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University of Delaware
Disaster Research Center

WORKING PAPER

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A TORNADO WARNING SYSTEM: ITS FUNCTIONING
ON PALM SUNDAY IN INDIANA

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1966

PREFACE

This primarily descriptive paper is intended to be part of a much larger theoretical report on warning systems that will be issued later. The theoretical report will incorporate material from two other descriptive studies (DRC Working Paper #7, "The Minneapolis Tornadoes, Notes on the Warning Process", and DRC Working Paper #8, "Warnings in the Colorado Floods") in addition to this one. Consequently a more extended general discussion of features of warning system is reserved for the later report.

Introduction

On Palm Sunday, April 11, 1965, a total of thirty-seven separate tornadoes touched down in six midwestern states killing two hundred and sixty-six persons, destroying or damaging over ten thousand buildings and causing over two hundred million dollars in property damage. This, the worst tornado disaster in forty years, swept through Illinois, Indiana, Iowa, Michigan, Ohio, and Wisconsin.

Indiana was the hardest hit state. It was struck by eleven different tornadoes that occasioned one hundred and thirty-seven deaths, thirteen hundred and sixty-nine injured, and over one hundred and seventy-six million dollars in property damage. From six to nine o'clock during the afternoon and evening of that day, tornado winds swept through approximately thirty towns and cities in nineteen counties, mostly in the northern and central parts of the state. Counties affected included La Porte, St. Joseph, Elkhart, La Grange, Marshall, Wells, Blackford, Grant, Madison, Delaware, Randolph Hamilton, Howard, Tipton, Clinton, Boone, Montgomery, Tippecanoe, and Starke.

Did the residents of these areas have any alert or warning of the tornadoes? If not, why not? If they were alerted or warned, why were the casualty figures so high? These were some of the many questions asked after the disaster. This report does not attempt to answer all such questions but restricts itself to some observations on certain aspects of the warning system operative in the state of Indiana that fateful day.

More specifically, we will describe how information pertaining to the imminence of tornadoes in northern Indiana flowed to and/or through certain

organizations to its final destination--the general public. To what extent did organizations coordinate their alerting activities with each other? Where did they get their information? How did the various formal organizations define their role in the period? In what way did they go about alerting the general public of the impending danger? In other words, what were some of the factors that affected the issuing, distributing and receiving of organizational information regarding a tornado threat on Palm Sunday in northern Indiana? (We shall also briefly examine what, if anything, organizations learned from their experience that day).

According to Williams, an adequate warning must provide recipients with "information about (1) the existence of danger, and (2) what can be done to prevent, avoid, or minimize the danger."¹ He goes on to say that the warning process involves the following steps:

1. Detection and measurement or estimation of changes in the environment which could result in a danger of one sort or another.
2. Collation and evaluation of the incoming information about environmental changes.
3. Decisions on who should be warned, about what danger, and in what way.
4. Transmission of a warning message, or messages, to those whom it has been decided to warn.
5. Interpretation of the warning message by the recipients and action by the recipients.
6. Feedback of information about the interpretation and actions of recipients to the issuers of warning messages.
7. New warnings, if possible and desirable, corrected in terms of responses to the first warning messages.²

In this warning process, in Indiana on Palm Sunday, some formal

organizations were more involved than others. In general, these included the U. S. Weather Bureau (WB), the Indiana State Police, County Sheriff's offices, city police departments, civil defense groups (CD), radio and TV stations and fire departments. Although warnings could conceivably have been initiated and disseminated by various other groups and agencies (and have been at times) the primary burden of warning the general public in this disaster was carried on by the aforementioned organizations.

It is useful to treat the activities of these organizations in their warning activities as a "system". Each organization did not carry on its activities in an independent fashion, but either by pre-planning or by on-the-spot innovation, they tended to coordinate their activities to reach a more or less common end. To use the word system to describe organizations interacting implies that, while the parts were semi-autonomous, they were interdependent and, therefore, could be conceived as a whole. It is suggested here that WB conceived (at least on paper) the semi-autonomous organizations mentioned above as making up a somewhat imperfect system, whose task it was to obtain, disseminate and act upon tornado threat information. The extent to which a number of units form a system is, of course, a matter of degree, and the degree to which the organizations mentioned above were actually interdependent and integrated is one of the major questions to be discussed in the rest of the report.

For purposes of providing a focus, the DRC teams in three trips to the state focused in the field on about two dozen of these organizations operating in eight of the counties which were hardest hit. These counties included

St. Joseph, Elkart, La Grange, Marshall, Grant, Howard, Boone, and Hamilton. The data presented and conclusions advanced in this report are based heavily on organizational logs, after-action reports, informal questionnaires, and interviews with one or more members of each of the following 45 organizations:³

St. Joseph County

South Bend City Police Department
County Sheriff's Office
County Civil Defense
South Bend Weather Bureau
WETL Radio Station
WSND Radio Station
South Bend Post, Indiana State Police

Elkart County

Elkart City Police Department
Goshen City Police Department
County Sheriff's Office
County Civil Defense
WCMR-TV Radio Station
WTRC Radio Station
WKAM Radio Station

La Grange County

County Sheriff's Office

Marshall County

Plymouth City Police Department
County Sheriff's Office
County Civil Defense

Grant County

Marion City Police Department
County Sheriff's Office
County Civil Defense
WMRI Radio Station
WTAF-TV Station

Howard County

Kokomo City Police Department
 County Sheriff's Office
 WFKO Radio Station
 WMKO Radio Station
 WIOU Radio Station

Boone County

Lebanon City Police Department
 County Sheriff's Office
 County Civil Defense

Hamilton County

Noblesville City Police Department
 County Sheriff's Office

Elsewhere in Indiana

Ligonier Post, Indiana State Police
 Indianapolis Headquarters, Indiana State Police
 Indiana State Civil Defense Headquarters
 WXLW Radio Station
 WHBU Radio Station
 WANE Radio Station
 WGL Radio Station
 WIBC Radio Station
 WOWO Radio Station
 WFBM Radio Station
 WFBM-TV Station
 WLBC-TV Station

Reaction of the System in Indiana to the Tornado Forecast

The United States Weather Bureau differentiates between "Tornado Forecast" and "Tornado Warning." Tornado forecasts are issued by it whenever weather conditions exist such that tornadoes could form. On the other hand, tornado warnings are issued whenever funnel clouds or tornadoes have actually been identified. The Indiana system reacted quite differently to these two types of weather stimuli on Palm Sunday, and, therefore, the

system's reaction to each will be described separately. This part of the report will be devoted to a description of the system's reaction to a tornado forecast, while the following part will consider its reaction to a tornado warning.

A tornado forecast inevitably enters a system via the local WB. All severe weather forecasts are issued by the U. S. Weather Bureau's Severe Local Storms Center (SELS) in Kansas City, Missouri to all local Weather Bureaus. At 11:45 a. m. (EST)*, SELS issued via teletype a severe weather forecast for the area from northeastern Missouri northeastward to north central Indiana. The South Bend, Indianapolis, and Fort Wayne Weather Bureaus were among those receiving the forecast. It was quite general and did not indicate any immediate tornado threat to any portion of Indiana. It should also be noted that this initial forecast did not indicate any possible disturbance in the Fort Wayne area.

The next input to the Indiana system from SELS was at 2:00 p. m.

SEVERE WEATHER FORECAST NUMBER 68
 ISSUED 1:00 P. M. CST (2:00 EST) APRIL 11, 1965
 U. S. WEATHER BUREAU TORNADO FORECAST FOR...⁴
 EXTREME SOUTHERN WISCONSIN
 EXTREME EASTERN IOWA
 PORTIONS OF NORTHERN ILLINOIS

A FEW SEVERE THUNDERSTORMS WITH LARGE HAIL
 DAMAGING WINDS AND ONE OR TWO TORNADOES ARE
 EXPECTED FROM 1 P. M. UNTIL 6 P. M. CST THIS
 SUNDAY AFTERNOON AND EVENING IN AN AREA
 BOUNDED BY THE POINTS 40 MILES SOUTH OF
 BURLINGTON IOWA TO 50 MILES WEST OF LONE
 ROCK WISCONSIN TO MILWAUKEE WISCONSIN TO

*All times in the present report refer to Eastern Standard time unless noted otherwise. It should be noted that the times given for the various SELS forecasts refer to the time the forecast first entered the system via local Weather Bureaus, and not the time that the general public became aware of the threat.

40 MILES SOUTH EAST OF CHICAGO ILLINOIS BACK
TO THE POINT 40 MILES SOUTH OF BURLINGTON
IOWA.

Although none of the system we are discussing was affected by this forecast, parts of northern and central Indiana were directly in the path should the line of tornadoes continue in a northeasterly direction.

The final and most pertinent input to the system issued by SELS occurred at 5:20 p. m. The information therein pertained to most of the northern half of Indiana.

SEVERE WEATHER FORECAST NUMBER 69
ISSUED 4:20 P. M. CST (5:20 EST) APRIL 11, 1965
U. S. WEATHER BUREAU TORNADO FORECAST FOR...

PORTIONS OF NORTHERN INDIANA
PORTIONS OF SOUTHERN MICHIGAN AND
PORTIONS OF NORTHWEST OHIO

SCATTERED SEVERE THUNDERSTORMS WITH A
TORNADO OR TWO LARGE HAIL AND LOCALLY
DAMAGING WIND STORMS ARE EXPECTED IN AN
AREA ALONG AND 60 MILES EITHER SIDE OF A
LINE FROM 10 MILES NORTHWEST OF LAFAYETTE
INDIANA TO DETROIT MICHIGAN FROM THE PRESENT
TIME TIL 8 P. M. CST THIS SUNDAY EVENING.⁵

In most situations, within ten minutes after local WBs receive a SELS forecast, it is re-issued by them via teletype and telephone. Typical organizations that receive such messages include: (1) airports and airlines, (2) state police, (3) radio and TV stations, (4) such groups as CD, city police and county sheriffs' departments, as well as the trained volunteer "spotters" of the local WBs.

In Indiana the three local Weather Bureaus also passed on the information to various organizations within the system. Among the first to be notified of

the tornado forecast were the Indiana State Police and many radio and TV stations. Immediately after receiving the forecast, the State Police alerted via radio and microwave all of their units operating within the area covered by the forecast. Although they directly contacted very few other organizations in the system, many of the latter regularly monitor all State Police broadcasts. Among the organizations monitoring such communications were all Sheriff's Departments, most City Police Departments, several CD units, and a few Fire Departments.

The responses by the local WB, State Police, and most Sheriffs' offices to the tornado forecasts were quite uniform. In the main, this was due to prior planning. In all eight counties studied, the three kinds of organizations interacted quite similarly in their handling of the tornado threat information. They along with radio and TV stations rather routinely disseminated the tornado forecasts to various other organizations and/or the general public.

However, despite some prior planning and routinization of tasks, there were still some very lengthy delays between the time the three major organizations received the information and the time it was passed on to others. Also, with the exception of Sheriffs' Departments, most other organizations monitoring the State Police radio, did not seem to respond directly to the information disseminated. Many organizations, whether they did not actually hear what was being transmitted on their monitors, or failed to act on the information. In fact, if there was any pattern to the responses of such organizations (as well as most of those directly notified by the WB or the State Police and Sheriff's office) it was that of inaction insofar as further dissemination

and transmission of the tornado forecasts was concerned.

Most organizational personnel interviewed were not apologetic about their lack of reaction to the forecast early Palm Sunday afternoon, but rather defended their inaction. Their rationale went something like this: Tornado forecasts are rather frequent in Indiana and each covers a very large area, in the order of 20-30,000 square miles. The chance that funnels will develop over any given area is extremely small and the probability that a damaging tornado will strike is even more remote. It would be extremely difficult to get the general public to stop whatever they are doing when a tornado forecast is announced and to take precautionary measures.

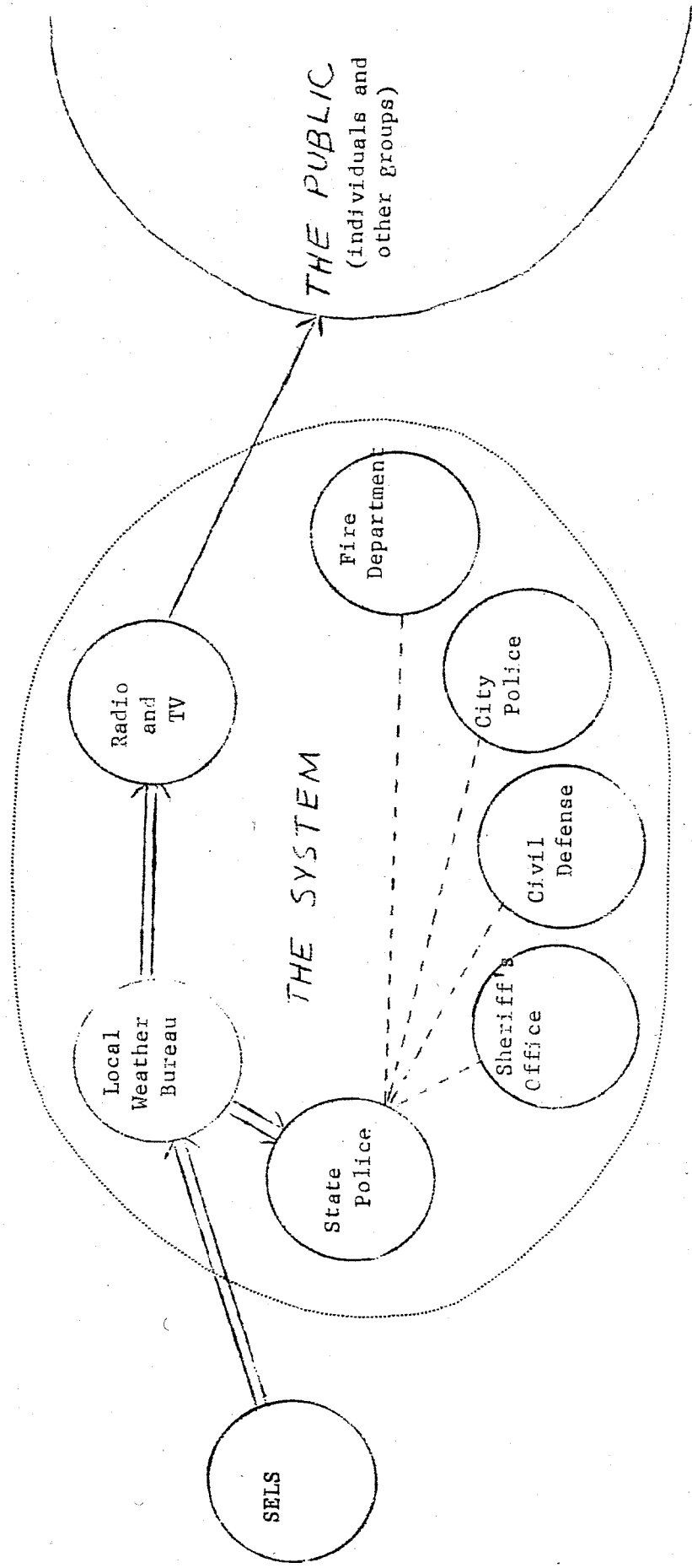
When asked, "What was your organization's role in alerting the public to the fact that tornadoes could develop?", interviewees from the State Police, CD, Sheriff's office, and City Police typically replied that they had only an indirect role in alerting the public. They said it was the responsibility of radio and TV stations to pass on such information. No member of any organization interviewed saw it as their responsibility to supplement or "back up" radio or TV alerting activities in response to a tornado forecast. The following quotation by a police chief summed up succinctly the feeling of other respondents in sheriffs' offices, city police departments and CD units when he 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."


In summarizing the reaction of the system, one would have to say that at 2:00 and 5:20 p.m. SELS gave adequate forewarning to the local WS's


regarding the possibility of future tornado activity. The South Bend and Indianapolis Weather Bureaus re-issued the SELS forecasts shortly after they were received. The Fort Wayne Weather Bureau relayed the 2:00 p. m. tornado forecast but not the one at 5:20 p. m. The 5:20 forecast affected most of the northern half of Indiana. State Police Headquarters and District Posts as well as selected radio and TV stations also received the tornado forecasts via telephone or teletype. Most radio and TV stations were understaffed during the Palm Sunday weekend and, therefore, in many cases the public issuing of the tornado forecast was delayed. (A few stations never passed on the forecast). Even so, many stations broadcast the forecast sufficiently in advance of the first tornado to allow appropriate precautionary measures to be taken on the part of the general public. Therefore, most persons listening to a radio or watching TV had access to this information. It is not known, however, how many persons were away from their radio and TV sets on this, the first pleasantly warm day of the year. Finally, several of the organizations monitoring State Police broadcasts had access to the tornado forecast. Diagram A depicts the paths of communication in the system in reaction to the tornado forecasts issued by SELS. (Diagram A on page 11).

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 Paths of Communication in the System in Reaction to a Tornado Forecast



 Indicates communication between organizations -- one disseminating the information; the other receiving it.

 Indicates communication disseminated by radio and TV (However DRC data are inadequate to show percentage of general public who received it.)

 Indicates organizations capable of monitoring State Police broadcasts -- some of which did on Palm Sunday.

Reaction of the System to the Tornado Warning

Just as local WB's have the authority to issue tornado forecasts, they also have the authority to issue tornado warnings. But unlike the former where the initial input to the system must necessarily come from SELS, the input from the latter can enter the system at any point. There are numerous ways in which this can happen, and did on Palm Sunday. Although an attempt is made to channel all information pertaining to the sighting of a funnel cloud or a tornado to the local WB, the information does not necessarily originate there. An individual may sight a tornado, call the police, who in turn will relay the message to the WB. A member of one of the organizations may spot a tornado, and relay it to the local WB. Or, a local WB having radar may pick up strong echoes on its screen; thus, the input would enter at the local WB as it did for the tornado forecasts.

The system's reaction to the tornado warnings is much more difficult to portray than its reaction to the forecasts. As was described in the previous part, the local WB routinely re-issued all SELS forecasts via teletype and telephoned certain other organizations which were not on the WB teletype line. If the information was not truncated at this point, it was normally passed on only to other members within the system. The system response to a response to a tornado warning was not as simple. First, the number of number of warnings entering the system at many points far surpassed the number of forecasts. Second, the interval between warnings was much shorter than it had been for forecasts. Third, verification concerning the authenticity of the warnings was much more difficult. The input to the system might

come from a citizen, a city policeman, or the WB. The sheer mechanics of sorting precise and accurate information in a short period of time posed several problems. Fourth, the response among the organizations to the tornado forecast was more uniform and easy to trace than it was to a warning. Because of these complexities, it would be impossible to follow systematically the communication process surrounding any one specific warning. Therefore, insofar as it is feasible, the system's reaction to warnings will be described very generally.

Three local weather bureaus covered the eight counties described in the present report--Indianapolis, Fort Wayne, and South Bend. Indianapolis and Fort Wayne Weather Bureaus both had radar which were used to track the paths of severe thunderstorms and those tornadoes which had developed. South Bend, on the other hand, had no radar, and, therefore, relied upon information from other WB radar stations nearby (i. e., Chicago, Fort Wayne, or Indianapolis).

The first actual tornado warning for parts of northern Indiana was issued by the South Bend Weather Bureau at 5:43 p. m.

Severe thunderstorm and tornado warning. Radio and television stations are requested to use emergency frequencies. Radar indicates some very strong storm echoes in the vicinity of Michigan City Indiana and in an area just west of Knox Indiana. In these areas a tornado may touch the ground. Residents in the counties of La Porte, Starke and Marshall should be on the alert for possible tornadoes and severe thunderstorms for the next 30 to 60 minutes and to take appropriate safety precautions. If a storm is observed in these areas that is considered severe promptly notify the Weather Bureau at South Bend Indiana. ⁶

Then two minutes later--

Correction...

Also echoes show that storms are moving east northeast about 45 miles per hour.⁷

The initial warning was issued approximately seventeen minutes before the first tornado touched down at Lapaz in Marshall County. It should be noted that 5:43 is the time when the weather bureau issued the warning, not the time that the public received it. Generally there was a delay of at least ten minutes from the time that the warning was issued by the WB to the time it was broadcast over radio and T. V. Neither the Fort Wayne nor Indianapolis Weather Bureau issued warnings at this time as the geographic areas under their jurisdiction were not immediately threatened.

The last warning issued by the South Bend Weather Bureau just about the time the tornadoes first started touching down was at 6:00 p. m. It read as follows:

Radio and TV stations are requested to use Emergency Warning Signal.

Confirmed tornadoes have been reported just north of Plymouth and from Marshall to Argos Indiana. This last one was seen in the vicinity of Donaldson Indiana just east of Hamlet on US 30 moving in a east northeast direction. Persons in St. Joseph, Marshall, Elkart and Kosciusko counties in the path of these storms should take emergency precautions during the next 30 to 60 minutes.⁸

The South Bend Weather Bureau not only issued the warnings via teletype, but it also telephoned several organizations to alert them. Those organizations notified included the State Police, Sheriffs' Departments, City Police Departments, Indiana and Michigan Electric Company, Red Cross, specified radio and TV stations, flying services, and airlines.

As the South Bend Weather Bureau had no radar which could be used to

track the tornadoes, from 6:00 p. m. on in the South Bend area, information pertaining to tornadoes began to enter the system via other units, e. g., CD, State Police, and so forth. From that time on, some members of these organizations previously having been dispatched to various points in the forecast area to watch for tornadoes, either directly or indirectly contacted the local WB.* In turn, the South Bend Weather Bureau issued these warnings over its teletype system, as well as attempting to contact organizations and individuals in the various communities by telephone. These warnings were issued by the WB up until approximately 7:30 p. m. when the threat to the South Bend area subsided.

The situation with regard to the issuing of tornado warnings by the Indianapolis and Fort Wayne Weather Bureaus was similar to that at South Bend. As members of the State Police, Sheriff's office, City Police and CD units channeled information of tornadoes to the WB's, the latter would, in turn, issue them via teletype. Seven of the eight counties studied were included in WB advisories prior to the time that tornadoes actually touched down in the county. Only one county was given no forewarning that it might be in the path of tornadoes.

The three local Weather Bureaus were relying quite heavily upon weather reports out of Chicago (Baer Field). First of all, Chicago was further west;

*Direct contact refers to the observer himself contacting the weather bureau; while indirectly refers to the observer contacting other units or his organizations headquarters, who in turn contacts the weather bureau.

and as tornadoes generally follow a path from southwest to northeast, Baer Field was in a better position to locate thunderstorms and tornadoes earlier than were the three Indiana Weather Bureaus. But second, and possibly more important, Chicago, unlike the three Indiana Weather Bureaus, had an up-to-date WSR-57 radar system which was quite effective in assessing the intensity and movement of thunderstorms. In fact, the U. S. Weather Bureau is recommending "radar coverage with modern WSR-57 type radar for all areas east of the Rocky Mountains as soon as practicable, insuring that all populous areas are well within reasonable radar range and that blind spots are reduced to a minimum."⁹

As the tornadoes swept through northern Indiana, they knocked out numerous electric power and telephone lines. The Indiana and Michigan Electric Company reported eleven breaks in its major lines in Indiana with a total of 54 steel towers downed by the series of tornadoes.¹⁰ Lack of power posed many problems for the various units within the system. Radio and TV which had been helpful in broadcasting tornado forecast information became inoperative in many areas due to the loss of electricity. Of course, individuals having transistor radios could still receive information from the radio and TV stations that had not lost power themselves. Also, lack of operating phone facilities posed communication problems for the system. Organizations which relied heavily on the phone for their sources of communication became extremely handicapped. For example, it was extremely difficult for the South Bend Weather Bureau to warn Bremen that a tornado was headed that way.

Issued at 7:10 pm est.

A tornado is just west of Bremen Indiana moving toward Bremen. Radio and TV stations are requested to use emergency warning devices as Bremen cannot be contacted by phone!¹¹

But even in those areas where electric and telephone service was not disrupted, the various units of the system had problems contacting certain persons. Convergence of messages on the telephone made it impossible for some organizations to contact particular parties to relay pertinent information to them. Thus, the South Bend Weather Bureau finally issued a bulletin to all broadcasting stations urging them to "ask people not to call the Weather Bureau unless they have weather to report. We have had numerous poor joke calls and they tie up the lines."¹²

When we speak of the system's reaction to the warnings, we are really referring to two quite distinct time periods. The first warning phase was that period of time in which the WB issued a tornado warning for a particular area, but the tornadoes had not yet touched down. The second phase referred to that period after a tornado started touching down but was still threatening other areas. This second phase can legitimately be considered a warning period, as much organizational activity during this time was geared to following the path of the tornado and reporting its progress to other relevant organizations. Another major, and possibly more crucial, difference between the two phases lay in the fact that in phase one, no organization was engaged in rehabilitative activity while in the latter, all organizations, excluding the WB and radio-TV stations became involved in immediate rehabilitation efforts.

The responses by the WB's and State Police to the sighting of a tornado

were fairly uniform. When the latter received a tornado warning from the WB, it immediately re-issued the message to the affected area. If any member of the State Police sighted a tornado, they immediately channeled this information directly to the local WB. This procedure was carried out in a fairly uniform and predictable manner during Palm Sunday.

On the other hand, the response of the other organizations--CD, Sheriff's office, and City Police--was not nearly so uniform. There seemed to be no pre-determined policy among these organizations with regard to what any one of them should do when one of their members sighted a tornado. Most of their disaster pre-planning had been geared to the rehabilitation phase rather than the warning phase of a disaster. Just as was true with respect to their reaction to a tornado forecast, they did not define it as one of their major task to pass on tornado warnings to the public.

In general the system did not function as a smoothly cooperating unit striving for a common goal. This is not meant to imply that there was any antagonism or deliberate lack of cooperation among organizations. Rather all organizations did not have a similar goal(s) toward which they were working. There was simply a lack of inter-organizational pre-planning regarding what to do in case of a tornado warning and subsequent impact. Several organizations carried out their warning activities as if no other organization were available to help. The local WB's and radio and TV saw their main task as that of warning the populace and relevant organizations of the tornado activity. The State Police conceived themselves as having two functions: (1) feeding information pertaining to sighted tornadoes to the

WB and other organizations in the critical area, and (2) aiding in the rehabilitation stage. The County Sheriff's office, CD and City Police more or less geared their activities toward the rehabilitation phase after the disaster struck. If they engaged in warning, it was primarily that of warning their own members. If organizational members warned other organizations, it was very sporadic. Consequently, there was much overlapping of some activities, while at the same time some crucial tasks were left undone.

Since the response in each "county system"¹³ varied somewhat, it might be helpful to describe the situation in two different counties to show differences in organizational response during the two warning phases.

County A. The State Police sighted a tornado at 5:50 p. m. and immediately called the local WB. The latter issued the warning via teletype to several organizations including selected radio and TV stations. In turn, they commenced re-issuing the tornado warnings; but due to the time lapse between the time the State Police first sighted the tornado and the time the radio and TV stations started broadcasting the warnings, the tornadoes had already started touching down in the county. As the tornadoes knocked out the electricity, those persons listening to the electrically powered mass media were cut off from further information.

The sheriff's office, which had monitored the 5:50 p. m. State Police message to the WB, dispatched its cars to various places in the county to watch for tornadoes. This was done just prior to the touching down of the first tornado in the county. The City Police in the county's largest city had also

been monitoring the 5:50 p. m. State Police message, but did not take any action at that time. Police headquarters did not notify other members of their own organization nor any other organization until after the first tornado hit the county.

County CD was not notified of the tornado warning until twenty minutes after it hit. At that time a member of the local police went to the CD director's home and notified him that a tornado had just touched down. The CD director immediately alerted and mobilized his men, but more to cope with the rehabilitative phase than to participate in the warning phase. Among those whom he alerted were the various township Fire Departments within the county. The pre-arrangement had been that in the event of a potential disaster, the CD director would notify all township Fire Departments. It was the responsibility of these organizations in turn to notify the public via phone, sirens, in person and so forth. County CD perceived one of its own functions as a back-up warning system to radio and TV. On Palm Sunday the plan was put into effect too late as the first tornado had already passed through the area.

Although there was neither systematic warning of the general public nor of some organizations, most organizations and the general public were alerted before another series of tornadoes started cutting a second swath across the county following the same path as the first one. Even though almost everyone was alerted after the first tornado went through, many were killed by the second one due to the convergence of people at disaster sites (i. e., particular localities where devastation had occurred).

During phase two after the tornadoes started touching down, there was a great amount of interorganizational communication. The major part of it pertained to requests for help in aiding the injured, but some of it also involved warning. Members of the State Police, Sheriff's office, CD, and in some cases City Police were following and reporting the progress of the tornado to the WB and organizations in areas which might be in immediate potential danger. However, this was neither pre-planned nor systematic alerting. Therefore, some organizations in later impact areas had warning prior to the impact of the tornado while others did not. Furthermore, the alerts which did reach some of the organizations in potential impact areas were received only one, ten, or thirty minutes before impact. This meant there was a very short period of time in which these organizations had to act on the information. As it turned out, many times the warnings came too late, so that it was physically impossible to warn the general public.

County B. Late Palm Sunday afternoon the County CD Director was in the adjacent county to the west (County C) assisting the latter's sheriff in the recovery of a drowning victim. At approximately 7:15 the State Police notified the County C sheriff that there was a tornado just entering County C from the west. The CD Director of County B immediately notified members of his organization, but did not notify any other organizations in County B. Rather, he waited fifteen minutes (to about 7:30 p. m.), until he saw the tornado "with his own eyes". He then radioed the City Police telling them of the tornado's location, the direction in which it was moving and also asked them to notify the local radio station. The CD director, then followed the tornado, relaying its

progress via radio to police cars thus keeping them aware of the tornado's progress. But the police apparently did not notify the local radio station nor any other organization within the county. The information died with the police. The Chief of Police was afraid that the people might panic unnecessarily if warned directly by them:

My idea about warning is different from some people. ... Some want to alert everybody (right) now. An alert is alright, but it has the tendency to panic people alot of times. ... I think you should alert your first aid centers, your CD, and things like this... but not the general public too much.

I don't like to panic them. I know some people personally, that the minute there's a sign of a tornado or (that there) might be a tornado,.... they panic right now.

When County B's Sheriff was asked when he first became aware of a tornado heading his way, he replied:

The (first) time that I knew that we (were) even going to have one was when it was going over. We didn't have any warning at all... I knew that there was a storm coming up by listening to the television. And the television didn't even list here (County B) as being in the danger area.

The tornado hit the county seat at 8:07 p. m., approximately thirty-five minutes after the CD director first notified the City Police of the tornado. Phase two of the warning period was almost non-existent for the county as all power to radio-TV stations and to the general public was cut off as the tornado went through. City Police communication was inoperative for about an hour until an auxiliary generator could be hooked up.

Organizational functioning in County B during the immediate pre-emergency period differed from County A's response in two major ways. First, most organizations and the general public had no warning of the impending disaster.

Second, the tornado blew down high voltage power lines as it cut across the county knocking out several major potential communication links among organizations and the public.

Other Counties. In the remainder of the counties studied, the organizational responses varied but the general pattern was similar and can be summed up in the following way. The system obtained the warning information from several sources including: (1) local WB radar and "spotters"; (2) State Police, CD, County Sheriff's office, and infrequently, City Police sightings; and (3) individuals. After the system obtained this input, the information was not always disseminated in a pre-planned or systematic way. On the whole, the local WB's and State Police seemed to have a more uniform method of distribution than did the other organizations. Upon receiving the information, the WB issued tornado warnings via teletype and phone to selected radio-TV stations and to certain other specified organizations. They were not always able to contact all persons on their list. This has, due to downed power and telephone lines, message convergency on the telephone, and lack of either adequate time or sufficient number of WB personnel to carry out the task.

The State Police generally notified the local WB and other relevant organizations in the potential impact area. Having some of the same communication problems as the WB, they were not able to notify all of the organizations they would have liked. Downed power and telephone lines and lack of sufficient time greatly curbed their ability to communicate effectively with others. Although, particular CD units, County Sheriff groups, and City Police departments were extremely effective in disseminating warning information to the proper destination, there was no uniform response county by county by any

one type of organization. One, two, or even three organizations may have coordinated their warning activities, but the county system itself lacked overall coordination. Some organizations, did pass the information pertaining to sighted tornadoes on to those who needed the information. But in most such cases coordination came about not as the result of pre-planning, but rather as a result of "on the spot" innovation.

Often pertinent information was not at the right place at the right time. There were many reasons for this, some of which were the same ones which plagued the WB and State Police. Several organizations were unable to use their own communication system effectively because of downed power and telephone lines, message convergence on the phone, and insufficient personnel. Some of the organizations were notified too late to be able to take part effectively in warning; others, although they had been alerted early enough, did not keep the information moving.

Responses by members of radio and TV stations varied widely. Some stations indicated they had very few problems, while others felt they were severely handicapped by various deficiencies. They ranged all the way from strictly physical problems to those of coordination. Media personnel typically commented as follows:

Being a Sunday night we were operating under reduced manpower. . . . all power to our studio and transmitter was out. We immediately went on emergency power from our transmitter location but broadcasting was on an intermittent basis.

Tornado warnings were generally too old--i. e. 15-30 minutes--to be truly worthwhile as a warning.

The Weather Bureau seemed to wait too long between transmissions. They should have maintained a more continuous communication pattern under these conditions.

All (warnings) were vague--'isolated tornadoes-maybe' or 'possible' and our immediate vicinity was not included until 7:00 p. m. and our transmitters were hit at 7:45.

We understood later that the local police had been notified earlier... that a tornado was headed toward (us) but (we) were not notified by the local police so we couldn't prepare our listeners.

Although it is impossible to tell from DRC data what proportion of the population was aware of the tornado warnings in their area, secondhand accounts obtained from interviewees, organizational reports and logs, newspapers, and informal conversations indicate that quite a few did not know of the warnings. The majority of those who knew of the warnings received the information from radio and TV. The warnings seem to be more helpful to them during phase one than during phase two, but, it should not be assumed that those who heard the warnings took precautionary measures to protect themselves from the threat.

Still, a sizable number of persons were not aware of the imminence of tornadoes in their area. Many simply were not listening to or watching radio and TV on this the first, nice Spring day of the year. In a few cases, the radio and TV stations were knocked off the air for some time and their usefulness as a disseminator of the warnings was minimized. Too, with the advent of the first tornado, many persons lost their power and telephone lines. This meant that unless they possessed battery-powered transistor radios they were unable to receive future warnings. Due to loss of telephone lines, many were unable to call for further information. Still others, realizing that something was wrong when they lost their power, tried to phone for more information; but because of the heavy convergence on the telephones were unable to get through. Hence, many persons were not forewarned of the threat of

tornadoes and even among those who were warned, many failed to take appropriate precautionary measures.

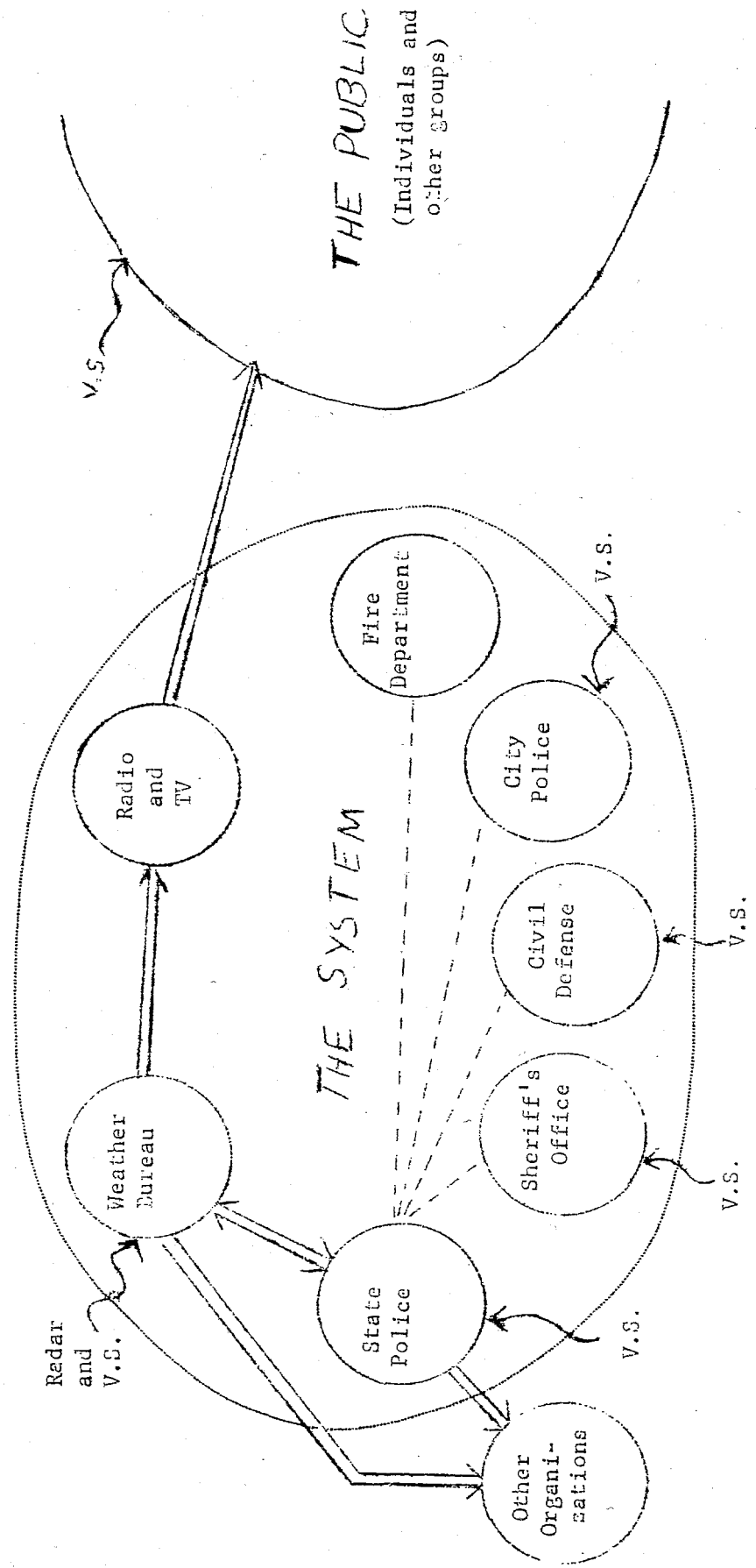
A diagram showing the paths of communication in general during both phases of the warning system, is presented on the next page. Only the fairly routinized lines of communication are drawn in the diagram. In actuality, communication lines could be drawn among all units within a system (and many times the communication was reciprocal), but it was not as routinized as those included.

Changes in the System Instituted or Planned Since Palm Sunday

Immediately after a natural disaster in which there was forewarning strikes a community, there exists a heightened interest on the part of organizational members and the general public regarding how they could better prepare themselves for a similar type of disaster in the future. This reaction has been common following many such disasters, especially after hurricanes, tornadoes, and floods.¹⁴ Communities seem ready to support changes which, they feel, would insure their future safety. The changes which are eventually made as a result of the disaster, however, are not as great as one might predict from the initial heightened interest.

During the three month period following the Palm Sunday disaster, the DRC field teams found heightened interest on the part of organizations and the general public to ameliorate many of the deficiencies in their alerting system. This increased interest, manifested itself in at least two ways: (1) the increased conscientiousness with which organizations carried out alerting functions and the precautionary measures taken by the public in response to the alerts; (2) expressed plans for inter and intra-organizational change to

Paths of Communication in the System in Reaction to a Tornado Warning



- ~> Indicates points of entry into the system via visual sighting (V.S.) or radar of a funnel cloud or tornado.
- ↔ Indicates reciprocal communication between organizations
- Indicates one-way communication.
- - - Indicates organizations capable of monitoring State Police broadcasts--some of which did on Palm Sunday.

better prepare the populace for possible tornadoes.

In the three months after Palm Sunday, several tornado forecasts and warnings were issued covering parts of Northern Indiana. In these instance, organizations were much more efficient and determined in making certain that the forecasts and warnings were fed to the appropriate destination than they had been prior to, and including, Palm Sunday. (Tornado forecasts and warnings were issued during one time--June 7-11, 1965--while the DRC team was in Indiana. Thus, team members were able to observe directly how several organizations handled the forecasts and warnings). The heightened interest of the general public in the two months (i. e., from April 15 to June 15) was evident from the greater precautionary measures which they took in response to forecasts and warnings. They seemed to seek out and act upon the relevant information pertaining to tornadoes. If observations elsewhere are any guide for the future, however, this change in attitude of organizational members and the general public along with subsequent actions will tend gradually to revert to past patterns as time passes.

Increased conscientiousness alone is not sufficient to assure that the organizational response will be adequate to meet future emergencies. If the general public is to have prompt and sufficient information, specific changes in the organizations' structure are necessary. Several organizations had either already made changes or planned to do so. These included procedural changes as well as changes in physical equipment which would facilitate the system's obtaining and disseminating severe weather information. About one-third of the specific organizations contacted stated that they had either already

made modifications or were planning to in the near future. The other two-thirds stated that at the time of inquiry, they had no plans for change.

Many organizations realized that they did not have the information soon enough to be of use to them on Palm Sunday, and even if they did, many times it was neither sufficiently detailed or continuous to enable them to take appropriate action. In an effort to alleviate this deficiency, for example, City A's Fire Department in County A has been included in the warning system network. They are presently hooked up directly to the local WB's teletype system. The Fire Department has a second teletypewriter connected in another teletype system. Several organizations within the community are on this second hook up. During an alert, therefore, the WB could remain in constant contact with the Fire Department. The latter, in turn, could transfer the information to the second teletype system and re-issue more complete and continuous information to various other organizations. Placing the Fire Department directly in the warning network thus not only provides more continuous information throughout the system, but it also alleviates some of the potential telephone convergence on the WB. For instance, CD now has a direct contact with the Fire Department which it did not have before. In a very similar manner, City B's Police Department has been hooked up directly with the WB teletype system, thus serving the same function as City A's Fire Department.

There are still other types of change being made. Two City Police Departments did not have adequate auxiliary power and on Palm Sunday were without full communication for a period of time. Both departments have now

ordered new generators. In still another city, the local police tested a new 80 watt radio which had been installed in one of the vehicles just prior to April 11. Their other vehicles were using 40 watt radios. When the latter vehicles were sent out to various parts of the county to act as "tornado spotters" Palm Sunday, they were not sufficiently powered to keep in constant communication with headquarters. Therefore, 80 watt radios are being installed in all of their vehicles.

Organizations in several counties met with each other in an attempt to formulate a more adequate alerting and rehabilitation system should tornado forecasts be given in the future. In County B, a meeting between City Police, National Guard, and CD was planned for late 1965 to make organizational preparations for future tornadoes. Presently, CD in City A is trying to set up an emergency operations center in the Water Works Building from which all alerting and rehabilitation activities would be directed. The primary purpose of planning the emergency center is to prepare for a nuclear attack. However, it would also be useful during any emergency situation. Still another city has changed the priority regarding which organizations are to be contacted in a tornado warning.

The mass media (radio, TV, and newspapers) have been spending much more time explaining the difference between tornado forecasts and tornado warnings, and what precautionary measures the general public should have taken when a warning has been issued. One radio station in County C used to await up-to-date information concerning tornadoes to come over the Associated Press wire. Since Palm Sunday, it has been organizational policy to telephone

the WB directly when tornado forecasts have been issued. This method enables the station to keep much more abreast of the current situation. Personnel in another radio station stated that, "it has been determined that a warning light in our control room, activated by the weather machine, would guarantee even faster dissemination." However, such a mechanism had not yet been installed at the time of the DRC study.

Shortly after Palm Sunday, the U. S. Weather Bureau sent a team of investigators to the six-state area affected by the tornadoes. The primary purpose was to study the alerting procedures used prior to and during the Palm Sunday tornadoes insofar as the national and local WB's were involved. Sensing some possible inadequacies in their functioning, as well as in the functioning of the system as a whole, they formulated ten recommendations for change to lessen or alleviate some of the deficiencies. It is presently impossible to tell what effect these recommendations will eventually have in influencing future changes within the system. The following WB recommendations are included verbatim in this report for they suggest not only changes within the WB itself, but also inter-organizational changes--especially pertaining to inter-organizational cooperation and communication.

1. Hold preparedness meetings in collaboration with the appropriate Federal, State, County, and local government officials and news disseminators in order to develop emergency plans for alerting all segments of communities whenever emergency warnings are issued. Urge news outlets to install positive alerting devices (remoted to the announcer's position where necessary) on weather teletypewriter machines installed on their premises.
2. Saturate the public before and during the season with explanatory

material on tornadoes, tornado forecasts, tornado warnings and the appropriate action to be taken in each instance with the assistance of press, radio and TV, schools, and community groups.

3. Strengthen severe storm warning reporting networks in local communities and insure that they remain alert and active.
4. Complete the state-wide weather teletypewriter dissemination networks connecting Weather Bureau offices directly with news outlets and provide for interstate connections as necessary.
5. Provide remote narrow band with radar repeater scope (or scopes) to each Weather Bureau office in tornado-prone areas where such office is dependent for protection on a radar in another locality.
6. Complete the radar coverage with modern WSR-57 type radar for all areas east of the Rocky Mountains as soon as practicable, insuring that all populous areas as well within reasonable radar range and that "blind spots" are reduced to a minimum.
7. Provide back up emergency radio communications between adjacent Weather Bureau offices and between Weather Bureau and appropriate Civil Defense, state, county, and local offices with emergency responsibility.
8. Provide adequate emergency power for all radar installations and all communications equipment (including teletypewriters) at all Weather Bureau offices.
9. Extend the RAWARC (Radar Warning Circuit) to include all Weather Bureau offices in tornado-prone areas.
10. Surveys. In addition to surveys such as this one carried out by Weather Bureau staff (and the separate and more intense local surveys carried on for research purposes) occasional surveys should be carried out by behavioral science groups and aimed at evaluating the effects of forecasts and warnings of individual user reactions.¹⁵

One other warning method should be mentioned. In a very few small communities, Fire Departments did sound their fire engine sirens just prior to and

during the Palm Sunday tornadoes. But in the majority of communities, no sirens sounded. Furthermore, when asked if any sirens had been sounded for tornado warnings since April 11, most respondents said "no". One community now utilizes intermittent blasts of the fire siren to indicate tornado warnings and a few township Fire Departments still sound their sirens. However, the majority of communities in northern and central Indiana have not gone to a siren system. In fact, almost all organizational respondents discounted a siren alone as an effective means of warning the public. A typical response was voiced by one of the county sheriffs, "I would be in favor of a warning system if it doesn't go to a siren system. I think, we're going to confuse the people if we go into a siren system." Other respondents felt that the public, being unable to understand or interpret correctly what was being communicated by the siren, would not take appropriate action.

Although very few organizational officials were in favor of a siren system, they realized that something had to be done because of the deficiencies of the alert system utilized on Palm Sunday. Presently several communities are investigating a community warning system in which not only blasts are sounded, but also over which voice communication is possible. It was felt that this type of system would be far superior to the single tone-emitting siren. Several law enforcement officers used the speakers on their cars to pass on crucial information to selected community areas on Palm Sunday, but they were insufficiently powered to reach everyone in need of the information.

Conclusions

If the warning system was adequate, as claimed by some, why did so many die as a result of the Palm Sunday tornadoes? Although certain physical

equipment must be present and functioning properly if the general public is to receive alerts sufficiently in advance of impending disasters, too often there is a distinct tendency to overemphasize inadequacies of the physical components of the warning system. Many difficulties in warning systems inhere in psychological and sociological conditions rather than engineering ones; the best technology will not solve such problems.

As the present report indicates, many of the difficulties encountered in the warning system in Indiana were due, in large part, to social and human factors. An adequate warning entails much more than merely pressing a button activating a siren or sending a message on a teletypewriter. An alert given is not necessarily an alert received.

As to the steps in the warning process mentioned in the first section of this report, the first three steps were carried out quite adequately, especially by the WB. These were:

1. Detection and measurement or estimation of changes in the environment which could result in a danger of one sort or another.
2. Collation and evaluation of the incoming information about environmental changes.
3. Decisions on who should be warned, about what danger and in what way.

The fourth step "Transmission of a warning message, or messages to those whom it had been decided to warn" implies that such messages not only must be sent but also that they must be received by other organizations in the system. In most cases, the WB sent the warning messages but the system tended to break down on the receiving end. Crucial organizations and the general public often did not receive the warnings in time or at all. Electric power and

telephone lines were down and tornado relevant information was often blocked or delayed before it reached the intended receivers.

In addition, there was the general assumption that providing relevant information to the radio and TV stations was sufficient to warn the public. Even assuming adequate transmission to these mass media, relaying a message does not guarantee that it will be received by people in general. Radio and TV audience differ from day to day and from time to time. Furthermore, the audiences at any particular time on a particular day constitutes only part of the general public. There was little or no attempt by the system to attempt to cope with the problem of "dead" spots in its transmission and to use mechanisms other than radio and TV warnings. The crucial point here is that one should not assume that a warning sent is a warning received or that a warning communicated to the general public through the mass media is a warning received.

Another, and possibly more significant, breakdown pertains to the fifth step "Interpretations of a warning message, or messages, by the recipients and action by the recipients". Many who received the tornado warnings early enough, both organizational members and the general public, failed to take adequate precautionary measures.

Two articles in Indiana newspapers that came out simultaneously four days after the disaster spoke to this very point.

In general, the alert seemed adequate. But specifically it appeared non-existent. By that it is meant that during the course of a year, between a half dozen and a dozen state wide warnings of tornadoes are announced over radio and television.

The attitude of most is that of concern but not of alarm. No one wants to take immediate refuge in a ditch or cellar everytime a storm warning is given. And coupled with that is the

attitude that it could happen to the other guy...but it will never happen to my home.¹⁶

One lesson of the twisters of Sunday may be that a more widespread attention to warnings may be given in the future. There were warnings on television Sunday evening that Howard was one of the counties threatened by tornadoes, yet many people did not catch them and others may have taken them with a grain of salt since similar warnings had been issued in the past and twisters have not materialized.¹⁷

These articles raise the question: "Why did not the public show alarm and take appropriate action?" The WB and other tornado warning disseminators too often assume a simple stimulus-response type of communication to be adequate. They just issue a warning and almost expect the populace to respond automatically. This fails to take into account the effect of a person's past experiences on his interpretation of the alert.¹⁸

Most people will not take precautionary measures on the basis of a single tornado warning, especially when they have undergone previous false alerts. They seek additional clues which will either confirm or refute the authenticity of the warning. Without confirmation, disbelief on the part of the general public will tend to prevail.¹⁹ Many persons who heard the WB tornado warnings over radio and TV Palm Sunday had a difficult time finding additional clues. TV stations interrupted usual programming to issue warnings, but then resumed their normal schedules. This tended to discount the possible seriousness of the situation. Other individuals looked outside for adverse weather conditions which create tornadoes, but found none. There was not a cloud in the sky. Not finding additional clues, most people continued their daily routine since the warnings were interpreted as being no different than those in the past when tornadoes failed to materialize.

Sometimes warnings disseminated by several different means might serve as authenticators for the recipients. Note, for example, the number and nature of the cues available to the people of Leedy, Oklahoma, in 1947 prior to a tornado.

...almost half an hour before [the tornado] struck, the funnel was sighted in the distance by a local telephone official. He immediately sounded the fire alarm, which brought all the volunteer firemen to a central point. Also, [it was] announced over a high-powered public address system that a tornado was approaching and people were advised to go to storm cellars. In addition, volunteer fireman and other able-bodied men canvassed the town, spreading the warning and assisting old people and invalids to places of safety. As a result, almost the total population was in storm cellars when the tornado struck... [leaving] ...two-thirds of the town... completely devastated.²⁰

Refusing to take precautionary measures was not unique to the general public alone. Organizational officials often failed to act upon or disseminate warnings for the same reasons the public refused. Consequently, many people never received the warning because organizational members with the information failed to define the situation as potentially serious.

There appears to be one major exception to the rule that "people will generally not take precautionary measures on the basis of a single clue..." One might hypothesize that if a community has been routinely impacted by a particular disaster agent, a single clue may be sufficient to initiate public response. This seems to be the case in disaster subcultures. Examples of disaster subculture in the United States would include parts of Florida and Texas which often experience hurricanes, parts of Oklahoma and Kansas in "Tornado Alley," and other areas such as Cincinnati which experience periodic inundation from flooding. In these and other disaster subcultures,

public and organizational response may be initiated on the basis of a single clue, such as a WB bulletin re-issued over radio and TV.

It is important for organizational officials to take the concept of disaster subculture into account when they are developing the most effective warning system. The concept may explain, for example, why a blast from a single siren in Oklahoma might be sufficient to initiate a functional response, whereas the same siren sounded in Northern Indiana might be totally ineffective.²¹

Williams suggests that the only assurance warning disseminators have that the recipients have actually received, interpreted correctly, and taken appropriate precautionary measures is through feedback (Step 6). During the pre-impact period Palm Sunday, there was very little feedback from recipients; the disseminators had no way of knowing how the latter were responding to the alerts. Therefore, it was almost impossible for the WB or any other alert disseminator to carry out the final step (Step 7) in the warning process--the issuing of "new warnings, if possible and desirable, corrected in terms of responses to the first warning message."²² If the warning process is to be most effective, disaster alert planners and disseminators would do well to take all seven steps of the process into account. The warning process must be viewed as a circular, not unilateral, communication process including both organizations and the general public.

FOOTNOTES

1. Harry B. Williams, "Human Factors in Warning and Response Systems," The Threat of Impending Disaster, ed. George H. Grosser, Henry Welcher, and Milton Greenblatt (Cambridge, Massachusetts: The Massachusetts Institute of Technology Press, 1964), p. 80.
2. Ibid., pp. 82-83
3. The activities of fire departments were not directly covered by the DRC field work, and represent the major gap in the data on the alerting system.
4. Weather Bureau Survey Team, Report of Palm Sunday Tornadoes of 1965: April 11, 1965 (Washington, D. C.: U. S. Department of Commerce, Weather Bureau, 1965), p. 8.
5. Ibid., p. 30
6. Ibid., p. 39
7. Ibid., p. 39
8. Ibid., p. 39
9. Ibid., p. 9
10. Marion (Indiana) Chronicle, April 21, 1965, p. 9
11. Report of Palm Sunday Tornadoes of 1965, p. 41
12. Ibid., p. 41
13. For some purposes, a county can also be visualized as a system.
14. A good example of this is cited in a forthcoming monograph, Thomas E. Drabek, Disaster in Aisle 13: A Case Study of the Coliseum Explosion at the Indiana State Fairgrounds, October 31, 1963 (to be published by the OSU Disaster Research Center).
15. Report of Palm Sunday Tornadoes of 1965, pp. 2-11.
16. "Was Adequate Alarm Given to Boone Tornado Victims Sunday?" Lebanon (Ind.) Reporter, Vol. 73, No. 169, April 15, 1965, p. 4.
17. Kokomo (Ind.) Tribune, Vol. 115, No., 225, April 15, 1965, p. 4.
18. The best summary of the social and psychological factor affecting a person's response to warnings is given in Charles E. Fritz, "Disaster," Contemporary Social Problems, edited by Robert K. Merton and Robert A.

Nisbet (New York: Harcourt, Brace, and World, Inc., 1961), pp. 663-670.

19. For example, see Daniel Yutzy, "Aesop 1964: Contingencies Affecting the Issuing of Public Disaster Warnings at Crescent City California" (Columbus, Ohio: Disaster Research Center, Research Note #4) May 21, 1964; Raymond W. Mack and George W. Baker, The Decision Instant: The Structure of Social Responses To Unanticipated Air Raid Warnings, Publication 945, Washington D. C.: National Academy of Sciences, 1961, pp. 45-46; N. J. Demarath, "Human Adaptation to Disaster, Some General Propositions: An Interpretive Summary," Human Organizations, Vol. 16 (1957), pp. 28-29.
20. Leonard Logan et. al., A Study of the Effect of Catastrophe on Social Disorganization, Technical Memorandum, No. ORO-T-194, July 22, 1952 (Chevy Chase, Md: Operations Research Office), quoted in Charles E. Fritz, "Disaster," Contemporary Social Problems, p. 668.
21. William A. Anderson, "Some Observations on a Disaster Subculture: The Organizational Response of Cincinnati, Ohio, to the 1964 Flood," (Columbus, Ohio: Disaster Research Center, Research Note #6, June 30, 1965.
22. Williams, "Human Factors in Warning and Response Systems," p. 83