SOME ASPECTS OF EARTHQUAKE PREDICTION IN JAPAN

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Introduction

Currently, the major focus of disaster studies in Japan is on examining the social impact of earthquake prediction, as is demonstrated by the fact that the Japanese Diet has recently passed legislation (Large Scale Earthquake Countermeasures Act of 1978) with a view to authorizing arrangements for minimizing earthquake damage. In this respect, the Japanese Meteorological Agency already plans to establish a comprehensive national information network on seismic activity throughout the country for the purpose of producing "earthquake reports" to facilitate the early forecasting of major quakes. The importance of research on the socio-psychological impact of prediction may become even greater in the future. In fact, with the Tokai area in central Japan as the initial target for the country-wide warning network, several research groups have been undertaking surveys on the social impact of earthquake prediction in this area since 1978.

The Large Scale Earthquake Countermeasures Act of 1978 provides that the area in danger of a damaging earthquake shall be identified, and that an emergency plan against conceivable disaster shall be drawn up for this area. Article IX of the Act requires that the Prime Minister shall issue an earthquake warning and shall order preparations against disaster in response to a report by the Director-General of the Meteorological Agency on the danger signal of a major earthquake, thus providing the legal basis for the earthquake warning system.

It is well known that Japan, as compared to other countries, is highly organized and prepared against disaster and has well-prepared advance planning. The presence of counter-disaster plans on various levels in Japan is well established. The research report of the Disaster Research Center of the Ohio State University notes well-organized responses in the emergency period following the Niigata earthquake of 1964 [Dynes, Haas, and Quarantelli, 1964].

This does not, however, mean that the problem has been solved. To my knowledge, seismologists as well as government agencies can not specify accurately the time, place, magnitude and probability of occurrence of an earthquake. In addition, there has been no empirical research on the impact of earthquake prediction. Japan has only recently begun to emphasize the importance of planning based on earthquake prediction, and the Act of 1978 was the first step in this direction.

This Act led, first of all, to the installation of earthquake activity monitoring equipment such as seismographs, stereometers, clinometers, extensometers and others in the Tokai aea, where a Richter magnitude of 7 or 8 earthquake is forecast to occur in the near future, and in the South Kanto region. At present the Meteorological Agency in Tokyo electronically receives information on earthquakes from this equipment.

When this monitoring equipment detects extraordinary ground activity on a dangerous level, the Earthquake Assessment Committee is supposed to meet immediately to analyze and assess the probability of an earthquake. Consequently, the news media, local government bodies, police and fire departments are to be notified of the opening of the Committee meeting after a lapse of 30 minutes.

There is not much space here to give details of the warning system in the case of the Tokai area. However, as stated at the beginning of this paper, it is obvious that the Act of 1978 initiated a new era of earthquake prediction in Japan. Currently the notable studies by sociologists as well as social psychologists of the social impact of earthquake prediction are reported as in progress. Some of the surveys have produced suggestive findings.

For example, the Institute for Future Technology has studied human response to the aftershock warning in the case of Izu-Oshima earthquake of 1978 [Institute for Future Technology, 1980]. A research group of the Institute of Journalism and Communication has also analysed the social impact of warning in the same case and psychological response to TV news of the earthquake prediction [Institute of Journalism and Communication, 1979].

In this report I shall briefly deal with some current aspects and problems of earthquake prediction in Japan. The focus will be on an examination of some of the problems that we face in our research at present.

The Izu-Oshima Earthquake of 1978

The Izu-Oshima earthquake of Richter magnitude 7.0 occurred at 12:24 p.m., Saturday, January 14, 1978, in the wake of a series of smaller earthquakes which started Friday night. The epicenter was the seabed about 10 kilometers off the Izu peninsula. The intensity of the quake was five on the Japanese scale (80-250 gals) in Oshima Island and Yokohama City and four (25-80 gals) in Tokyo. At 2:00 p.m. in the afternoon on Saturday, the Meteorological Agency named it the "1978 earthquake off Izu-Oshima".

The main earthquake was followed by numerous aftershocks; a total of 161 tremors, mostly minor ones, occurred in the Kanto region and 158 tremors of these were recorded between 12:30 p.m. Saturday and 5:00 p.m. Sunday (see Table 1). The earthquake caused tsunamis 35 centimeters high at the beaches of Oshima Island and 12 centimers at Tateyama in Chiba Prefecture. However, there was no report of tsunami damage.

The damage to transportation routes and other facilities was caused by landslides. Notable damages to facilities occurred in the eastern parts of Izu Peninsula and Oshima Island. Landslides disrupted the National Highway in Izu Peninsula at five places and blocked other main roads. Train traffic on the Izu-Kyuko railway between Ito and Shimoda was suspended due to damage to the rails. Thus, transportation was seriously affected.

The total casualties in the earthquake were recorded as 13 killed, 14 injured, and 11 others missing as of 6:00 p.m. January 15, according to a report of the Prefecture Police Department. The danger of landslide

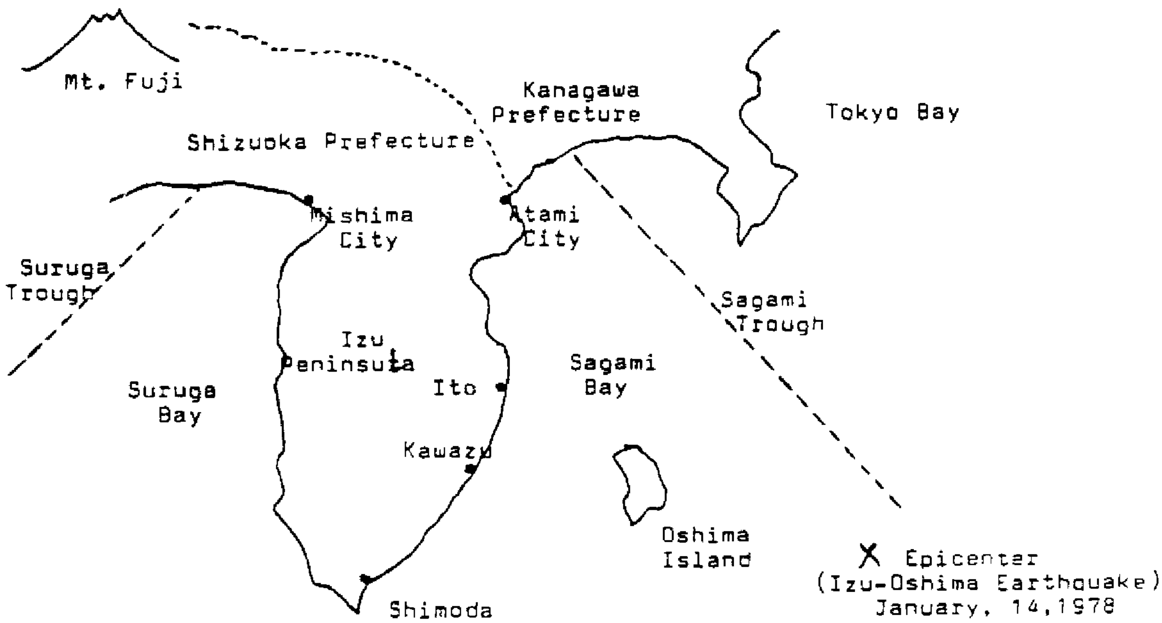
Table 1

Main Earthquakes Which Occurred On
January 13 and 14, 1978

Time	Intensity (gals)				
	80-250	25-80	8-25	2.5	0.8-2.5
January 13					
8:28 p.m.,			Oshima		Yokohama
January 14					
8:12 a.m.,			Oshima		Yokohama
8:31				Oshima	
9:06			Oshima		
9:33			Oshima		
9:36		Oshima		Tateyama	Tokyo
9:38			Oshima		
9:45		Oshima	Yokohama	Tokyo	
9:47		Oshima	Tateyama	Tokyo	Niijima
12:24 p.m.	Oshima	Tokyo	Nagoya	Mito	Hachijo
	Yokohama	Mishima	Chiba	Osaka	Kobe
		Shizuoka	Kofu		Katsuyama
1:42 p.m.,			Oshima	Yokohama	Shizuoka

and rock fall continued until Saturday night. The quake damages were especially extensive in the town of East Izu. Nearly 1,000 of a total of 5,000 houses in the town were damaged at the time of the major quake; water supply and telephone communications were disrupted following the main shock.

The earthquake also produced similar situations in the Kawazu and Inatori area on Saturday. Under these conditions, the Self-Defense Force transported a total of 400 tons of drinking water to the above areas as landslides had disrupted access to these areas at many points.



Map 1

Map of Izu and Oshima

A significant consequence of the shocks was that sludge containing hydrogen cyanide flowed out of a breached reservoir near the slag dump of a metal refinery plant in Yugashima, Izu Peninsula. The sludge went into one of the rivers in the area and flowed into the Suruga Bay. The outflow of sludge from the reservoir was estimated at 100,000 cubic meters on January 15 and 5,000 cubic meters on the next day. As a result, the water of Mochikoshi River and Kano River was contaminated with noxious hydrogen cyanide. The accident, indeed, seemed incidental to the earthquake. However, as it seemed, its main cause was attributable not only to the earthquake but also to the weak reservoir bank.

According to the report by the Disaster Headquarters on January 18, the damages to public facilities were estimated at Yen 11,637,000,000 (about $52,900,000).

Individual and Organizational Response to Aftershock Warnings

When a disaster occurs suddenly and transcends the range of preliminary training or planned arrangement, the counter-emergency activities of public agencies often lose adequate organizational response and fall into preposterous group behaviors. We can see such an instance in the case of the Izu-Oshima earthquake.

A careful observation of organizational responses in an emergency period was made in the research conducted by Prof. R.R. Dynes, E.L. Quarantelli and J.E. Haas on the Niigata earthquake of June 16, 1964 [Dynes, Haas, and Quarantelli, 1964]. The characteristic of Japanese administrative structure, as a comparative study of disaster response by Prof. B.F. McLuckie found, is that it is highly centralized as compared to its U.S. counterpart [McLuckie, 1975].

The organized activities of community teams under the mobilization plan of government agencies were evaluated highly. In the case of the Niigata earthquake, the normal lines of authority and those specified in disaster plans were effectively operative at the time of emergency in spite of the large extent of the damages.

This can also be said from the findings in the case of the Izu-Oshima earthquake of 1978. In the cities and towns on Izu Peninsula there were few local defense organizations, and they were not well equipped for emergency service. But once the Prefecture Disaster Headquarters was organized, as had been provided for in the plan, the rescue teams, with the aid of the Self-Defense Force, quickly started action and moved into these areas. They arrived in the damaged areas without delay, though disrupted highways prevented them from using normal means of transportation.

The Disaster Headquarters has a centralized command and could control all available public and private organizations. And it could also call on outside organizations for assistance. In this circumstance, volunteers' activities in the impact area were used only on a limited basis and there was no organizational competition over relief. Formal organizations consistently acted as the major source of relief work, and the activities of voluntary organizations were controlled effectively by the centralized authority.

According to Prof. A.H. Barton's cautious comment, however, the important thing to be noted here is that a case such as the emergency fighting system in Japan might be vulnerable to types of impact not covered by the working plans [Barton, 1969]. In addition, public agencies do not always perform their expected organizational role.

In the case of the Izu-Oshima earthquake, the warning about aftershocks from the Prefectural Office produced unpredicted behavior both on the individual and organizational levels. In this connection, I would like to concentrate on the problem of the social response to the earthquake warning. The discussion on this point is drawn from the data in the survey carried out by Institute of Future Technology [Institute of Future Technology, 1980, pp. 175-255]. It can be called a typical case of inadequate organizational response in an emergency system. What follows is a general description of the case.

In the afternoon of January 17, the Committee of Emergency Disaster Headquarters released information about the possibility of aftershocks in the Izu-Oshima area. On the next day, the Shizuoka Prefecture Disaster Headquarters forwarded the information to public offices and organizations in the quake-stricken area. The above action was, of course, in compliance with what the plan had set forth. However, what complicated the situation was that the Prefectural Governor officially announced the information as emergency news to newsmen in his press interview. Under the extraordinary circumstances, the information was mistaken for a "disaster warning" and further amplified on the TV and radio transmission to that effect.

I should comment on the early stage of rumor dissemination. It should be noted here that the initial announcement was too laconic and that the disaster plan had not been based on a cautious study of the response behavior to a warning on the parts of individuals and organizations in transmitting information. Upon receiving the information, they stepped up its transmission to other organizations and individual residents. For instance, the LPG Association supplying gas to Shizuoka Prefecture already had an emergency network. At that time, with the network given full play, the information was transmitted as a disaster warning from the LPG Association to other organizations and factories. But the information was inaccurate and fragmentary.

Residents were confused with the fragmentary information and sought accurate information. With rumors spreading quickly beyond imagination, prefectural and municipal offices were swamped with inquiries about the warning. By an unofficial record of the Disaster Division of the Shizuoka Prefectural Government, it received more than five hundred inquiring calls. The switchboard was overloaded and at times unable to respond.

Ambiguous information and rumors caused more apprehension among people than necessary. Some of the large factories in the Shizuoka area allowed employees to return home. On the other hand, in a number of communities the leaders of Chonaikia Associations announced warnings on their own judgement and called for evacuation. ("Chonaikai Association" is a kind of local group in Japan and it was traditionally organized as the civil defense organization on a large-scale level of neighborhood units.)

Figure 1 is a flow chart of the described information on aftershocks and the purpose of rumor dissemination on January 18. It is obvious that the cause of confusion in this case occurred from the paper plan itself without preliminary consideration of disaster warning. It should also be noted that the announcement of fragmentary information and its transmission between organizations was one of the major causes of confusion [Institute for Future Technology, 1979 pp. 102-105]. The Disaster Headquarters lacked the capacity to manage unfounded rumors and to cope adequately with such a situation.

In the above case the flow of information and rumor ran mainly through the interorganizational communication network which had been prepared for a time of emergency. The initial warning news was flashed on TV and radio broadcasting. However, we do not think that the announcement of fragmentary news by the Prefectural Governor and TV was the only cause of confusion.

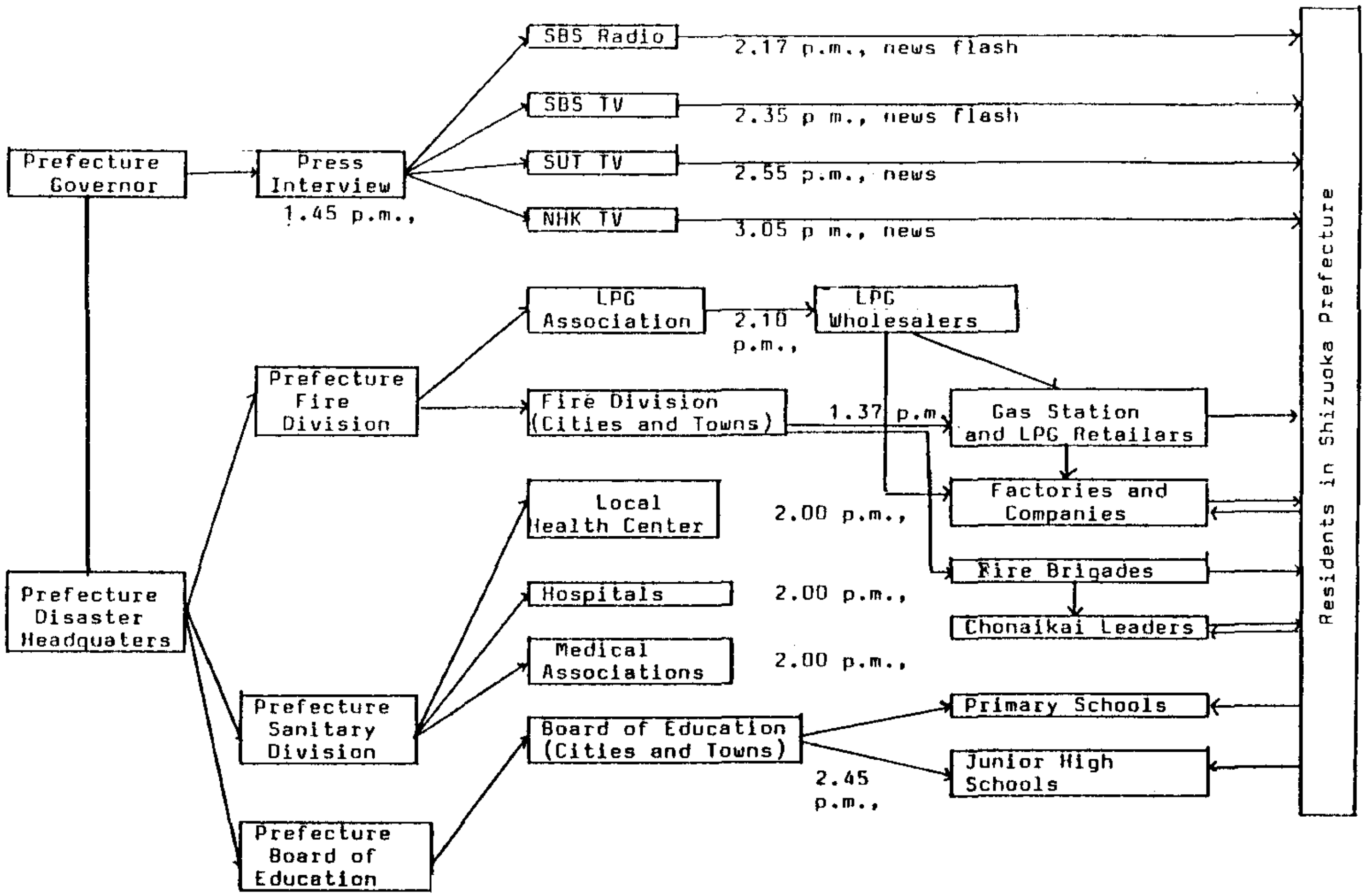


Figure 1

Communication Flow of Warning on Aftershocks and Process of Rumor Dissemination (January 18, 1978)

It can be said that the careless handling of information by some organizations on their communication channels made it misleading. A typical example was the case of the LPG Association. Rumors were amplified through telephone communications and distorted through person-to-person verbal communication between and within organizations.

There seem to have been two notable phases with respect to rumor dissemination--the first being short news flashes on TV and radio services and the second being careless information services from formal organization to others. In addition, interpersonal communication amplified inaccurate rumors by verbally passing on a shocking warning and sensational information. This was clearly pointed out by the intensive survey of the Institute for Future Technology.

Table 2

Percent Hearing Information about Aftershocks

Response	Percent
Heard	39.7%
Not Heard	60.3

Survey Results

As is well known, one of the outstanding characteristics of rumor is the verbal communication of non-confirmed information from person to person. Therefore, in a rumor analysis it is necessary to track its dissemination routes quickly. In this respect, telephone interviews might be an expedient research method to trace the source of the rumor and its communication routes though it involves qualitatively uneven data.

The interviews were made by specially trained telephone operators in the Dentsu Research Center shortly after the rumor dissemination. In addition to the above interviews, civic leaders as well as executives of public organizations were also immediately interviewed by researchers of the Institute for Future Technology.

Table 3

Percent Hearing Rumor Major Earthquake Will Occur in Shizuoka Area in a Day or Two

Response	Percent
Heard	54.1%
Not Heard	45.9

Now let us look at the survey findings and observe the mass responses to the rumor. The survey results indicated that 39.7 percent of the respondents heard the predictive information about the aftershocks through TV or radio news (see Table 2).

Table 4

Rumored Time of Expected Earthquake

Time	Percent
Soon (within one or two hours)	2.6%
After two or three hours	7.8
4-6 p.m.,	16.9
About 6 p.m.,	4.7
After 6 p.m.,	7.0
This afternoon	1.5
This evening	4.7
Within the course of the day	7.8
In a couple of days	0.9
Uncertain	33.1
Others	13.0

On the other hand, as Table 3 shows, 54.1 percent of the respondents heard about the rumor by telephone or verbal communications with family members, friends, neighbors and others. The residents of the impact area have a much higher percentage than those of other areas. Especially, in the Izu area 87 percent of the residents heard about the rumor. This percentage indicates that the quake area residents have developed highly anxious feelings because of the disaster. The time of the expected earthquake in rumors is shown in Table 4.

Table 5

Source of First Information About Aftershocks

Source of Information	Percent
SBS TV (local broadcasting station) news	20.3%
Other TV and radio news	16.3
Announcement by loud-speaker truck (public address)	3.5
Emergency broadcast system	5.2
Telephone communication with family members	4.1
Verbal communication with friends and acquaintances	25.0
Telephone communication with friends and acquaintances	5.8
Verbal communication with family members	8.1
Hearsay	10.5
Others	1.2

As already mentioned, a primary source of information about the aftershocks was the announcement of the prefectural office which was transmitted mainly through interpersonal communication. Table 5 shows the various sources of information through which it was transmitted.

Observing chronologically the percentage of the people who heard the warning and readily received it as a rumor at the given time, as Figure 2 shows, rumor dissemination demonstrates an increasing tendency.

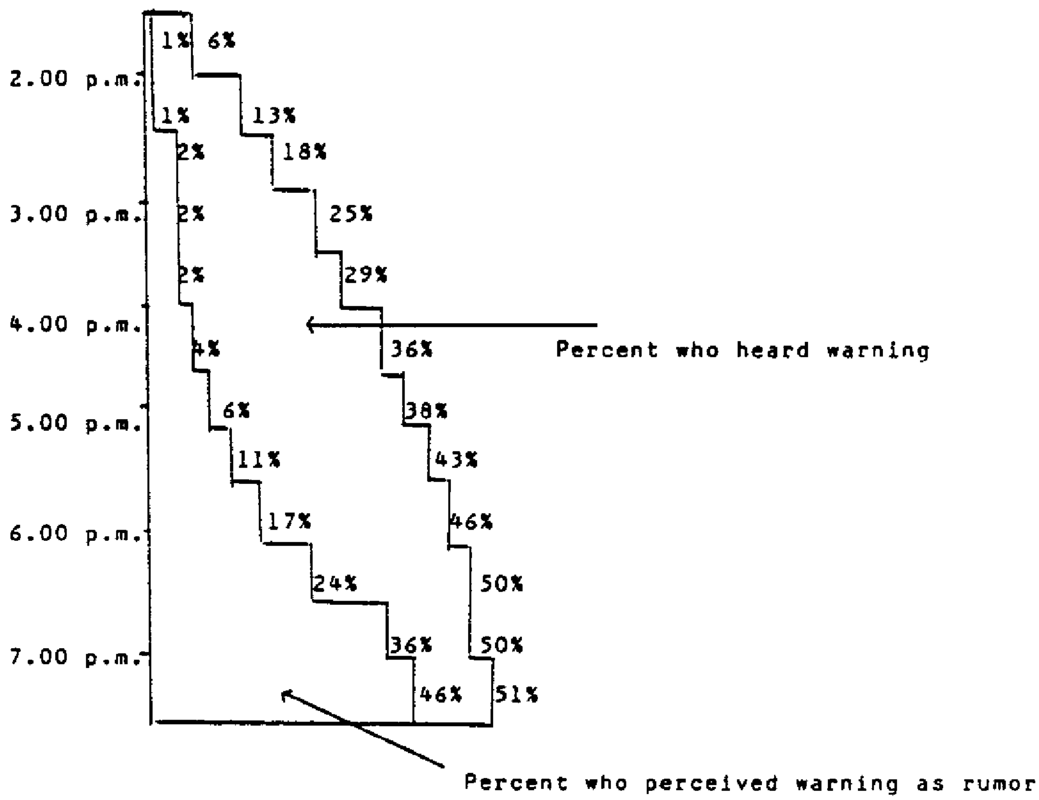


Figure 2

Percent who Heard Warning and Perceived it as a Rumor

At 5:24 p.m., TV and radio news denied the rumor, and at 6:00 p.m. the Director of the General Administration Department of the Shizuoka Prefectural Government announced accurate and detailed information in his interview for SBS TV news. Thus, the rumor was denied, and a sense of security returned to people.

Concerning the rumor itself, as Table 6 suggests, most people took the information for a warning about the danger of another earthquake. People who believed the rumor reached as high as 31 percent. When the 39

Table 6

Reliability of Rumor

Response	Percent		
Unconditionally believed it	9.6%	30.8	70.0
Believed it to some extent	21.2		
Half in doubt	39.2		
Did not believe it mostly	20.3	29.0	
Did not believe it at all	9.6		

percent who were half in doubt are added a total of 70 percent believed the rumor they had heard. These percentages tell us much about the degree of rumor dissemination.

What did people do after hearing the rumors? The answer is given in Table 7. Table 8 indicates levels of anxiety after hearing the rumors.

Table 7

Reaction to the Rumor

Response	Percent
Wanted to obtain additional information by TV or Radio	33.1%
Prepared emergency items	34.6
Talked with family members and neighbors about what to do	16.3
Telephoned to the broadcasting stations or municipal office to confirm the warning	2.3
Returned home quickly	6.4
Went out to school to collect children	1.7
Evacuated to safe place	1.2
Others	4.4

Table 8

Levels of Anxiety after Hearing the Rumors

Response	Percent
Very much worried	25.6%
Somewhat disturbed	30.0
Uncertain	13.0
Not disturbed	23.1
Not worried at all	7.8

As a result, so far as the case of the Izu-Oshima earthquake, there was no panic nor any kind of deviant mass behavior. A majority of the residents in the quake area showed an extremely low degree of sensitive behavior in the face of the rumor. This deserves admiration.

However, more important is that in the Izu-Oshima earthquake ambiguous information from formal organizations caused confusion and the communication network for use in the time of an emergency served for spreading rumors. This suggests that organizational response to the transmission of information such as a disaster warning should be based on cautious judgement.

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