shelter, although other apparently less directly adaptive types of protective action, such as prayer, are occasionally employed.

The National Opinion Research Center's study of the 1952 tornado in White County, Arkansas revealed at least eleven different forms of protective behavior exhibited by those threatened by the storm. In decreasing frequency order these included: precaution against wind and water, fire precautions, taking cover in a particular location within the structure, going to another residential structure, and placing oneself with relation to objects with a protective goal (e.g., under table, bed, etc.), as well as a variety of other less common protective behaviors. In this case there was little time for elaborate processes, such as evacuation.⁸

During the warning period prior to Hurricane Carla (a situation with much more forewarning) evacuation was not only possible but highly appropriate. Thus 43 percent of the respondents left the community, 22 percent stayed in the community but left their homes, and 35 percent remained in their homes. This latter statistic should not be interpreted as meaning 35 percent took no protective action, for most of these undoubtedly took many precautions, short of evacuation.⁹

The second sort of adaptive behavior, investigative, we have already touched upon in many ways. One further point should be noted. In most situations, persons aware of a warning usually seek to validate their own initial interpretation of its meaning (which is usually that "it doesn't mean anything") by observing the reactions of those around them, by watching the sky, by telephoning significant persons, by listening to the radio, or by other similar attempts to further define the situation. The implementation of protective measures must usually await the outcome of these attempts at confirmation. However, it should be noted that there are times when relatively immediate protective actions will be taken without confirmation attempts. The Mack and Baker study on three false air raid alarms indicated that even in these cases, with only a siren as a warning message (probably the most vague and nonspecific sort of warning message imaginable) a small group of hearers did take direct protective actions.¹⁰ The point here is not to dispute the existence of investigative and confirmation seeking behavior -- which, of course does occur quite commonly -- but to put a somewhat different interpretation upon it. Verification seeking is an alternative form of behavior, rather than a necessary precedent for protective action. It may well be a necessary precedent attitudinally, but not behaviorally. In his family study, Drabek found five basic evacuation processes. Of these five, only two might be construed as involving attitudinal commitment to the validity of the warnings. In the other three processes, people evacuated either intentionally or unintentionally, despite the fact that they did not believe that they were in danger.¹¹

Whether investigative or protective behavior comes to the fore, is of course, the result of many factors in the situation. However, what might be called organizational encouragement can tip the reaction to a warning message to a protective direction. Mack and Baker in their analysis emphasize the power of an organization to structure human response, regardless of people's attitudes. They note this is possible because:

Attitudes are separable from behavior. An organization can inhibit a man's discriminatory behavior even if he holds prejudiced attitudes. When the United States Navy desegregated recruit companies, white apprentice seamen shared bunk, mess and shower facilities with Negroes whether or not they were prejudiced. Why? They received, interpreted and acted upon the organization's signal to behave in a non-discriminatory manner because the organization had power over them. They had become accustomed to the fact that the organization could impose sanctions, that it would reward those who responded

to directives and punish those who did not. They had become conditioned to conforming when a directive announced that "All personnel will now..." do the following, whether it was fall out for rifle drill or form companies into racially integrated units.¹²

If an organization is present to encourage action in its members, and if the organization is oriented toward emergency measures, then it can be expected a higher proportion of the members will take protective action in reaction to a warning signal. This principle receives support from the study of false air raid alerts in Washington and Chicago. In Washington, many workers were in government offices where the correct response had been made known, or if they did not know what to do, there was a good chance that others would, especially supervisors or colleagues with civil defense training. Probably encouraged by this organizational environment, 20 percent of the persons involved took protective action even though only 7 percent thought the air raid sirens indicated a real air raid alert. In contrast, in Chicago, where most people were not in their organizational environment but with their families at the time of the alert, although 43 percent thought the sirens indicated a real air raid alert, only 2 percent took protective action.¹³

Of course, organization influence is helped if other cues are confirmatory of the warning message. In the 1966 flood on the Red River at Grand Fork, North Dakota, the flood crest developed very slowly and was preceded by torrential rains. Continual warnings were issued and were taken seriously. But the job of warning was undoubtedly made easier by the visual perception by everyone of the heavy rains and the steadily rising river.

Finally, a passing remark on the latent consequences of behavior is necessary. Sociological analysis has shown that behavior often has consequences other than that which the actor intended. Drabek shows the importance of this element in describing an interview with one of the families he studied. In this case the family had professed great concern upon receiving the warning message, but said that they did not evacuate. After probing, he learned that the family did leave home to investigate the threat and upon returning, were barred from their neighborhood by police who had, in the interim, established cordons about the area. Thus, although the intent of their behavior was to investigate, the effect was evacuation.¹⁴ If nothing else, this example shows the care that must be taken in drawing a distinction between investigative and protective reactions in response to warning messages.

Group Reactions

Warnings are crucial for community, organizational, and individual disaster responses. But they are crucial in a way only if preventive or ameliorative measures are taken. Such measures can be of two kinds. Steps can be taken to lessen the impact of the disaster agent, or the consequences of the impact of the disaster agent might be lessened in some ways.

Measures to Lessen the Impact of the Disaster Agent

In certain disasters it is possible to take direct action to limit or eliminate the damaging impact of the agent involved. Due to the amount of resources, specialized techniques, and quality of personnel normally required to institute these measures, this activity is usually the task of public, community organizations. For example, in floods, sandbagging or diking is often started in an attempt to control the spillover of water from a rising river. Temporary flood gates in some instances can be installed. In an epidemic a program of inoculation can be started in order to immunize as much of the population as possible. Fire breaks may be created in forests. While certain of these activities might be carried out by individuals acting alone -- such as a man drenching his home with water when a forest fire approaches it -- usually organizations with public health and safety orientations become involved.

In some respects, this points up that warnings may be more important for organizations than individuals. Most of the preventive measures in modern mass societies for the usual disaster agents can only be effectively instituted by large organizations. In many cases, even if everyone in the population were warned of the danger, there is very little they could do as individuals to prevent the consequences of the disaster agent.

Measures to Lessen the Consequences of the Disaster Agent

Steps can also be undertaken to limit the consequences of the impact agent, while not directly affecting the disaster agent itself. In these cases, both public organizations and individual residents may take part in the ameliorative measures. In the case of hurricanes, objects which might be blown away can be secured or placed in a sheltered place. Large plate-glass windows can be boarded up or taped to withstand high winds and flying debris. Hanging objects such as signs can be taken down. Supplies such as food, fuel, medical items as well as substitute heating and cooking facilities can be obtained.

In certain types of disaster events, evacuation is a major way of preparing for the worst consequences of a disaster agent. Because of the demands of this task if carried out on any scale, organizations with special control and disaster-aid functions are almost always directly involved. Furthermore, the decision to evacuate tends to come from local community leaders in their capacity as organizational heads. In specific disaster-prone areas, these procedures tend to be somewhat organized and fairly regularized.

The following illustration shows how some of the above mentioned preparations may require the extensive involvement of many different organizations, both inside and outside the impacted community.

In 1955, the two cities of Marysville and Yuba City, on either side of the Feather River, were threatened by rising waters. The State Division of Water Resources and various levee commissions patrolled two hundred miles of levees ready to give warnings if leaks were discovered. Further information for warnings were provided by hydrologic data from northern and central California collected by means of a radio steam gauge network. Constant telephone contacts were maintained with various agencies and personnel in the field. The Marysville Levee Commission called 2,000 troops from Beale Air Force Base for assistance. Trucks hauled fill material to workers attempting to strengthen the levee with thousands of sandbags.

As the threat continued, local officials in Marysville ordered the evacuation of low-lying areas. Residents who left quickly proceeded to Beale Air Force Base in cars, trucks, and buses. Further warning messages were issued by the Marysville City Council, and after a break in the levee, the decision was made to evacuate Marysville. Yuba City officials ordered evacuation of lower sections of the city and the Sutter County Sheriff evacuated residents of the threatened outlying areas. When the flood threat had fully diminished, city officials told residents that they could return.¹⁵

The dissemination of warning messages usually triggers the preparation of resources to cope with the danger inherent in the disaster agent. As earlier indicated, the clearer the nature of the disaster agent, the more efficient the response. However, another factor that also affects the response efficiency is whether the threatened community and the organizations therein have developed disaster plans.

Disaster plans normally include provisions for the allocation of personnel and resources, specific individual task assignments, instituting an emergency authority structure, increasing internal and external communication, etc. The advantage of having a pre-impact plan to aid in the coordination of community response is obvious. However, when these plans have been based upon past disaster experiences of the community or organization, they may be unable to handle effectively a different kind of disaster agent. In part, this is why the accuracy of the warning about the disaster agent is important. When the planning capabilities of the organization are based and contingent upon past demands, it may find its capabilities insufficient for meeting new, unexpectedly high demands. To some extent, this was the source of the problems in New Orleans after Hurricane Betsy. The community had been warned about a hurricane and responded according to its past patterns, but the disaster agent that had to be dealt with was a flood. In a way, many organizations were never warned about this threat and suffered accordingly. One of the public utilities had carefully placed its cars and trucks in locations that in the past had been quite safe from hurricane winds and rains. However, the localities involved were in a flood area and much of the equipment was therefore lost in pools of water.

In many American communities, however, a great number of organizations do not have pre-impact plans. Upon receiving warnings of a disaster agent, they must ready their resources and personnel on an ad hoc basis. This is very difficult to do under emergency conditions and is usually relatively inefficient. Thus, even the best of warning systems may be rather useless unless the appropriate groups and agencies are prepared to respond in ways that have been thought through and exercised prior to the impact of a disaster agent.

In certain communities, as in the example given earlier, a disaster control center may be established to coordinate the community's preparation for and response to impending danger. If the disaster agent is of any duration, almost inevitably such a command post will be established to monitor the continuing threat and to be alert for secondary dangers. Often a pre-existing facility, such as the command center in the police department or the emergency operating center at civil defense, will be utilized by the community to serve as this focal point. Sometimes, however, a center must be established on the spot. In those cases, the local telephone company, mass media agencies, or nearby military organizations are often responsible for providing the telephones and other communication facilities necessary for the center. Normally, such command posts will facilitate the warning process and be an integral part of the warning system.

Later Warnings

There is a surprising lack of attention to later warnings often needed in a disaster situation. As we shall try to show, a disaster agent impact frequently generates a considerable number of secondary threats which may linger for a long time after the initial impact. Individuals and groups need to be warned against those dangers also. Since this is a topic that is relatively neglected in the literature, we shall devote more space to it than otherwise would be the case, (although it is important in its own right besides the lack of attention). The point is well made in a discussion of Hurricane Carla:

Warnings were handled with great dispatch from the time of suspicion that a hurricane was forming until the time it had passed across the nation. But with the passage of the storm into the Canadian wilds, the need arose for another type of warning and informational program. The existing program, which had not been planned, was in consequence, ineffective. The type of warning needed in this instance would pertain to conditions in the devastated areas, and the dangers to be found therein which made immediate return impossible or so hazardous that the public welfare demanded that it be prohibited. Clearly, this was not a proper function of the Weather Bureau, as was the detection and prediction of movement of the storm.

Perhaps the weakness of warning apparatus was due to the fact that no agency was specifically invested with this duty, and no agency had either the equipment or the trained personnel required for the task.¹⁶

The initial impact of a disaster agent may be only the beginning of a set of tasks for a community. The community must protect itself against secondary and continuing threats. For example, power lines may be broken and fall across streets and sidewalks endangering the lives of those in the area who survived the initial impact. Also common is the creation of secondary effects which may, in the long run, be more destructive than the original disaster agent. For example, earthquakes create tsunami waves. Hurricanes often foster floods.

Most disasters involve some degree of continuing threat. Certain disasters, however, because of the characteristics of the agent, the physical setting, the timing of the impact, etc., may produce greater devastation from secondary threat than others. The earthquake that struck Niigata, Japan offers an excellent example of the occurrence of secondary threat and the resulting devastation.

Within the city the earthquake totally or partly destroyed 8,637 houses, damaged 9,633 others, disrupted all the public utilities, severely interrupted all means of communication, and put out of commission almost all the land, sea, and air transport facilities. The port area was so damaged and the entrance from the sea was so cluttered with debris, that almost all movement into the harbor was blocked. Every one of the eighteen lines of the National Railway system coming into the city were broken in at least two places. Crevasses and over 150 landslides caused blockage of all major highways and secondary roads in the area. Damage to the airport prevented the flight of anything but very small planes or helicopters. Over 50 percent of the land area of the city was flooded to a depth of three to five feet. The initial inundation resulted from the weakening of the embankments of the two major rivers in the city. A subsequent flood came from the tsunami generated by the earthquake, arriving thirty-three minutes after the first shock and continuing for six hours. Additional destruction ensued from nineteen small and five major fires that broke out immediately after the earthquake. Particularly serious was the huge conflagration in a major oil refinery in the port area. This fire burned twelve days and engulfed 90 tanks, 302 residences, and 197 nearby buildings. For a time there was a threat of poisonous fumes. Over 6,500 residents of this area had to evacuate.

Community records indicate that 152,401 persons in Niigata city alone were directly affected by either the earthquake, floods, and/or fires. Although the destruction was extensive, only 11 persons were killed and 120 injured in Niigata city. For several days after the earthquake there was concern over the possibility of a widespread dysentery epidemic. However, only thirteen cases were identified.

The secondary impact of a disaster agent may be anticipated by the community; that is, the community may expect that a certain type of initial disaster agent will be followed by a secondary impact by a different type of agent. This anticipation may be caused by past experiences with similar types of agents, adequate warning on the part of those agencies who normally perform such functions, general knowledge concerning disasters, etc. As an example of an anticipated secondary impact, following the Alaskan earthquake, many communities both within the initial impact zone of the earthquake and located as far away as California and Hawaii anticipated the occurrence of tsunami waves. The communities mobilized their resources, undertook pre-impact activities, and evacuated threatened areas. The community organizations normally responsible for interpreting environmental cues and warning the community performed these traditional tasks. When the waves struck these areas, therefore, at least a minimum of warning had been undertaken.

It is possible for an unanticipated second disaster agent to strike the community. New Orleans was faced with a dual disaster when Hurricane Betsy was followed shortly by a flood. While organizations had been warned and prepared for the hurricane, they neither anticipated nor were warned of the flood. These organizations were confronted with a situation which required reassessment in allocating existing and emergency resources. Preparation was not possible due to the unanticipated nature of the second impact.

In many disasters, the same organizations that issued the warning messages concerning the initial impact also may be involved in warning of secondary impacts. The United States Coast and Geodetic Survey may initially warn the local community of the possibility of tsunamis following an earthquake, this warning being disseminated through the local warning system. The local river authorities may warn of the flood following an earthquake. These organizations may, of course, be aided by other organizations in the community who normally do not function as a part of the warning system, but who do perceive cues of possible danger, and issue a warning message to the community. For example, a gas or petroleum company in the community may notice breaks in its lines following a disaster and warn the locality of fires or gas explosions. A shipping company through radio contact with its ships at sea may learn of the approach of a tsunami and pass this information on.

Warning may come also from individual community members who have developed a heightened awareness to perceive environmental cues following the first impact. For example, after the Alaskan earthquake, warnings about tsunami waves came mainly from individuals in coastal villages who cautioned their neighbors about the possibility of tidal waves following the earthquake. However, often community members may be deeply involved in such post-impact activity as search and rescue and therefore pay little attention to the environment, particularly in the sense of looking for cues of approaching secondary threats. The major responsibility for warning the community, therefore, falls to the local organizations.

FOOTNOTES: Chapter V

1. The concept of disaster subculture was first expounded by Harry Moore and later developed at DRC. See Harry E. Moore, . . . And the Winds Blew (Austin, Tex.: University of Texas, 1964), chap. 10; and William A. Anderson, "Some Observations on a Disaster Subculture: The Organizational Response of Cincinnati, Ohio to the 1964 Flood," Disaster Research Center Note, no. 6, mimeographed (Columbus: Disaster Research Center, The Ohio State University, 1964).
2. Jeanette Rayner, Hurricane Barbara: A Study of the Evacuation of Ocean City, Maryland August 1953 (Washington: National Academy of Sciences-National Research Council, 1953), p. 2.
3. Horace D. Beach, Management of Human Behaviour in Disaster (Ottawa, Canada: Department of National Health and Welfare, 1967), p. 84.
4. Raymond Mack and George W. Baker, The Occasion Instant: The Structure of Social Responses to Unanticipated Air Raid Warnings (Washington: National Academy of Sciences-National Research Council, 1961).
5. Harry B. Williams, "Human Factors in Warning-and-Response Systems," in The Threat of Impending Disaster: Contributions to the Psychology of Stress, ed. by George H. Grosser et al. (Cambridge, Mass.: MIT Press, 1964), p. 96.
6. E. S. Marks et al., "Human Reactions in Disaster Situations," unpublished report, photographed (Chicago: National Opinion Research Center, University of Chicago, 1954), p. 372.
7. Williams, "Human Factors."
8. Marks et al., "Human Reactions," p. 90.
9. Harry E. Moore et al., Before the Wind: A Study of the Response to Hurricane Carla (Washington: National Academy of Sciences-National Research Council, 1963), p. 36.
10. Mack and Baker, Occasion Instant.
11. Thomas E. Drabek, "Social Processes in Disaster: Family Evacuation," Social Problems 16 (Winter 1969): 336-349.
12. Mack and Baker, Occasion Instant, p. 40.
13. This is cited in Beach, Management, p. 84.
14. Drabek, "Family Evacuation."

15. Adapted from William W. Stiles, "How a Community Met a Disaster: Yuba City Flood, December 1955," The Annals of the American Academy of Political and Social Sciences 309 (January 1957): 160-169.

16. Moore et al., Before the Wind, p. 134.

CHAPTER VI

IMPLICATIONS FOR NUCLEAR CATASTROPHE

In this chapter, implications concerning warnings in natural disaster situations will be projected into a more inclusive context which might occur in a nuclear catastrophe. The basic assumption being made here is that the general range of warning problems experienced by communities in natural disasters would be relatively similar to those which would be encountered in a nuclear catastrophe. While the scope of impact would be greater from a nuclear disaster agent and there would be additional difficulties from radiation, the same kind and range of warning problems would have to be solved if there is to be an efficient and effective community response. The following should also be noted. The Office of Civil Defense considers the handling and dissemination of information on secondary and continuing threats as a direction and control function. As such, activities of that kind after the initial "attack warning" are regarded as a communication activity rather than successive "warnings." The implications can be stated in a series of eleven propositions.

General

As indicated in chapter 2, a disaster agent having certain dimensions or characteristics would make warning more difficult and ineffective: an agent that was infrequent, had non-obvious physical consequences, was rapid in onset, involved a short period of forewarning, was of long duration, had a wide scope of impact, extremely high destructive potential, and both little gross predictability and gross controllability would generally maximize warning problems. In the main, of course, the characteristics listed are those involved in nuclear weapons. Only the period of forewarning is not necessarily short (and obvious physical consequences are certainly as important as nonphysical ones like radiation). The possible lengthy period of forewarning does allow the opportunity for protective actions and is one saving grace in an otherwise rather gloomy picture. This in fact brings us to our first point.

(1) Warning is important in all disasters, but even more so in a nuclear catastrophe. In the very worst natural disaster, even if there is no warning at all and impact is total, it is still confined to a relatively circumscribed area involving a specific part of the total population. (The largest natural disaster insofar as casualties are concerned appears to have been either a 16th century earthquake or a 19th century flood in China; in both cases, estimates of those killed are in the 800,000-900,000 range.) The range and scope of a nuclear disaster is obviously larger, and without too much imagination can be seen as involving the area and population of a total society. Without warning it is not inconceivable that there might not be enough of a societal population base left to attempt the other usual emergency tasks such as search and rescue, etc. Unless some degree of warning is achieved, it is possible that

there is little purpose in being concerned about other problems. However, even if one does not postulate maximum impact and maximum destruction, warning would still appear to be a more critical function in a nuclear catastrophe than it is in natural disaster.

(2) Warning in a nuclear disaster must not only indicate the presence of a threat, but what can be done to prevent, avoid, or minimize the danger. We have stressed in this report that warning is not warning unless it does more than alert a community to trouble; it must indicate what can be done, individually or collectively, about the difficulty. In a nuclear disaster the problem is compounded by two matters. One, the effects of nuclear weapons are generally multiple and involve a series of concurrent and sequential threats -- what the example given from the Niigata earthquake earlier barely suggests. Thus, persons and groups must be warned at the same time not only of multiple dangers, but of the different kinds of preventive and protective actions necessary for the short and long run threats involved, from blast to radiation. Second, it is clear that relatively few people in American society either understand the full nature of the threat or, perhaps more important, what they could do about such a danger. The warning system must explicitly address itself to this problem in some way. However, as we tried to indicate, warning involves a system that encompasses different processes and it is these that emergency planning can do something about. We now turn to the process of collecting, collating, and evaluating threat data.

Collection, Collation, and Evaluation of Threat Data

The following discussion deals with the collection, collation, and evaluation of threat data at the more macro level, i.e., at the national and regional level. We do this because in the current warning system for a nuclear situation, the processes are generally set up at that organizational level. If, of course, we were talking of just local organizations, these remarks would not apply, for such groups would have far more problems than similar organizations presently have in detecting, summarizing, and judging natural disaster threat cues.

(3) The collection of potential threat data in a nuclear setting is probably the currently best handled of all the processes in the present warning system. It is already in the hands of a few organizations, especially at the national level, who through the use of their professional staffs will be active in seeking out cues at appropriate times. This refers, of course, to initial threat cues in a pre-impact period or "attack warning" procedures. The handling and dissemination of information on secondary and continuing threats is considered a command and control function by the Office of Civil Defense and is regarded as a communication activity rather than "warning." In saying the current collection process for nuclear threat cues is seemingly adequate, it is not being said that there can be no room for improvement. However, that kind of discussion would get us into an analysis of nuclear attuned organizations which we have not directly examined and with which this report has not been directly concerned. We are saying that the problems of multiple

organizations, passivity in seeking threat cues, competence in detection of cues, etc. that plague the collection of threat data in natural disasters do not seem to prevail as much in the case of a nuclear threat.

(4) The collation of threat data in a nuclear setting may not be as well handled as the collection of the information. As we indicated in our discussion of natural disaster situations, this is partly the function of two factors. One, even if there is a central point where information is collected, there is always considerable room for slippage of information within an organization during a period of stress. It is almost a sociological truism that important information in an organization tends to get segregated or "stuck" in particular subsegments or units. A simple illustration of what is almost certain to occur to some degree is illustrated by the general knowledge everyone now has of how intelligence data at the national level has not been properly collated at time of crisis in the past (e.g., the information that was collected but not collated in the warning system about the coming Japanese attack on Pearl Harbor). That the language that is likely to be used in the collation process is also almost certain to present something of a communication problem can be easily seen by observing how the technical jargon of civil defense officials in talking of radiation is noncomprehensible to most people.

(5) The evaluation of threat data in a nuclear setting might pose some problems. Because of the technology involved, there should not be serious difficulties in accepting the reliability of sources of threat information. The perceived meaning of the information may also not be extremely problematical. However, there is almost bound to be conflicting or inconsistent data. As we indicated earlier, there is a tendency to resolve inconsistencies by hesitation or acceptance of the least threatening definition of the situation.

At the level of our organizational focus, the collection, collation, and evaluation of threat data in a nuclear setting is almost certain to be relatively more efficient and effective than other processes in the warning system. More difficulties are certain to be involved in warning decisions or warning messages in a nuclear setting.

Warning Decisions and the Dissemination of Warning Messages

Since both macro and micro social units are usually involved in these processes, we will be talking both of national-regional organizations and local civil defense offices. In general, we will refer separately to the different group levels involved.

(6) The decision to warn will be a very difficult one in a nuclear setting. This is probably the most obvious of all our statements. The consequences, either way -- to put it in almost absurd terms -- will be serious. Clearly, too many false alerts (and in this kind of situation two such alerts probably would be seen as "many") would not only destroy the credibility of the warning organization, but generate a political reaction of the first

order. This would be true at any organizational level. Even more important here is the problem of multiple responsibilities for issuing warning messages. In the nuclear warning system, basic responsibilities for warning rest at the local community level. It almost follows from what we discussed earlier in this report that different decisions will be reached in different communities. Confusion in the situation is also likely to be reinforced by the absence of total clarity in some localities over who has what responsibility for what nonweather threat warning messages are to be issued, particularly when the danger is believed rather immediate, (e.g., what will police departments do if they learn that many of the communities in a region of their state have issued warnings, but there has been no warning in their own community?). In theory, the formal responsibility and right of the local civil defense office is usually clear, but, as we have indicated, in actual fact local warning responsibility is frequently informal and divided. All of the elements that are bound to influence a decision to issue a warning message are almost certain to result in a widely varying local pattern of nonwarning to warning messages.

(7) The dissemination of warning messages in a nuclear setting is unlikely to proceed smoothly. The more impersonal mechanisms which can be easily triggered such as sirens, do not generally communicate a real forewarning of danger. Chains of personal contacts, even if they could be initiated, simply would not provide enough time for appropriate responses in a nuclear setting. Only the interorganizational warning subsystems in a community would probably react well in such a setting; this would mean that at least the key emergency groups at the local level would be alerted. However, the most serious problem will be alerting the public and indicating the real nature of the threat. It is difficult to see that current local warning procedures for a nuclear threat -- primarily sirens -- are specific enough and carry enough urgency to move many people to action quickly and adequately enough. By themselves, sirens do not do a very good job of carrying a warning message in a much less demanding crisis situation, that is, a natural disaster. For economic, political, technological, and other reasons, it might be necessary to continue to place heavy reliance for initial alerts on sirens. However, it is necessary that complementary devices and procedures be developed; complementary devices and procedures such as have been worked out for tornado watches and warnings. Only in this way can there be any assurance that in a nuclear setting it will be possible to issue genuine warning messages. This part of the nuclear warning system does not now exist. A parallel kind of system barely exists in some localities for certain kinds of natural disasters which are expected and give a great deal of forewarning. It is not surprising that it does not exist for a crisis kind of situation that the vast bulk of Americans do not expect and have had no experience with in their local communities.

All in all, there are some very problematical aspects to warning decisions and the dissemination of warning messages in a nuclear setting. However, even if these problems were solved, they would accomplish little if appropriate responses were not evoked. Thus, we now turn to an examination of response to warnings of danger in a nuclear setting.

Response to Warnings of Danger

(8) Some of the general factors that could affect response to warnings of a nuclear catastrophe are not subject to any kind of direct control. The United States like all countries, does not have a "nuclear disaster subculture"; but unlike other societies, it likewise does not have a "war subculture." While this is a fortunate fact in most respects, it means that the population has little prior highly stressful wartime experience to draw from in its general response to massive, almost national threats. Further, as already noted, there is little real expectation among the largest segment of the population of such threat. However, certain events, such as the Cuban missile crisis, do generate a "spirit of the times" that does sensitize people and would affect their response to warnings. However, such matters are outside of the control of any warning agency for certain; the best that can be said is that response to warnings in such situations would more likely be appropriate than at other times. But even in this, as previously discussed, specific responses to warnings in such situations would be highly conditioned by factors in the immediate ongoing social situation. Some of these factors might be influenced by prior training, but many are really outside of any direct control (e.g., persons can hardly be put together with their other family members all the time).

(9) Individual reactions in a nuclear setting do lend themselves to some kinds of training and planning. As indicated in our earlier discussion, there can be organizational encouragement of certain kinds of behavior. If investigative behavior is not too desirable in a nuclear setting, and this might very well be the case, persons can be educated in various ways not to undertake such behavior. Various kinds of protective actions, of course, lend themselves even more to pre-impact education. Steps can be taken to insure that people can quickly find the necessary confirmation that will lead to the taking of protective steps. Perhaps consideration ought to be given to the fact that there are latent consequences to behavior; perhaps indirect ways of evoking protective actions might be explored instead of making a frontal attack upon the problem.

(10) Group reactions in a nuclear setting lend themselves most to some kind of planning and training. Measures to lessen the impact of a nuclear agent are best handled by organizations rather than individuals; similarly, for steps to lessen the consequences of the disaster agent. These are matters that require the development of extensive emergency plans and training. They are also matters that are taken up in great detail in each of the last chapters of the series of DRC reports of which this report is a part. As such, we will not discuss the details here, but suggest an examination of those reports that deal with groups and organizations such as the local civil defense office, police, and fire departments, etc.

(11) As we indicated in our earlier discussion, even in natural disasters, the problem of issuing information on later threats after an initial impact is a serious and difficult one. Dissemination of later information is

generally not well organized and often is not too effective. In part, this is because there are some inherent difficulties in trying to reach people and groups while struggling to cope with an initial impact of a disaster agent on a local community. However, the problem of secondary threats and secondary disaster agents is almost certain to arise in a nuclear catastrophe. The dangers will be many and of a high degree of intensity. Unfortunately, the nuclear setting will be an even more difficult situation for issuing later bulletins than any post-impact natural disaster situation. Nevertheless, it is a problem that must be attended to, first by becoming explicitly conscious of the possible problems, and then by considering how warnings can be maximized even under such extremely difficult situations.

In this paper we have selectively looked at some of the problems associated with warning systems. We have suggested or implied various solutions to some of the problems. The solving of such problems would probably do little to prevent the occurrence of the disasters themselves -- whether natural or manmade -- but they would certainly contribute to a recovery of the individuals and groups that were involved.

APPENDIX

A CASE STUDY OF WARNING SYSTEMS

This is a case study of the warning systems in Topeka, Kansas that were activated when a tornado hit that city in June 1966. The description and analysis is intended to familiarize the reader with the actual operations of warning systems in natural disasters. While the Topeka, Kansas situation is somewhat more complex than most, for that reason it illustrates well the range of problems involved in preparing for and transmitting warnings when there is a major weather threat to a community.

Introduction

On Wednesday, June 8, 1966, several isolated tornadoes touched ground in central Kansas. During the early evening, one of two tornadoes in the area near Topeka ground a diagonal path 8 miles long and 4 to 8 blocks wide across that city of 128,000 people. Red Cross estimates indicated that 800 dwellings were destroyed, 810 suffered major damage, and 400 more received minor damage. Around 550 persons were injured, of which 85 were hospitalized. However, only 17 deaths were recorded. Property damage was estimated at \$80 to 100 million, probably the highest dollar damage ever resulting from a single tornado.

Because of the prevalence of tornadoes in the state of Kansas during the spring and early summer months, elaborate warning systems had been devised for the city of Topeka, primarily through the local civil defense organization and the local station of the U.S. Weather Bureau. Three types of warning systems may be delineated in terms of the populations alerted in the event of impending severe weather conditions. An intraorganizational warning system is devised to inform members of a particular organization of the presence and progress of storm conditions. This organization may be part of a larger warning network, but the intraorganizational system itself is designed by and for the benefit of the particular group only. An interorganizational system is designed to alert those organizations which are particularly vulnerable to the damaging effects of a tornado due to the nature and concentration of people they involve (for example, schools and hospitals) or which have important functions in emergency situations: for example, police departments, sheriff's officers, etc.). A public alert system is responsible for warning the "general public" as individuals.

During the tornado which struck Topeka, the intraorganizational and the public warning systems were highly effective, as evidenced by the low ratio between the number of deaths and the amount of property damage. However, certain phases of the interorganizational system broke down, and most of the organizational officials involved in this system were alerted to the storm

conditions as members of the public. This study examines all three types of systems and attempts to indicate the reasons for the ineffectiveness of the interorganizational warning system.

The Warning Systems

In skeletal form, the Topeka tornado warning system is represented in figure 2.

Figure 2: The Topeka Tornado Warning System

<u>Interorganizational</u>	<u>Intraorganizational</u>
(1) Weather Bureau teletype networks	(1) Citizen's band radio club storm watch lines
(2) Weather Bureau back-up calling list	(2) Radio Station A, mobile unit system
(3) Telephone hot line (prior to the siren sounding)	(3) Sheriff's civilian weather watchers
(4) Back-up telephone chain (after sirens have sounded)	(4) Police watch system
<u>Public</u>	
(1) Sirens	
(2) Radio and television	

We will now discuss each of these separately.

Interorganizational Alert

A statewide weather bureau teletype system, including the weather station at the Topeka Municipal Airport, is monitored by the local radio and television stations, the city police department, the county sheriff's office, and the local post of the state highway patrol. The local weather bureau supplements this network with a telephone calling list. Notified by the bureau over normal telephone lines are nine radio stations outside Topeka which do not have weather teletype monitors; the superintendent of schools, notified both as a precautionary measure and in preparation for the possible use of schools as future evacuation centers; a local citizen's band radio organization; and a local ham radio operators' club.

Under the direction of Civil Defense, a "hot line" system links the city police and fire departments, the county sheriff's office, the highway patrol post, and Civil Defense over direct telephone lines. An additional line to the nearby Air Force base was being installed at the time of the tornado disaster. Under this hot line system, the first agency notified of severe weather conditions or of a tornado watch will relay this information to the other organizations. The purpose of this network is to insure that all these governmental agencies are aware of weather conditions as reported by the weather bureau in advance of any siren sounding.

Finally, after the public alert sirens have been sounded, use is made of a back-up telephone fan-out system by Civil Defense. Its purpose is first to insure that certain organizations have heard the sirens and secondly to see that these sirens have been correctly interpreted as warning of an immediate threat of tornadoes to the area. The three primary categories (sheriff, police, and radio-television) would have already been notified by the weather bureau teletype monitor, but confirmation of the actual presence of a tornado is given by telephone from the airport weather station. Apparently, the police department would be the first organization called by the weather bureau since it sounds the city-wide Civil Defense sirens. (As in all the ensuing phases of the chain, the legitimacy of the calling party is confirmed by use of a prearranged code name which is to be given only in the event of a tornado alert. Separate code names have been assigned all the organizations in this chain.) After the tornado alert has been verified by the weather bureau and the sirens have been sounded, the police department places five calls which actually initiate the back-up chain. Each agency in turn, after receiving the telephone alert and satisfactorily confirming its legitimacy, places additional calls until all the listed organizations have been contacted. All telephone communications, including the initial call from the weather station to the police, are handled by normal switchboard lines, but many through unlisted numbers.

In addition, it should be pointed out that many organizations have facilities for receiving communications other than those needed in these warning systems. For example, the fire departments, some radio and television stations, and at least one hospital have police radio monitors. Also, some have worked out smaller warning networks of their own as a kind of back-up to the back-up chain.

Intraorganizational Alert

Perhaps the most interesting organization involved in tornado warnings in Topeka is the private citizen's band radio club. This local group, using privately owned equipment, has developed, with the aid of local weather bureau personnel, a storm watch system whereby five members in cars equipped with mobile radio units are sent to prearranged positions on one of nine stormwatch lines. These five line units are positioned at distances of 5 miles (due to the limited range of their equipment), thus extending 25 miles

from their central control station. Also, another base unit, which is in contact with central control and thus with the 5 field units, is located immediately adjacent to the radar screen at the airport weather station, enabling a club member to communicate simultaneously with members of the watch line and observe weather patterns on radar.

A local commercial radio station (Station A) also has a prearranged mobile alert plan. When it is apparent that severe weather conditions are in fact in the area, four station personnel, in mobile units equipped with radio apparatus for contacting the station and for broadcasting "on-the-spot reports" directly, are dispatched in four directions. When one of the mobile personnel sights an actual formed cloud, the station interrupts its programming to allow the reporter to broadcast what he is seeing and where, where the funnel cloud is heading, and what areas should take cover. Of course, at this point the system has become a public alert system, but the purpose of the plan itself is to keep the broadcast personnel at the station informed so that they in turn may pass this information on to their listeners.

The sheriff's office has enlisted the services of twenty to twenty-four civilian weather watchmen throughout the county, all of whom reside outside the city limits. These watchmen notify the weather bureau and the sheriff's office of the presence and progress of storms in the area. Also, the city police department dispatches five patrol cars into different parts of the city to observe and report on weather conditions as a part of its weather watch.

Public Alert

As mentioned previously, Topeka radio and television stations have weather teletype monitors, and some also monitor the police radio. Information gathered from these sources concerning weather conditions is passed along to the public as a part of their normal programming. In addition, radio Station A has specific preplanned devices and procedures which it enacts during a tornado watch. Whenever this station receives a tornado watch bulletin, it first begins what is termed a beep system. This involves the superimposition of five recorded beeps every two minutes over the regular programming. In addition, any statement from the weather bureau is read every fifteen to twenty minutes. When one of the mobile reporters assigned to a weather watch location sights an actual tornado, a recorded siren sound is broadcast, interrupting the actual programming. This siren tape includes a recorded voice announcing that this is a tornado alert, followed immediately by the remote broadcast.

Other radio stations also have specific, but less extensive, procedures. For example, one station which originates separate AM and FM radio broadcasts as well as television switches to "simulcast," whereby all three stations carry the same emergency programming.

In Topeka, the Civil Defense sirens represent the central mechanisms for warning the public. There are nineteen sirens located through the city in addition to one operated by the railroad shops and one by the Air Force base. The city police department is the only agency which can sound the public sirens and is responsible for doing so when a tornado, verified by the weather bureau as representing an imminent threat to the community, is sighted in the area. The police department is also responsible for alerting the railroad so that they may sound their siren at the same time. To the public, the sirens are intended to mean that there is immediate danger of a tornado and that cover should be sought at once. After the sirens have sounded and the threat of a tornado has ended, the "all clear" is given only by the commercial radio stations.

Warning Systems in the Disaster

On Wednesday, June 8 at 11:00 a.m., the U.S. Weather Bureau teletype carried a tornado bulletin placing the Topeka area under a tornado watch from 2:00 p.m. until 8:00 p.m. Throughout the afternoon, the teletype carried reports of isolated tornadoes touching down and of tornado damage in the countryside. For example, at 3:09 p.m. an isolated tornado touched down in the country 160 miles southwest of Topeka. At 5:25 p.m., another tornado damaged farm buildings in an area 80 miles due west of the city and was reported traveling in a northeasterly direction, away from the Topeka area.

At 6:05 p.m., weather bureau radar at the airport picked up two separate storm cells (i.e. the circular configuration observable on the radar screen as a result of an electronic "echo" from a storm), one to the southwest and another to the northwest. The northern cell appeared to be the stranger of the two, a suspicion strengthened by reports of a funnel cloud 54 miles north-northwest at 6:30 p.m. moving away from the area in a northeasterly direction. At 6:50 p.m., the weather teletype carried a notice of heavy thunderstorms moving into the western edge of the area, but as late as 6:58 p.m. the strongest activity visible on radar was still to the northwest. Then, at 7:00 p.m., a call from the airport tower advised the weather station of a dark cloud to the southwest. At this time, three telephone calls were received from private citizens reporting a funnel cloud southwest of the city. The weather bureau began to scan the southwest area closely, and two minutes later (7:02 p.m.), a hook appeared on radar in an area 7 miles southwest of Burnett's Mound (located on the southwestern fringe of the city). Moving into the city in a northeasterly direction at an estimated 30 miles per hour, the tornado crossed the Mound (despite Indian legends to the contrary that no tornado would ever cross the mound), inflicting heavy damage in an area of apartment houses at 7:18 p.m. Remaining on the ground as it continued its diagonal path through the city, it passed through the Topeka Municipal Airport, exiting from the northeast edge of the city at 7:30 p.m.

At 11:00 a.m., all organizations monitoring the U.S. Weather Bureau teletype system had been notified of a tornado watch for the Topeka area. At that time, the local weather station promptly relayed this information to the organizations on its supplemented calling list. Throughout the afternoon and evening, the teletype reported on the progress of storm conditions, including the radar sighting of the two storm cells. Apparently, the police department took the initiative and relayed the teletype information they were receiving to the other agencies connected by the hot line network. In this manner, the fire department, the sheriff's office, the local highway patrol post, and Civil Defense were advised as to weather conditions between 11:00 a.m. and 1:00 p.m. Additional contacts were made during the afternoon, as indicated by the fact that police informed the highway patrol of strong thunderstorm activity in an area 54 miles northwest of the city at 5:24 p.m.

As evening approached and weather conditions grew worse, various agencies began to enact their intraorganizational alert systems. Radio Station A initiated its beep system at 2:00 p.m., coincidental with the tornado watch period and broadcast the latest information from the weather teletype at regular intervals. At 6:30 p.m., because of the wind and heavy rain outside their studio, the station dispatched its four mobile units and switched to emergency power. At 7:00 p.m., the mobile reporter atop Burnett's Mound reported a tornado southwest of his position, and immediately the station played its recorded siren, followed by the broadcast from the reporter at the scene. This required that the station interrupt another Kansas AM station with whom they share broadcast time between 7:00 p.m. and 7:30 p.m. Their remote broadcast reportedly preceded the official teletype notification from the weather bureau as well as the sounding of the public alert sirens. At 7:10 p.m., the mobile reporter radioed that the tornado had hit the Mound and that he was proceeding to follow it into the city when contact with him was lost.

The citizen's band club had received notification of the tornado watch at 11:00 a.m. as part of the weather bureau's supplemented calling list and set up their standby units. At 2:00 p.m., the weather bureau called again to report that weather conditions were growing more severe, at which time one of the club members was sent to the weather station to standby his radio there. At 5:00 p.m., after observing the radar screen, this member sent out other club members on the weather watch line which was most likely to sight an approaching tornado. About 7:00 p.m., the observer stationed on Burnett's Mound sighted the funnel cloud and, while fleeing from the area in his car, radioed the weather station and requested that they notify the police to sound the public alert sirens immediately.

Also, as the storm was approaching, the county civilian weather watchers were reporting to the sheriff's office and to the weather station. They continued to do so until the high winds ended telephone communications. As mentioned above, the Topeka Police Department made use of the hot line system during the afternoon. When the 3:00-11:00 p.m. communications shift reported for work, the tornado watch bulletin was rebroadcast to all police cars during the half hour between 4:30 p.m. and 5:00 p.m.

The police communications section consists of two rooms: the dispatch room and the switchboard operation room. Normally, two regular police dispatchers are on duty in the dispatch room, but one from the 3:00-11:00 shift was on vacation June 8. His position was filled by a part-time summer employee who had previously worked in the communications section but never as a dispatcher. The switchboard was manned by another part-time employee who had only been working in the department for a week.

At 6:00 p.m. the patrol lieutenant came into the dispatch room and represented the ranking officer on duty at the time of the emergency. At 6:40 p.m. the dispatch officer returned from the switchboard room where he had just read the teletype report of a tornado passing through a community 54 miles to the northwest. He informed the patrol lieutenant of this whereupon the lieutenant decided to dispatch the five patrol cars on a weather watch. After the cars were deployed, the dispatch officer decided to radio an officer on patrol, who had some prior experience as a dispatcher, to report to the station and assist in the radio and switchboard rooms. This officer arrived shortly thereafter.

At 7:00 p.m. the unit assigned to weather watch duty on Burnett's Mound radioed that he had sighted a funnel cloud approaching the city from the southwest. At this time, the dispatcher instructed the patrolman who had just arrived to place the warning calls listed in the warning plan while he himself placed a hot line call to the weather station notifying them of the tornado sighting. Apparently, the weather bureau was attempting to phone the dispatcher at the same time, after having picked up the hook on radar, and took the opportunity to advise him to sound the sirens. Immediately, the dispatcher went to the switchboard room, removed the protective cover from the siren button showing the patrol lieutenant what had to be pressed, and returned to the radio room. While the lieutenant was sounding the siren (at 7:04 p.m.), the dispatcher notified a local ambulance service (not a part of the warning system) of the situation and assumed they would notify all hospitals over their direct telephone lines. By this time, traffic on the police radio, which only this officer and the part-time employee were manning, was increasing rapidly as reports of the tornado, the damage it was causing, and the areas in need of assistance began to pour in.

Meanwhile, the patrol lieutenant, after setting off the sirens, apparently noticed the other officer in the process of alerting organizations on the back-up list and advised him to get into a patrol car and head for the section of apartment houses where the tornado was just reported to have struck. The officer stopped his calling and left immediately. Thinking of the casualties that would result from the disaster, the lieutenant went to a place on the floor above and called the supervisor of the large general hospital (Hospital A), informing her of the tornado and advising her to prepare to receive casualties. He attempted to call another hospital (Hospital B), but someone else in the building was dialing on the same outside line, so he returned to the patrol office where he was able to contact Hospital B and relay the same information. Next he called a radio-television station,

requesting that they broadcast a notice for all off-duty policemen to report for service. He was attempting to call another station when telephone service at police headquarters was lost.

The fire department had been notified of the tornado watch early in the day by both the teletype bulletin and the hot line call from the police department. However, their first knowledge of the actual tornado came when the public sirens were sounded, at which time the police radio monitor was turned up and the officer on Burnett's Mound was heard describing the direction of the funnel cloud.

The sheriff's office, in addition to the storm messages received by teletype and hot line, was continually advised of the progress of the tornado by its civilian weather watchers until phone service was discontinued. They were not contacted through the interorganizational back-up chain.

The local highway patrol post initially learned of the watch by teletype and hot line, and by means of the latter were continually informed of weather conditions by the police department throughout the afternoon. When the sirens went off in Topeka, the patrol radio officer went to the weather teletype but found no tornado information on it. He then phoned the weather bureau by direct hot line and they verified the tornado alert. Immediately he sounded the tone alert over the radio and broadcast to all highway patrol units that Topeka was under a tornado alert, after which he put the message on the state-wide teletype.

Civil Defense officials learned of the watch from the police hot line call at 11:45 a.m., but when the tornado struck their only warning was the public sirens. CD was not contacted as part of the back-up chain. When officials began arriving at CD headquarters, their own fan-out calling system was initiated to call in members for emergency service.

Of all the organizations which comprise the siren back-up list, perhaps the most important is the county medical society. The two-man staff of their organization learned of the possibility of tornadoes through radio and television. As the tornado was approaching the city, the society's switch-board operator was watching the emergency announcements on television and hence was aware of the situation. But she received no call from the police department and did not feel that it was her responsibility to telephone the seven hospitals and clinics on the calling list without official notification from the police as the warning plan specified. Therefore, the society placed no calls to the hospitals listed.

The second major link in this chain is the school system. Since the disaster occurred in early June, regular school sessions were not threatened by the tornado as classes had already been dismissed for the summer. However, summer session had just begun, and partly for this reason the superintendent of schools was contacted by the weather station when the tornado watch had been issued. At the time the funnel was sighted approaching the city, classes had been dismissed for the day. Thus the school

superintendent (and hence the other education officials in the remainder of this phase) received warning only as part of the regular citizenry.

Hospital A, although it did not receive a fan-out call from the medical society, was contacted by the police patrol lieutenant. However, this occurred at the same time as the tornado was entering the city, immediately after which the hospital's phones went out. Thus, they were unable to relay the warning to Hospital E, their responsibility under the fan-out system.

Hospital B apparently experienced some difficulty during the pre-impact period. Through the radios and televisions to which its patients were listening, the hospital's staff had become aware of the tornado watch and, later, of the severe weather conditions. However, when the sirens were blown, it was not clear whether or not this signaled the immediate threat of danger. But from the information gathered from radio and television broadcasts, it was decided to interpret the siren warning as signaling immediate danger and emergency preparations were initiated. At this time, the patrol lieutenant was having difficulty getting an outside telephone line, and by the time he was able to contact the hospital supervisor the tornado had already struck in the area. Apparently, when hospital officials decided that the sirens meant imminent danger, they placed their assigned warning call without waiting for one to reach them.

The staff at Hospital F had gradually become aware of the tornado watch from the radio during the latter part of the afternoon. However, they received no other warnings until the sirens were heard and right after this the back-up call from Hospital B. But in addition to the systems already described, Hospital F had developed a separate plan to insure that two other institutions in the area had also been warned. A car, equipped with a mobile citizen band radio unit, was to be sent from the hospital to Clinic C, which would send a similarly equipped car to Hospital E, which in turn would send one back to Hospital F. However, at the time of the June 8 tornado, the car from Hospital E did not arrive, and if it had, Hospital F had no operational equipment of its own to complete the chain.

The staff of Hospital E also had gradually learned of the watch from the radios to which patients were listening during the afternoon. At the time of the siren sounding, both the administrator and a secretary were listening to radio Station A; thus there was no doubt regarding the meaning of the siren alert. Emergency procedures were implemented immediately. The hospital received no back-up call nor did it attempt to contact Clinic B.

Finally, the patients of Hospital C were also listening to radio Station A, and the staff became aware of the watch during the course of their normal afternoon routine. In addition, one staff member is assigned to monitor police radio communications and was thus able to relay weather information from this source to other personnel. Hospital C experienced no difficulty in interpreting the meaning of the sirens, but there was some question concerning the source of the "all clear" notice. Hospital personnel interviewed were

uncertain who was to call them in the back-up chain and did not receive a call in any case. No call was placed to Clinic A apparently because after the tornado had struck they were unable to place out-bound calls.

Conclusion

For the population of Topeka as a whole, the general impression is that the warning systems were adequate and that the low number of recorded deaths can be attributed to the effectiveness of the public warning systems. But effectiveness in turn is dependent on other factors. Some of these were peculiar to Topeka, or at least operative only in similar communities. Other factors would have played a part in any community threatened by a similar kind of disaster.

As indicated earlier, Topeka is in a highly tornado prone area of the country. It is clear that an elaborate tornado disaster subculture has emerged in response to this condition. A complex organization and technology, along with corresponding attitudes and values, is present among the residents and organizations of the city. There is not only an elaborate pattern for sensitizing the community to a particular kind of danger but equally as important, there is widespread knowledge about the appropriate course of action to follow when certain cues are presented. Many another area in the country has been flooded with as many tornado watch bulletins and other weather information as was Topeka, but the organizational and individual response has been of a different order. It was less the advance notices -- necessary as they were -- that was crucial but rather than Topeka is psychologically and socially prepared for tornadoes whereas other localities are not.

Furthermore, the planning and preparation for this kind of disaster, particularly mechanisms for detecting its approach, are rather elaborate in the Topeka area. A great number of different groups search for danger cues, and several of them almost simultaneously -- but independently -- sighted the tornado in this particular instance. There are even two separate ways for alerting the general public, with the less official one of the radio station apparently sounding an alarm in this emergency before the police triggered the sirens. Moreover, because of the multiplicity of danger-detecting groups, there is a high probability that more members of the general public will become aware of a potential threat than would be the case if fewer organizations were involved. The somewhat noncentralized and multiple in-depth warning systems against tornadoes in Topeka is very complex. In fact, few organizational officials probably could spell out all the details of the systems as they are set forth in this report. Nevertheless, the different ways of learning about a particular kind of danger serves the community well.

The time at which the actual tornado struck the city allowed maximum dissemination of weather information. The period between 6:00 p.m. and 7:30 p.m. is traditionally devoted to news and weather broadcasts on the media of mass communication, particularly television. A majority of the population of Topeka, including a large part of the personnel of organizations most involved in emergency situations, reportedly received weather and tornado information from these means during the course of their evening meal. This information left little doubt as to the meaning of the sirens when they were sounded at 7:04 p.m. Even though there was some later question regarding the delay by the weather bureau in confirming the presence of the funnel cloud on their radar, it seems that there was a minimum of ten minutes between the time the sirens were subsequently set off and the tornado moved into the southwest portion of the city. Admittedly, this period was shorter for those persons living outside the city itself in the southwest fringe area if in fact they were able to hear the siren warnings. But the period also was longer for those residents in the central and northeastern portions of the city.

The intraorganizational warning systems made important contributions to the public warning systems. The citizen's band club's weather watchers, the sheriff's county weather watchers, and the police tornado watch personnel furnished the weather bureau with confirmed tornado sightings and information on the progress of the funnel. This information was particularly important in increasing the time period between the siren sounding and the striking of the tornado. Also, radio Station A's mobile weather watchers enabled that station to broadcast to the public immediate information on the approach and the possible path of the tornado.

The personnel of most organizations on the interorganizational telephone back-up chain (except the police department and sheriff's office) received warning only as members of the general public, due to the breakdown of this chain. In most cases, the sirens were heard and their meaning was clear, due largely to the reinforcing information from radio and television. The overall interorganizational warning system worked well in informing organizations of adverse weather conditions in the afternoon, but was largely inoperative in warning of the imminence of danger or confirming the reason for the siren soundings.

For these latter tasks the pivotal point in the system is the police communications section. However, it encountered three difficulties in the June tornado. First, some relatively inexperienced personnel were on duty, although the dispatch officer attempted to compensate for this as soon as the police weather watch was established by requesting an experienced patrolman to come to the station to assist in the radio and switchboard rooms. Second, the threat quickly became a reality; thus, as soon as it was known that the tornado had hit in the apartment house area in the southwestern part of the city, the urgent need of obtaining additional information about that seemed to have higher priority than warning about possible danger. In a way, the stance changed from preparing for to responding to an actual disaster. This was manifest in the attempt to substitute the fan-out warning calls with direct notification of probable casualties to the city's hospitals.