The Debris Flow in Izumi, 1997 and Dissemination of Disaster Information

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At 0:40 a.m. on July 10, 1997 a debris flow occurred along the Harihara River in Izumi City, Kagoshima Prefecture, killing 21 and injuring 13.

It is pointed out that the debris flow disaster countermeasures and evacuation activities have many difficulties. Our research group visited the site of the disaster in October, 1997, and interviewed municipal officials from Izumi City, and Mr. Mamoru Furukawa, head of Harihara Area citizens' hall to verify the problem of the disaster countermeasures and the evacuation activities in the debris flow disaster and so on. Secondly, based on the interview, from the end of 1997 to the beginning of 1998 we conducted a questionnaire survey of 112 survivors (of whom 73 answered).

As a result, the following facts were brought to light.

(1) Though the residents assumed flood damage, there was no sense of crisis about debris flow.

(2) 40 percent of residents heard evacuation advice directly, a little over 10 percent indirectly, and 40 percent did not hear any evacuation advice.

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(3) 70 percent of residents did not intend to evacuate.

(4) Though some residents felt a change in the amount of water in the river as being ominous, it was never connected with a debris flow disaster.

Moreover, regarding evacuation activities, who should take leadership in assisting people who needed help and in the refuge when they evacuated became important issues.

1. Character of this disaster

A debris flow occurred along the Harihara River In Izumi, Kagoshima Prefecture, about 0:44 a.m. on 10th of July, 1997; a 200-meter high and 100-meter wide area of the mountainside of the right bank collapsed, releasing 160000 cubic meters of mud. The debris flow swept over the sediment control dam under construction 400m down at the lower reach, and covered an area 150m wide and 600m long on the lower reach in sediment. The debris flow buried 19 houses (totally destroyed 19 & partly destroyed 1), killing 21 residents and injuring a further 13.

The rainy season lasted until July 20, one week longer than usual in southern Kyushu. Izumi had recorded 1250 millimeters of rainfall, during the rainy season, twice as much as in normal years. Izumi had 613 millimeters of torrential rainfall for 4 days, from July 7 until July 10. And on the 9th, the day before the disaster, 275 millimeters of rain fell. In particular, 60 millimeters of rain from 10:00 a.m. until 11:00 a.m. and 55 millimeters from 4:00 p.m. until 5:00 p.m. was like "tipping over buckets of water." But the rain turned to a drizzle, and stopped from 9:00 p.m. At midnight, about 3 hours later, a massive debris flow suddenly struck the area with a loud noise.

In this disaster inhabitants couldn't evacuate properly, and they suffered as a result. Why couldn't they evacuate properly? There are thought to be three factors.

(1) Characteristics of natural disaster in the process of the debris flow

(How could they have predicted the debris flow?).

Table 1 Monthly Rainfall and the Daily Rainfall of Izumi in 1998(Rainfall Average of Usual Year)

June	413.0 mm (328.8 mm)	July	837.5 mm (336.4 mm)
July 7	63.5 mm		
July 8	59.0 mm		
July 9	275.0 mm		
July 10	216.0 mm		

(2) Officials' countermeasure

(How did officials appeal to them to evacuate, and inform them of the dangerous condition in the disaster?).

(3) The residents' countermeasures.

(How suitable were the risk perception and the evacuation activities?).

Considering the possibility of predicting the disaster and difficulty of the evacuation, while there was heavy record-breaking rain:

(1) by the time the disaster occurred, the rain had stopped;

(2) changes in the mountain and the collapse of sediment weren't checked; and

(3) the debris flow occurred late at night when it is difficult for inhabitants to evacuate.

These conditions made disaster prediction and evacuation difficult. But, this can be said not only about this case of debris flow but also about other disasters. As is stated later, there were some ominous signs of the disaster to follow.

On the other hand, were officials' and residents' countermeasure predictable and prudent? We would like to clarify them according to interviews with the administration and inhabitants, and the questionnaire survey of the inhabitants living in the area who were given the evacuation advice.

2. Disaster Countermeasures by Municipalities

2.1 Countermeasures on July 9

At first, we would like to describe the countermeasures of the Izumi municipal office before the debris flow occurred. Izumi has the severe rain which hadn't been experienced before on July 9. It was from 10:00 a.m. until 11:00 a.m. and from 4:00 p.m. until 5:00 p.m. that were peak hours of rain. Particularly the hourly rainfall of 60 millimeters of rain from 10:00 a.m. until 11:00 a.m. and 55 millimeters from 4:00 p.m. until 5:00 p.m. were like "tipping over buckets of water."

Officials at the Kagoshima Local Meteorological Observatory issued heavy rain and flood warnings for Kagoshima at 10:45, the first peak. In the area the warnings mark was lowered following a series of earthquakes in the northern part of Satsuma district (northwestern Kagoshima Prefecture) in May of this year.

Izumi City got FAX information, which was used by the Dial Q2; "Ascii Weather Net" by the weather forecasting company (International Meteorological & Oceanographic Consultants

Co., Ltd.) every hour in addition to weather bulletins from Kagoshima Prefecture. This service provides not only the present state of the weather data, but weather forecast in one and three hours. Izumi City has been utilizing this data in its disaster prevention policies as well.

Then, Izumi City judged that some damage could be caused by heavy rains, and the disaster countermeasures conference was held at 16:30 and a disaster headquarters was formed at 17:00.

Izumi City has the standard that the headquarters for disaster countermeasures against wind and flood damage is to be established when it has 150 millimeters of rainfall continuously, when it has 50 millimeters for 1 hour, or when the water gauge at Kasuga bridge of Komenotsugawa shows an abnormal mark. The evacuation warnings was given to about a thousand households near the Komenotsugawa River once in July 3, 4 , 1995, when the water gauge of Kasuga bridge exceeded the danger water level of 4m 20cm, as well.

An evacuation warnings wasn't taken out by the rain on July 9. However, 17 refuge sites designated by the city were established at the same time that the headquarters for disaster countermeasures was established. Then, an evacuation advice was given through the heads of the citizens' hall of each area in the whole the city and transmitted by wire broadcasting. City officials were sent to establish the refuges. On the other hand, the city officials (mainly in charge of planning or public information) informed the evacuation advice by the phone to 161 heads of citizens' halls. The heads of the citizens' halls who received the telephone calls were supposed to read the broadcasting sentence prepared in advance over the wire broadcasting system. Sentences were prepared for each disaster and hazard situation, numbered, and bound in order. The heads of the citizens' halls were supposed to read the appropriate sentence following direction from the city. The broadcasting sentence at that time was No.4, and it was as follows.

Emergency Broadcasting Sentence for Disaster Prevention No.4

This is Emergency Broadcasting for Disaster Prevention by the City.
Heavy rain and flood warnings have been issued.
The ground has become loosened by heavy rain, and a disaster such as soil fall or landslide may occur.
Watch surroundings carefully and evacuate if you feel any danger.

Evacuate to the refuge as soon as possible, considering the conditions on the way to the refuge.

The nearest refuge is established at (where) at the (when) o'clock.

(repeat)

This took about one hour because 5 or 6 city's officials passed on the evacuation advice by phone to the 161 heads of the citizens' halls. It is said that there is about two appeals for evacuation over the wire broadcasting system like this every year, and there is more frequent establishment of the headquarters for disaster countermeasures.

There damage reports from two sites in the city at about 17:00. One report was that the levee of Era River collapsed in eastern Komenotsu area, and the other was that the northern Komenotsu Station street area was flooded and the houses in the area were flooded below the floor level. The northern Komenotsu Station street area is a place where water tends to collect, so it readily floods when severe rain falls. The area was flooded two times in the morning and in the afternoon as well in that day.

But, rain stopped before 9:00 p.m. , and the people who evacuated came back to the houses, and 17 refuges designated by the city were closed from 9:00 a.m. until 11:10.p.m..

Less than two hours later, the debris flow occurred at Harihara district.

Most of the wind and flood damage experienced in Izumi City were floods, and the last debris flow disaster occurred in the southern part of the city at the turn of the century. Actually, Izumi hasn't experienced sediment disasters except this debris flow of the Harihara Area since the Izumi municipal government was formed. Therefore, from experience, the city paid more attention to floods than to debris flow in its rainfall countermeasures. Most concern about rain disaster was felt in the southern part of the city: the lowland near the sea and the river where water tends to collect, and places between the mountains, such as Kokiba, Maruzuka and Hiraiwa, where there was damage by earthquake in March this year. This time, the area where severe rain fell was the northern part of the city, so the city officials couldn't foresee the occurrence of the damage because the area of the debris flow was higher above sea level and steeply inclined.

2.2 The Citizens' Hall and Wire Broadcasting

We would like to explain about the citizens' hall and the wire broadcasting system used by officials to give the evacuation advice in Izumi City.

Many municipalities themselves have some information system such as disaster prevention radio communications and off-talk communication systems, which can transmit information to the inhabitants. However, the wire broadcasting system was used in Izumi City as an information system.

It is not directly from the city officials to inhabitants. In the case of Izumi city, 161 heads of the citizens' halls of the city transmit it to the inhabitants in each area with wire broadcasting systems based on the city's directions. The head of the citizens' hall in Izumi City is the chairman of the neighborhood association, or self-governing body in other areas. It can be said in other words that the neighborhood association or self-governing body exists in the citizens' hall unit. This means city officials transmit the information to the chairman house of 161 neighborhood associations, and each chairman tells the inhabitants of neighborhood association of the information all together at the same time by the wire broadcasting system.

Information such as evacuation advice when the disaster occurred is transmitted by 5 or 6 city officials to 161 heads of the citizens' halls as mentioned above. The "Emergency Broadcasting Sentence for Disaster Prevention" is distributed in advance to each head of the citizens' hall "Emergency Broadcasting Sentence for Disaster Prevention". "Emergency Broadcasting Sentence for Disaster Prevention" is made corresponding to each disaster or situation, and the number is given to each. If something happens, the city tells the head of the citizens' hall to read No.○, and the head who got the direction is supposed to read the sentence using the wire broadcasting system.

Inhabitants can use this wire broadcasting by joining "the citizens' hall". In other words, inhabitants cannot use wire broadcasting if they do not join the neighborhood association, "the citizens hall". Most inhabitants are members of "the citizens hall" in Izumi City; of course, some are not, though.

2.3 "Hazard Map"

Izumi Public Works Office, Kagoshima Prefecture, made the map of dangerous area for debris flow disaster, "Is your town safe?" in 1996. There are 41 dangerous streams of debris flow and 17 landslide-prone places designated in Izumi City, and this Harihara side was mentioned as a dangerous stream of debris flow, too. The map didn't show the area which was dangerous as a result of the debris flow, but just showed the dangerous mountain stream with

only a blue bold line along the river. Strictly speaking, it can't be said that it was "Hazard Map". It wasn't distributed to each household, though the map was being made for the citizens.

A map with really the same contents was made as "New map of dangerous area for debris flow disaster '97" in 1997 as well, and it was delivered to the city on July 3. This map was intended to be distributed to the inhabitants living in the danger area through the head of the citizens' hall at the same time as the printed matter distributed by the city twice a year. The date it was to be distributed was July 10; the day the debris flow disaster occurred. Written on the side of this map was "Danger! Watch for this warning sign!" It was mentioned that warning signs of potential debris flow were that the mountain rumbles, the water level of the river falls though it keeps raining, and the flow of the river becomes muddy and includes driftwood. These phenomenon were seen this disaster, and damage might have been reduced if this map had been distributed earlier.

2.4 Disaster Experience

Looking at the disaster experience (wind and flood damage) of Izumi City, damage such as flood caused by rainfall seems to happen somewhat frequently as mentioned above. There were local severe rain in 1965, typhoon No.15 in 1965, local severe rain in 1971, typhoon No.19 in 1971, local severe rain in 1972, typhoon No.9 in 1976, and so on. 'The history of the river and life in Izumi' (Izumi City Board of Education, 1991, pp100-102) mentioned wind and flood damage as the main disasters since Izumi City was municipalized in 1954. Izumi City suffered damage as recently as the Kagoshima floods in 1993. But these disasters were flood and wind damage, and there was no experience of sediment disasters such as debris flow.

As the experience of the debris flow disaster in Izumi City, there was a record that the debris flow, which was called "Yamashio: the tide of mountain", hit Yukawanai hot springs, the southern part of the present Izumi City, in 1902, more than 95 years before. Inhabitants called it "mountain tide" in this area.

> *The landslide called "Yamashio: the tide of mountain" should be mentioned specially in the record of natural disasters in Izumi. The landslide suddenly struck Yukawanai hot spring on August 10, 1902. The landslide washed away and killed 17 visitors at the hot springs and so on in a flash. Clouds were low, and thick fog had blanketed the area since the morning.*
>
> *Izumi soon swelled into a storm, the ground became soft because of the heavy rain*

where the upper reaches of mountain stream was along the hot spring and both sides of the steep valley. Landslides occurred, and it is said that the soil of the mountain fell down into the mountain stream.

Big trees on both sides also fell, and dammed up the stream. It became a so-called natural embankment, and held back a large quantity of water. At about noon, it broke, and out flowed the water (the rest is omitted).

(Izumi City Board of Education, 1991, 'The history of the river and life in Izumi' pp96-98) :translated by the writer

As there had been no debris flow for almost a century, few considered it to be a real problem. The debris flow on July 10 caught residents and officials completely unawares.

2.5 What We Learn from This Disaster as Countermeasures for Coming Disasters

The 2 following countermeasures are examined in Izumi City after this debris flow disaster.

(1) Seven rain gauges should be installed in the city in addition to the water gauge in Kasuga bridge of Komenotsu River.

(2) Radio receivers instead of phones should be installed in the citizens' halls and the houses of the heads of citizens' halls because telephone contact takes longer than one hour.

3. The Conditions of the Victims

3.1 Research Method

Here we would like to verify the conditions and details about the victims in Harihara, Sakai town (Harihara Area), Izumi City .

We adopted the same method as the investigation in the "Offshore Southwestern Hokkaido Earthquake" in 1993 ("Disaster Information" research group, Institute of Socio - Information & Communication Studies, Tokyo Univ., 1994). Using a residential map we interviewed inhabitants in the stricken area, who knew the area and the circumstances of the victims, which households the victims were from and what kind of conditions they died under. The following section covers this investigation, referring to disaster-related data, newspaper articles, and so on.

3.2 Outline of the Damage

First, we would like to give an outline of the victims in Harihara Area. 21 people were killed and 13 were injured as mentioned above in Harihara Area.

Figure 1 shows the houses of the stricken area, and was prepared by the Izumi City Fire Headquarters. Totally destroyed buildings are shown by dotted lines, and partly destroyed buildings by solid lines and Dotted lines.

Next, the conditions of the debris flow, based on the map.

The debris flow occurred around the upper reach of the Hariharagawa River, in the southeast of the map: the right of this map. The debris flow flowed from the south to the north: from the right to the left of the map. The big debris flow swept over the sediment control dam along the Hariharagawa River, totally destroying 1, 2, 3, 4, 5, 6, 9, 11, 12, 15, 16 and Wakamiya shrine, partly destroying 7, 8, 13, 10, 13, and crushing 16, where it stopped. The debris flow and

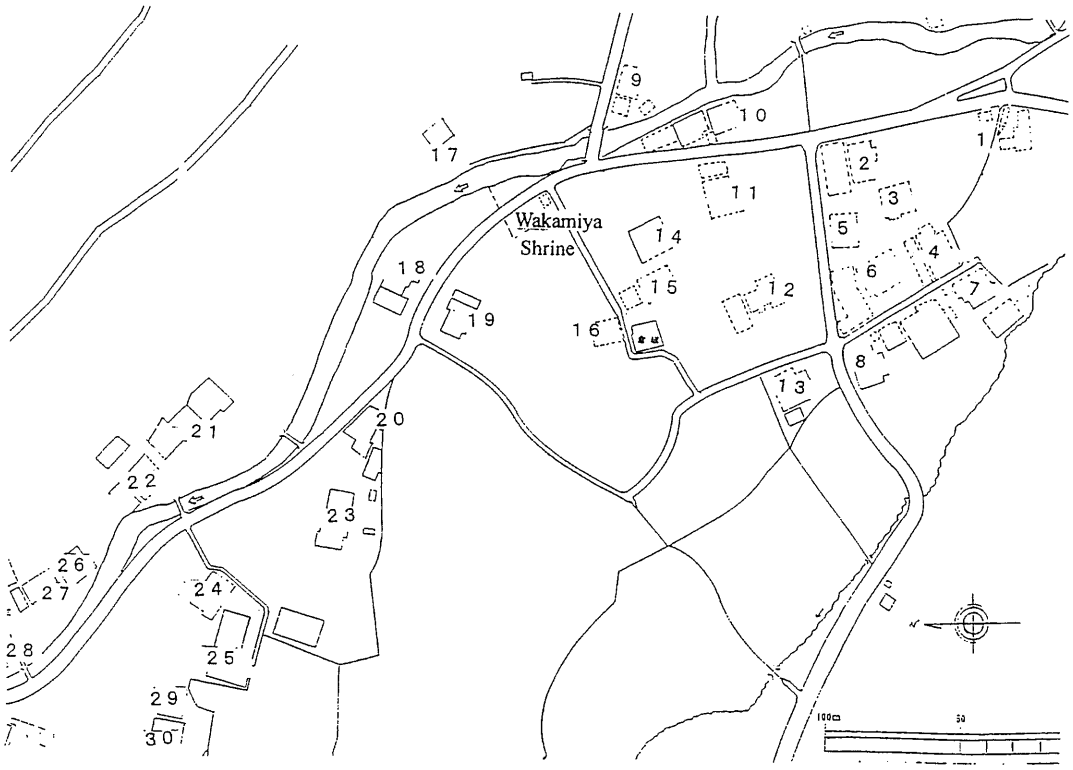

Figure 1 Map of the Debris Flow Disaster in Harihara Area, Izumi City.
(Source: Izumi City Fire Headquarters.)

sediment were dammed by the bridge in front of 22 along the river. Therefore, building 22 was also damaged, far from the place where the big debris flow stopped. Flood damage below the floor level occurred in the houses along the river in the area on the lower reaches from 22.

Next, we must mention the victims. People were killed or injured in the debris flow in 13 households of 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 15, 16. The debris flow killed people in all of these households except for 7. Table 3.1 shows the conditions of the victims by household.

3.3 The Conditions of Victims

We would like to describe about the victims in Table 3.1.

(1) No.1 A.T's house

It was the nearest of the victims' houses to the start of the debris flow. The house was totally destroyed. A.T (Female, 69 years old), who lived by herself, died. It seemed that she was killed while sleeping, though we cannot be sure because she lived by herself.

(2) No.2 K.K's house

There were 4 people in K.K's family, K.K (Male, 46 years old) , Y.K (Female, 46 years old), his wife, N.K (Female, 15 years old), the eldest daughter, and Y.K (Female, 15 years old), the second daughter. They all died except for N.K, the eldest daughter. The house was totally destroyed. According to N.K, the eldest daughter, who escaped death narrowly, they heard the loud noise and tried to evacuate from the entrance or the back door, and it was when N.K tried to put on her shoes that the debris flow washed them away. It seemed that N.K and her parents were carried in the same direction. The bodies of her parents were discovered around Wakamiya shrine, about 100 meters north from the house. N.K was saved narrowly, though she was washed away to near 22 (E.I's house), about 150 meters on the lower reach along the Hariharagawa River. Only Y.K, the second sister, was carried in a slightly different direction, and her body found near 23 (S.T's house), southwest of 22.

(3) No. 3 S.T's house and No. 4 K.T's house

No.3 was the house of the married couple, S.T (Male, 77 years old) and N.T (Female, 71 years old). No.4, which adjoined No.3, was the house of K.T (Male, 47 years old), their son. No.3 S.T's house and No.4 K.T's house were totally destroyed. The roof of No.3 S.T's house hit No.13 M.F's house about 70m away. Only T.T (Female, 19 years old), the eldest daughter of K.T, survived because she was out of the house that day when the disaster occurred. It was said that he returned home at about 9:00 p.m. on the night before the disaster after his farewell

party because he was transferred to another office. K.T (Female, 12 years old), the second daughter of K.T, was missing in the beginning of the disaster. However, her body was discovered underneath a toppled refrigerator when the sediment which accumulated on the home was dug 1.5 meter before noon on the 11th, the day after the debris flow. (The morning paper Yomiuri Shimbun on July 12, 1997)

(4) No 5 T.E's house and No 6 I.E's house

No. 6 was the house of the married couple, I.E (Male, 64 years old) and K.E (Female, 61 years old), and No. 5 which adjoined it was the house of T.E (Male, 36 years old), their son. No.6 I.E's house and No.5 T.E's house were totally destroyed. Only T.E survived. The newspaper report said the moment when "T.E was about to grasp the end of the sleeping bed because he heard the thud of 'Dhoon!', it seemed that the sediment came rushing down with the sound of 'GOOOO !' Though he did not know what was happening, he noticed muddy water in his mouth several times and he found himself was being washed away." (The evening paper Yomiuri Shimbun on July 10, 1997). T.E was washed away several meters and ended up underneath the lumber. After that, he however escaped by himself and asked for help. But his parents, his wife and 2 children died. The roof of the parents' house (No.6) flowed to and hit No.13 M.F's house, and the parents' bodies were discovered around No.8 T.F's house. His daughter S.E (Female, 6 years old), who was missing in the beginning of the disaster, was discovered in the evening of the 10th.

(5) No.7 Y.F's house

Y.F's house was mostly destroyed, and the family of three got injured. The Y.F house next to No.1 A.T's house was the nearest house where the debris flow occurred.

The newspaper report said that there was heavy rain, so S.F (Female, 48 years old), Y.F's wife, evacuated for a while at about 8:00 on July 9. She returned to the house after about three hours because it had stopped raining. Y.F went to see the sediment control dam in the upper reach because he heard the sound of a big rock. He came home soon at about 11:00 p.m. Because nothing was strange, he returned to the house and he went to bed on the 1st floor. However, Y.H said that he found himself in the mud after hearing the sound of "Dooon!" at 1:10 a.m. on the 10th. Muddy water flowed into the first floor from the east (Hariharagawa River direction). S.F, sleeping on the first floor, sprained her left foot when it occurred. M.F, the daughter, was sleeping on the same floor, and received a hard blow to her face in this accident. When M.F cried out "Mother!", though she answered, the light wasn't turned on, and it was still dark. She went outside, and there were no houses around there destroyed by the debris

Table 3.1 The Conditions of Victims in Harihara Area

No.	Name (Sex/Age/Relation)	Died/Injured	Condition
1	A.T (Female, 69 years old)	Died	
	It seemed that she was killed while sleeping		
2	K.K (Male, 46 years old, Father)	Died	
	Y.K (Female, 46 years old, Mother)	Died	
	N.K (Female, 17 years old, Eldest Daughter)	Injured	
	Y.K (Female, 15 years old, Second Daughter)	Injured	
	They heard the loud noise and tried to evacuate. They evacuated from the entrance or the back door, and it was when they tried to put on their shoes that the debris flow washed them away. N.K, the eldest daughter, was saved though she was washed away to near the garden of 22. K.K and Y.K, the parents, were carried in the same direction (around Wakamiya shrine) as N.K, the eldest daughter, but Y.K, the younger sister, was carried away in a slightly different direction, 23.		
3	S.T (Male, 77 years old, Father)	Died	
	N.T (Female, 71 years old, Mother)	Died	
	They were washed away while sleeping. The roof of 3 hit 13.		
4	K.T (Male, 47 years old, Father)	Died	
	K.T (Female, 47 years old, Mother)	Died	
	K.T (Female, 12 years old, the Second Daughter)	Died	
	K.T was a son of S.T and N.T . They were washed away while sleeping. The second daughter K.T's body was found before noon on 11. T.T (19 years old), the eldest daughter, was saved because she was out of the house the day when the disaster occurred.		
5	T.E (Male, 36 years old, Father)	Injured	
	R.E (Female, 35 years old, Mother)	Died	
	S.E (Female, 6 years old, Daughter)	Died	
	S.E (Male, 4 months old, Son)	Died	
	They were washed away with their house while sleeping. Only T.E survived. Though his daughter S.E (Female, 6 years old) was missing in the beginning of the disaster, her body was discovered in the evening of the 10th.		
6	T .E (Male, 36 years old, Husband)	Died	
	R. E (Female, 35 years old, Wife)	Died	
	They ware parents of 5 : T.E . They were washed away with their house while sleeping. The house was carried to around 13. Their bodies were found in the front of 8.		
7	Y.F (Male, ? years old, Father)	Injured	
	T.E (Female, 48 years old, Mother)	Injured	
	T.E (Female, 20 years old, Daughter)	Injured	
	The house was totally destroyed.		

Table 3.1 (continued)

9	Y.H	(Male, 62 years old, Husband)	Injured
	S.H	(Female, 62 years old, Wife)	Died

S. H, his wife, heard a strange sound and woke Y.H up. They went out through the entrance. They saw the hut in front of the entrance being washed away and they were washed away to the river at the same time. The debris flow along the river was stopped by the bridge in front of No.22 house. Y.H jumped up at the bridge, and was caught in the tree of the nearby orange farm. The body of++ S.H, his wife, was discovered near there.

10	K.F	(Female, 58 years old, Mother)	Died
	S.F	(Male, 33 years old, Son)	Injured
	M.F	(Female, 4 years old, Grandchild)	Died

They heard the sound and rocks, sediment and water flow into the house. Though S.F protected, hugged K.F & M.F, and crouched down, they were washed away as they were. S.F. said that he was caught between the rocks when he regained consciousness. But K.F & M.F died. Their bodies were found on the 10th.

11	M.D	(Male, 38 years old, Father)	Died
	N.D	(Female, 37 years old, Mother)	Injured
	K.D	(Female, 9 years old, Daughter)	Injured
	T.D	(Male, 8 years old, Son)	Injured
	S.K	(Female, 81 years old, Grandmother)	Injured

N. D, the wife, heard the sound and saw the living room where M.D, her husband, was supposed to be sleeping. But M.D was not there. So it seemed M.D might have been awake, went outside to see and was washed away. M.D's body was discovered in the precincts of Wakamiya shrine. S.K (Female, 81 years old), M.D's grandmother, who came to the house, was also injured.

12	T.E	(Male, 70 years old, Husband)	Injured
	M.E	(Female, 65 years old, Wife)	Died

T.E was woken up by the sound. He found no roof on his house and his surroundings were flooded. He went to the veranda and the floor was swaying. When he tried to evacuate he was washed away. T.E. was saved in the tree near the orange farm which was about 30 or 40 meters from the house. T.E's wife was killed.

15	T.H	(Male, 70 years old, Husband)	Injured
	N.H	(Female, 65 years old, Wife)	Died

They were swept away while sleeping. T.H was saved, and said he didn't know what happened, and whether it was a dream or reality in the beginning of the disaster.

16	T.H	(Female, 71 years old)	Died

She lived by herself. Her body was discovered near the house. The debris flow crushed T.H house, and stopped.

flow (The evening paper Asahi Shimbun and Yomiuri Shimbun, July 10) .

(6) No.9 Y.H's house

Y.H (Male, 62 years old) house on the east side of the Hariharagawa River was totally destroyed by the debris flow. Y.H was injured, and S.H (Female, 62 years old), his wife, died. Y.H. said his wife heard the strange sound and woke Y.H up, and they went out through the entrance. They saw the hut in front of the entrance being washed away and they were washed away to the river at the same time. The debris flow along the river was stopped by the bridge in front of No.22 house. Y.H jumped up at the bridge, and was caught in a tree in the nearby orange farm. After that, he was rescued by M.O living in 25. (The evening paper Asahi Shimbun, July 10). The body of S.H, his wife, was discovered near there.

(7) No. 10 K.F's house

K.F (Female 58 years old) house on the west side of Hariharagawa River was almost destroyed by the debris flow. At that time, S.F (Male, 33 years old), her son, and M.F (Female, 4 years old), her grandchild, were also in K.F's house. K.F and M.F were killed and S.F was injured.

According to S.F and from newspaper reports, they heard the sound then rocks, sediment and water flowed into the house (The morning paper Yomiuri Shimbun, July 11). Though S.F protected, hugged K.F & M.F, and crouched down, they were washed away as they were. S.F said that he was caught between the rocks when he regained consciousness.

According to another newspaper report, fire defense rescuers discovered K.F, his mother, waving her hand eagerly near the residence, which was about to be buried in the sediment, at about 6 a.m. on the 10th (the evening paper of Asahi Shimbun, July 10). S.F's legs were buried in the sediment, and he couldn't move. He clung to the root of a tree which was flowing, and pulled up the upper half of his body on the sediment. S.F was rescued after one hour by rescuers. However, K.F, his mother, disappeared while they were rescuing him. Her body was later discovered.

M.F wasn't discovered then. M.F's body was discovered between the car and the sediment near the river about 150m from K.F house in the afternoon of the 11th . (The morning paper Nikkei Shimbun and Yomiuri Shimbun, July 12).

(8) No. 11 M.D's house

M.D (Male, 38 years old) house was totally destroyed, and M.D died. N.D (Female, 37 years old), his wife, K.D (Male, 9 years old), his daughter, and T.D (Male, 8 years old), his son, were injured.

N.D said she heard the sound and looked into the living room where M.D, her husband, was supposed to sleeping. But M.D was not there. She said M.D might have been awake, went to see the outside and might have been washed away then.

N.D was swept away by the sediment when she heard the sound "Dooon!" She said that she tried as much as possible to prevent her two children sleeping together from separating from her according to the newspaper report. After that, though she and her two children were rescued. M.D, her husband, died. (The evening paper of Yomiuri Shimbun and Nikkei Shimbun, July 10, and the morning paper of Yomiuri Shimbun, July 11). M.D's body was discovered in precincts of Wakamiya shrine, about 50m from the house in the afternoon of the 10th. S.K (Female, 81 years old), M.D's grandmother, who came to the house on the day, was also injured.

(9) No. 12 T.E's house

T.E (70 years old) house was totally destroyed by the debris flow. T.E was injured, and M.E (65 years old), his wife, was killed.

T.E said that he found no roof on his house and his surroundings were flooded when he was woken up by the sound. He went to the veranda and the floor was swaying. When he tried to evacuate he was washed away. T.E. was saved in the tree near the orange farm which was about 30 or 40 meters from the house. T.E's wife was killed.

(10) No.15 T.H's house

T.H (Male, 60 years old) house was totally destroyed by the debris flow. Though T.H was saved, N.H (Female, 62 years old), his wife, was killed. T.H., who was swept away by debris flow while sleeping but who was saved, said he didn't know what happened, and whether it was a dream or reality in the beginning of the disaster.

(11) No.16 T.H's house

T.H (female, 71 years old) house was totally destroyed by the debris flow. The debris flow crushed T.H house, and stopped. T.H was killed. Because she was living by herself, we can't be sure of the detailed conditions. Her body was discovered near the house.

3.4 Summary of this Chapter

The debris flow occurred just after midnight, and most people were sleeping. There were many deaths in the area from this disaster because it occurred at night when they were sleeping and couldn't grasp the conditions. Moreover, they hardly felt any danger of the debris flow.

In this light, we divided the circumstances of the victims into the following two cases.

One was that they were engulfed by the debris flow while they were still sleeping like 5, 15; the other was that they were washed away when they noticed some unusual situation, such as hearing the strange sound, and they were engulfed by the debris flow when they tried to evacuate like 2, 9, and so on.

Certainly, the debris flow moves as fast as a car. We can't do anything when we are sleeping or evacuating. It is needless to say that it is necessary to evacuate before the debris flow occurs to reduce the number of victims. Though it may be really a little possibility, we may be able to evacuate from the debris flow and take some countermeasures if we can know the signs of the debris flow before it occurs from, for example, any strange sounds and the like. People living in areas prone to debris flow should learn about the dangers of debris flow in their daily lives, and think about evacuation methods before the debris flow occurs. The number of victims might decrease if we think of concrete evacuation activities or methods from the time when the disaster occurs until when it reaches us. For example, we should go upstairs to evacuate vertically from the debris flow.

4. Response of Inhabitants (1)

- According to the Interview with Mr. Furukawa, the Head of Harihara Area Citizens' Hall -

In this chapter, we would like to describe our interview with Mamoru Furukawa, the head of Harihara district citizens' hall, on October 5, 1997. Some important points in disaster countermeasures will be clear. (Emphasis by headline and the underline is given by the writer).

4.1 The Outline of the Interview

Interview with Mamoru Furukawa, head of Harihara district citizens' hall, on October 5 , 1997.

Interviewer : Nakamura Isao, Naklamori Hiromichi, Mori Yasutoshi

○ **Two Peaks of the Rainfall**

Mr. Furukawa: There was were two peaks of the rainfall on the previous day.There was the first peak from 10:00 a.m. to 11:00 a.m., and it was the most rainfall that we have had. After that, the rain turned to a drizzle, so I thought the weather would improve. However, it began to rain again about 3:00 p.m. I remember that the second peak of the rainfall was from 5:00 p.m. to 6:00 p.m. But I thought the rainfall at that time was beyond our experiences until then. I was going around there at that time, and I saw the river

was running at full volume. There were many places where it would overflow. I thought it would be a terrible disaster, though I thought it would be flood damage at most. I couldn't image that the debris flow would occur. The rain had turned to a drizzle about 8:00 p.m. at night, and then I got information from everyone that at 8:30, the volume of the river water was decreasing. One person said that the river level decreased, and at 11:00 p.m. another person said that it had dropped as if the river had disappeared. Probably about 11:40 some sound of the collapse can be heard from the direction of the mountain.

Nakamura: Did you hear the sound?

Furukawa: Yes. I heard and all the people around me heard, too. Umm, It was the sound of the stones mixing, "Gott ! , Gott !", mixed with a "Gooooh !" in the rumbling of the earth. It was as if the sound of the earthquakes we had heard before then had been brought near here. So we heard such a sound and I opened the window, but it was dark, and I felt somewhat uneasy. I went outside and to the river, because I wanted to know where the sound had come from. I felt the stone wall which was piled to the riverside in farms around the dam crumbled and I want to see what happened to the river. I thought that then the amount of water was about the half of water at 5:00 - 6:00 p.m. When I looked at the flow of the river, people in the neighborhood were gathering by twos and threes. We were all watching it. I then asked people living on the riverside, "Do you think the flow of the water of the river has changed?". They said "No. The river has as much water as ever." I thought the rainfall had decreased as much as the half of that at the time of the peak; it had already stopped for no less than two or three hours. We heard, however, the sound of stones rolling inside of the river. But it didn't last. The sound of many little stones falling, "Gott, Gott, Gott", and it passed us. We thought they were rolling for 10-15 meters. Oh, was the stone wall that collapsed a little while ago drifting here? I thought. I judged that the danger of that sound has passed. We judged the water of the river was decreasing and came back. But, when I asked a neighbor later, the water of the river decreased too much about 8:30 and rapidly at 11:30. But I didn't know these things. Therefore, We judged that the water was decreasing tentatively, but it was increasing if we try to think conversely. We didn't notice it, ... I thought we overlooked one point .I came back here (the citizens' hall) from the river, and It was just 12 o'clock exactly (mentioned above). I was certain that these things occurred before 12:00. I'm not sure exactly when, though, because I didn't look at the clock. Then, I

went to bed and slept.

Nakamura: Did you go back home?

Furukawa: Yes. I went back home, so I didn't know about the big collapse. My house began to shake, and I thought it was an earthquake and I woke up. I heard the sound, "Goooh!" when I woke up. My house was shaking slightly. When I woke up, the light was turned on. Lightning caused a black-out. I thought it was strange; I didn't think it was an earthquake, and I went out of the room to get a flashlight. However, I felt what seemed like oil on the hallway. I would now know this was muddy water. It was strange. I couldn't grasp what was happening. I felt not upset but uneasy. However I couldn't open the front door. I turned to the back door, and I went outside. The house warped a little. Then, I turned to the opposite side, and a pile of debris from a house had already come there, so we couldn't go out of the front door. We passed a hedge, and went through the orange farm, and went to the road. When we went to the road, much debris from houses and cars was drifting on the road. It was dark and we couldn't see clearly. It was very dangerous because it sounded as though a gas tank blew up and there seemed to be a gas leak. I couldn't understand what was happening at the time. I called my daughters' family and they were all right. I evacuated all of the family, of course grandchildren, and myself from our house to the citizens' hall. The city established the headquarters for disaster countermeasures the previous day; the headquarters for flood damage countermeasure or the headquarters for heavy rain countermeasure. On our way to the hall I contacted the headquarters with the cellular phone my son had. I said by the phone "I don't understand what happened around here, but this must be a serious accident. Come and check what happened here."

○ **The Problem of the Wire Broadcasting for the Disaster Prevention**

I received a telephone call from the municipal office on the day before the disaster. "What is it?" I asked. Official staff ordered me to broadcast the No.4 warning distributed by the municipal office before then.

Nakamura : What time was it?

Furukawa: Umm, Probably it was 5 o'clock. It was about 5:35 or 5:40 when the official made contact with me; I came back to the hall and broadcast it. At 5:30 or ..... 5:00, the broadcasting sentence of "The refuge is now established" was given ..... . It was probably 5:30. Time to establish had already passed, so I thought I need not to say any more about time when I broadcast the warning.

Nakamura: (This blank) is Harihara the citizens hall, ….

Furukawa: Aha. This was "Farm Village Environment Improvement Center".

Mori: Where is it ?

Furukawa: It is said "LOGITY", and it is in the ocean park of the city. It is a city facility.

Mori: Was there actually any person that went there on the previous day?

Furukawa: No member of my hamlet used it the previous day. Some people of the next hamlet used it. Because it was not evacuation WARNINGS but evacuation ADVICE.

Nakamura: So, did you broadcast it after 5:30?

Furukawa: Yes, I did.

Nakamura: How many inhabitants didn't join in this wire broadcasting in the hamlet?

Furukawa: Didn't join in? This broadcasting system was installed in all houses.

Nakamura: But was there no person who actually went to "Farm Village Environment Improvement Center"?

Furukawa: No one went there. Some intended to go there. They said "We will go" during the meeting. I said you should go there when it was light outside. So I left and came back. However, they phoned me, and said the road had already been covered with water, so they had given up going there by car. Therefore, I advised them to go to the citizens hall.

Nakamura: Who was it?

Furukawa: It was Mr. Tatsuo Takeshima.

Nakamura: Was he an old man?

Furukawa: Yes.

Nakamura: Did he live by oneself?

Furukawa: No. He was married and lived with his wife

Nakamura: Did he live near the river?

Furukawa: Yes, he did.

Nakamura: Did they fear the flood when the water was increasing ?

Furukawa: Umm, I thought the person next door faced the most danger at the time. He came there for help because it was dangerous there when I patrolled, too. He said that he intended to evacuate with the neighbor. I phoned them to find out whether they came to the shelter or not. I said, "Why didn't you come?" He said, "We didn't go because neighbor didn't go." I heard later, it was said there lived one old woman with her daughter who was young. The daughter the old mother lived with was asked to

evacuate. But she didn't evacuate because the mother say she wouldn't go. Mr. Takeshima said his family wouldn't evacuate because the neighbors wouldn't go.

Nakamura: What time did they say that they wanted to go?

Furukawa: It was about 6:20.

Nakamura: Therefore, Mr. Takeshima stayed at home all the time, and ..... .

Furukawa: He did, after all.

Nakamura: Didn't the person suffer any damage this disaster?

Furukawa: No, very little. But, after all, Mr. Ihara's house, which was next door and was close to the river, was flooded above the floor level. Though I thought our evacuation activities were greatly influenced by the surrounding conditions and the behavior of the surrounding people. He tried to ask Mr. Ihara next door to evacuate, but he wouldn't go. It was no problem if they evacuated by themselves, but they stopped evacuating because others wouldn't evacuate. And it was also problem when they evacuated to the refuge and there was no one else there. It was thought that they would stay there if someone was here, but they came back home because there was no other people.

Nakamura: How many people actually came back home because no one was at the refuge?

Furukawa: I haven't confirmed that yet. It was possible, however, that some people came to the refuge. Although almost all of Mr. Koba's family died, one child survived. We can find this out if we interview the surviving child. I haven't heard yet. When we went to Maekawa and came back, all of Mr. Koba's family were riding in their car. It was not clear whether the family just got in the car or had gone somewhere and just come back. A brother of the wife said "They came back home because no one was the refuge though they went there." So, I probably thought that they had turned back because no one else was here.

Nakamura: What time did you see them in their car?

Furukawa: It was at 11:50 - 11:55, after we heard the sound, before 12 o'clock at night. And, the child said that it came when he turned to the back door and was putting on the slippers because the sound was heard and the family would evacuate. Then, she was washed away.

Nakamura: What's her name ?

Furukawa: Her name was Mr. Koba. She was the one child of the Koba family who survived.

Nakamura: Can we find out whether they were trying to evacuate if we ask the child?

Furukawa: Yes, you can. I think. I don't know whether you will succeed or not, for I haven't

interviewed her yet.

Nakamura: Didn't you think that the debris flow occurred when you heard the growling sound?

Furukawa: No, I didn't. A large-scale disaster never occurred to us, though I thought of a small-scale disaster slightly. I didn't think that the large-scale disaster would happen here. If a disaster happened, it was predicted only the flood damage. I heard later that Ezaki, who died in the disaster, at night of 9th made contact with her younger sister, who lived on the lower reach of the river, "Evacuate from your house to my house because your house was dangerous.". If she went to her house, she would have been caught up in the debris flow. I thought that she imagined that her house (: upper reach) was quite safe.

○ **No Idea of the Debris Flow in Mind and Devotion to the Precaution of the Flood Damage**

At the time Mr. Douwaki said to Ms. Kei Furukawa, who lived next door, "Evacuate to our house," because the bank of the river just behind the house was washed away the previous day. I watched it, too. And I advised them to evacuate early if it collapsed even a little more because it would be dangerous and I came back. Mr. Douwaki, advised Mr. Furukawa to evacuate to his house. Though persons were saved there..... . They thought the place where they lived was quite safe.

Mori: Inhabitants in the hamlet generally felt that they were safe away from the water, didn't they.

Furukawa: Yes, they did. We predicted only flood damage.

Nakamura: Did inhabitants know before the disaster that it was specified that the basin of Hariharagawa River was a debris-avalanche disaster area?

Furukawa: Yes, they did. They knew it because there were some signboards in our hamlet.

Nakamura: But they didn't imagine that a debris flow could occur.

Furukawa: Still we thought it would be flood damage at most..... .

Nakamura: Did you see the debris flow as flood damage.

Furukawa: Umm, yeah.

Mori: So they wouldn't think the mountain would collapse..... .

Furukawa: We could image the surface of the mountain crumbling, but couldn't image the mountain collapsing on a large-scale.

Nakamura: Freshet with the sediment was never thought to come.... .

Furukawa: That's right.

Nakamura: And what did you think about the dam which was constructed?

Furukawa: At first, we wondered why the dam should be constructed. We thought it was a safety countermeasure for the bullet train because the bullet train would pass the lower reaches of the river.

Nakamura: Was a meeting held to explain the purpose of the dam when construction began?

Furukawa: No.

Nakamura: Then, did you think that you felt safe because the dam was constructed?

Furukawa: Yes, we did. We felt safe because a safety establishment which there was not here until now was constructed. There was a reservoir exactly above the dam. The reservoir was more than 50 years old and it had been repaired. Therefore we felt safe because Ministry of Construction were building the dam. However, the dam could never resist such a debris flow. And we also thought that it was a countermeasure for the decaying reservoir.

Mori: How long have you lived in the Harihara Area?

Furukawa: I was born in Nagasaki. I have lived here since just after I was born.

Nakamori: Didn't you hear such story about disaster that freshet should come when a growling sound was heard and the water of the river decreased?

Furukawa: It was not a matter of not hearing the story. I thought our judgment might have been different if we knew how ominous the threat was. I didn't know that the water of the river decreased. I thought it was some how connected to the dam. The previous day the dam was full of water at the peak and overflowed. I thought it was designed so it would not overflow. The outlet at the bottom was supposed to be big enough. But it overflowed.

Nakamura: At that time, did you feel that the dam was dangerous?

Furukawa: I didn't see it. Mr. Haruo Kido went to see it, and he said "It was terrible." He did not see the dam overflowing, either. Because he saw some driftwood on the bank of the dam and said that it was the proof. The people who saw it said the river water decreased too rapidly. They said it was very strange. The water flowed until then, after which it decreased suddenly as if it began to flow backward. I thought mud and sediment choked the hole of the drainage of the dam at that time. I thought the debris and sediment poured into the dam which was full of water, and caused it to collapse. The sound I heard was probably the dam collapsing. The force of the water created the sound of the stone rumbling. We usually heard such sound that each big stone could be heard,

"Gott, Gott, Gott". It was the sound that many stones flowed "Gorrrrr, Gorrrrr".

○ **Correspondence to the Situation beyond Human Understanding**

Nakamura: Did you usually hear the sound, "Gott, Gott"?

Furukawa: Yes, we did usually if the water was increasing. I think we couldn't know what we should do when a phenomenon happened beyond human understanding. One man woke up and noticed there was no roof on his house. When he woke up and he could see the sky, he went to the floor of the veranda .He said that the floor of the veranda was swaying. When he saw it, he thought this earthquake was so bad that a water pipe had ruptured, and the house was flooding. However, we must try to think what kind of water pipe we have in our place. Our water pipe is 50 millimeters in diameter. No matter how much it bursts, it is only a little water that could be scattered around there. But we would think like that. Anyway we can't understand anything clearly during a disaster or accident. I thought that an aircraft fell and blew the roof off or that some gas explosion blew the house. A person who lived in the lower reaches but didn't suffer any damage wondered if the U.S. Armed Forces attacked Izumi because he or she knew the war.

Nakamura: Didn't you think that a flash flood happened and washed away the houses?

Furukawa: No, we didn't. If we knew such things, we would be supposed to think "Oh, was it debris flow?"

Nakamura: Mr. Furukawa, you said you have lived here since immediately after you was born. How long have you lived here?

Furukawa: I was born in 1937, so I have lived here for 60 years.

Nakamori: Have you experienced any evacuation over the 60 years?

Furukawa: I don't remember.

Nakamori: Haven't you experienced any evacuation except for flood damage?

Furukawa: No, I haven't.

Nakamori: Have you experienced any disaster here?

Furukawa: I can't remember. Typhoon, if anything.

Nakamori: Did you evacuate when the typhoon came?

Furukawa: No, I didn't.

Nakamori: Have your father's or grandfather's generations experienced an evacuation?

Furukawa: I have not heard their evacuation. There is the word "Yamashio (the tide in mountain)" in the local dialect. It was a small-scale debris flow or a landslide on the surface of a mountain. It was just 10 meters square, so it was a small scale. The biggest

Yamashio of the area I have heard occurred at the mountainside in the southwestern area. The person who saw it said the Yamashio didn't reach the river. The scale was bigger.

Nakamori: The previous day of the disaster It rained heavily....., and you came..... .

Furukawa: At 12:00, we advised them to evacuate, and I came to make sure who came. But I came here after the debris flow occurred.

Nakamori: Was there anyone who evacuated to the hall then?

Furukawa: No. There was no one. It was very disappointing.

Nakamori: Were there any people who evacuated to areas other than the citizens' hall?

Furukawa: There was one person who evacuated to his brother's house.

Nakamura: His brother may also thought flood damage ..... .

Furukawa: His brother lived on the highest place of upper reach to avoid flood damage. He evacuated to his brother's house.

Nakamura: Who was it?

Furukawa: It was Mr. Hideo Ezaki.

Nakamori: Actually did he narrowly evacuate from his house after the debris flow occurred with nothing but the clothes he was wearing?

Furukawa: Yes. But they were all washed away by the debris flow. They died or were injured. Others were already rescuing victims. We were far from evacuating! The wind blew when the debris flow occurred.

Mori: The wind blew from the mountain to the sea?

Furukawa: Probably.

4.2 The Point of Disaster Information According to the Interview

For disaster managers we would like to enumerate some problems in disaster countermeasures according to the interview.

(1) The disagreement of the judgment of the amount of water in Hariharagawa River.

There were two different judgements on the drop in the river level.

(a) The judgement that the flow of water was calming gradually.

(b) The judgment that water decreased rapidly.

The former was the actual case. The head of the citizens' hall suggested that they might implement better countermeasures if they took judgement (b).

(2) Initiative of the evacuation activities.

There was no person who actually evacuated. It was possible that inhabitants came for a while and went home. However, wasn't the wire broadcasting connected with the evacuation activities easily and directly? The municipal official staff delegated communication to the head of the citizens' hall, so there is possibility that the evacuation activities of each area depend on the head's ability and crisis awareness.

(3) Evacuation activities dependent on other person.

The decision and timing of our evacuation may be decided by some neighborhood and relative's behavior.

(4) Someone being in the refuge.

We can point out the problem of establishment of refuge, too. If evacuees come to the refuge and there is no one there, they would go back home.

(5) Role of "disaster story" and coping with some disaster beyond human understanding.

When we are faced with the disaster beyond human imagination, there are cases that we can't even judge what has happened. Though there was such word as "Yamashio (the tide of mountain)", there are many places which have no "disaster story" of some actual damage. Especially, if it is not for such word, evacuation activities may be delayed.

5. Response of the Inhabitants (2)

-According to the Survey of the Questionnaire to Inhabitants -

Anyway, in this disaster, what kind of mentality did inhabitants have? Under what kind of the conditions of dissemination of information did inhabitants behave? What kind of behavior did inhabitants take? We conducted the following questionnaire with 73 inhabitants over junior high school age in the basin of Harihara River where the evacuation advice was given.

Participants

All inhabitants who lived in the area where the evacuation advice was given: 112 people over junior high school age were given the questionnaire. [125 people (45 households) lived in the area where evacuation advice was given (including 13 elementary school student)]. This survey was conducted from December 21, 1997, to January 10, 1998[1]. the questionnaire Survey

[1]73 inhabitants responded (65.2%)

(distributed and collected by the self-government association, or mailed to people who had moved out.)

5.1 Risk Perception

To what extent did the people perceive the risk before the disaster? We asked the respondents who experienced two heavy rainfalls on the 9th about their perception of the damage. About 60% (58.3%) of respondents felt "no damage would occur in Harihara," and 40% (37.5%) felt "Some damage might occur."

Moreover, most people (92.6%) responded "overflowing of the river" when we asked about the kind of the disaster presumed by the person who answered "some damage might occur." No one expected the debris flow, which actually happened.

This result show that many inhabitants didn't think any disaster would occur though they

Table 5.1 Perceived Likelihood of Damage by the Heavy Rain

How did you feel when the heavy rain fell	(%)
Felt Some Damage might Occur	37.5 (27).
Felt No Damage would Occur	58.3 (42).
No answer	4.2 (3).
N	72

Table 5.2 The Kind of the Disaster Presumed by the Respondents

What kind of the disaster did you predict?	Felt Some Damage (%)
River overflow	92.6 (24).
Landslide	11.1(3).
Debris flow (Yamashio: tide of the mountain) and major damage	0.0(0).
N	27

Table 5.3 Inhabitants' Feeling when Heavy Rain Stopped

How Did you Feel when the Heavy Rain Stopped?	(%)
Relief and safe and because rain had stopped.	76.4 (55)
Uneasy because some accident might still happen though the rain stopped.	13.9 (10).
No answer	9.7 (7).
N	72

were faced with the heavy rain which had never been experienced until then. Also according to the survey, we can know that there was no idea of the debris flow in their mind at all. Even the person who presumed some disaster might occur predicted flood damage

We asked the respondents who thought there would be no damage why they thought so. 80% (78.8%) of the respondents "never expected that the place where I lived will be damaged. "Even if they met with the crisis situation, they thought they would be safe, which can be said was the typical mental state: "Normalcy Bias."

After that, rain had stopped after 8 p.m. We asked the respondents their feeling at that time. 76.4% felt "relief and safe because rain has stopped." The inhabitants who thought that only overflowing of the river might occur felt relief that the rain had stopped.

5.2 The Effect of the Wire Broadcasting.

Izumi City requested by phone after 5 p.m. each head of the citizens' hall to broadcast on the wire the evacuation advice: "Evacuate independently if you feel danger." Mr. Furukawa, the head of the citizens hall of Harihara Area, said the advice was carried out in the Harihara Area about 5:40 p.m. . Half (51.4%) of the respondents heard the advice directly and indirectly, (41.7% of the respondents heard it directly and 9.7% heard it from some person indirectly) . The evacuation advice to local citizens was transmitted to some degree. But sometimes it couldn't be heard in rainfall because it is transmitted by speakers installed outside.

What kind of effect on formation of crisis consciousness was the evacuation advice given? 70% (70.3%) of the respondents felt "danger" when we asked the respondents who heard the advice directly or indirectly whether one felt danger of disaster. Therefore, it can't be said that the broadcasting system played a big part in the formation of crisis consciousness.

On the other hand, when we asked what the people who heard the evacuation advice did after hearing it that 40% (40.5%) of the respondents "went outside and saw the river and so on actually.". It seems that the person who was afraid of some flood damage took the disaster

Table 5.4 Hearing the Evacuation Advice

Was the Evacuation Advice of the Day before the Debris Disaster?	(%)
Heard DIRECTLY.	41.7(30)
Heard from Some Person INDIRECTLY.	9.7(7)
Never heard.	37.5 (27).
No answer	11.1 (8).
N	72

precaution behavior that they went to see the water level of the river after the broadcasting. 40% of the respondents consulted about the evacuation, too. 18.9% of the respondents consulted with one's family about the evacuation, 16.2% of the respondents with a neighborhood or a relative, and 59.5% of the people with no person. It would be said that the evacuation advice given by wire broadcasting did not raise their crisis consciousness very much but promoted precaution to the disaster and preparation behavior for evacuation to some extent.

5.3 Evacuation Activities

No one evacuated to Farm Village Environment Improvement Center or Harihara Area citizens' hall, which the city specified as refuge sites. But, it would be thought that a relative's or acquaintance's house which is safe is also a refuge site to evacuate to.

So, we asked inhabitant what kind of evacuation activities they did before the disaster. As a result, it was found that 5.6% (4 people), "evacuated to the refuge site at the time of the disaster." and 2.8% (2 people) "came back to home before the disaster though I evacuated for a while." So combining these two, 8.4% of people evacuated. So it was below 10%. Conversely

Table 5.5 The Mental Influence of the Evacuation Advice

How did You Feel when You Heard the Evacuation Advice?	Heard (%)
Felt great danger.	5.4 (2).
Felt a little danger	18.9 (7).
Felt no danger	70.3 (26).
No answer	5.4 (2).
N	37

Table 5.6 Inhabitants' Behavior after Hearing the Evacuation Advice

What did You Do after Hearing the Evacuation Advice.	Heard (%)
Listened for information on the television and the radio.	10.8 (4).
Listened for information from the city wire broadcasting system.	2.7 (1).
Went outside, and saw the river.	40.5 (15).
Made contact with my family by the phone.	5.4 (2)
Made contact with staff of self-government association in the hamlet by the phone.	5.4 (2)
Made contact with a relative, a friend or an acquaintance by the phone.	10.8 (4)
Extinguished the gas fire and turned off the gas.	5.4 (2)
Prepared the goods for the disaster for the evacuation.	10.8 (4)
Others (specifically)	8.1 (3).

the people who didn't think about evacuation accounted for 70% (51 people) of all respondents. It can be said that the evacuation activities were not very active before the disaster. And, 12.5% (9 people) of the people, "didn't evacuate though I wondered whether we should evacuate or not." The interview with Mr. Furukawa contained the stories that the old man couldn't evacuate because the road on the way to the shelter was flooded and that the person did not evacuate because the neighbor wouldn't evacuate, and so on.

5.4 Knowledge about Debris Flow

Why didn't inhabitants' sense the crisis even a little, and weren't any evacuation activities active? It related deeply to people's knowledge about debris flow. Needless to say, the debris flow is different from the earth-fall and the landslide. The debris flow rushes out all at once with the water and include sediment and stones. It is the most dangerous disaster of the sediment disasters. When we asked inhabitants whether they know the danger before the disaster, only one-fourth (23.6%) of all respondents said they did. It seemed that other many people, "knew the word but not the meaning" (44.4%), or "thought it as dangerous as landslide" (29.2%).

Table 5.7 Consultation after Hearing the Evacuation Advice

Did You Consult with Anyone after Hearing the Evacuation Advise?	Heard (%)
With my family about the evacuation.	18.9(7)
With a neighbor or relative directly	16.2 (6)
With a neighbor or relative by the phone	0 (0)
With no person about the evacuation.	59.5 (22)
No answer	5.4 (2).
N	37

Table 5.8 The Evacuation Activities before the Disaster

What did You Do after Hearing the Evacuation Advice.	Heard (%)
What did You Do before the Disaster as Evacuation Activities	(%)
Came back home before the disaster though I evacuated for a while.	2.8 (2)
Evacuated to the refuge site at the time of the disaster.	5.6 (4)
Didn't evacuate though I wondered whether we should evacuate or not.	12.5 (9)
Didn't think about evacuation.	70.8 (51).
No answer	8.3 (6).
N	72

Because of the condition, there were few people (6.9%) who recognized it as a debris flow when it occurred. More than half of the people "didn't know what had occurred "(56.9%) when disaster occurred, 6.9% "thought an airplane had crashed" and 6.9% "thought something had exploded." (6.9%) .

On the other hand, when we asked them whether they knew that Hariharagawa River had been specified as the dangerous stream of debris flow. 63.9% of the people "knew it" before the disaster, and it was found out that, surprisingly, many people knew. This was probably because

Table 5.9 Knowledge about the Danger of the Debris Flow

What did You Think of Debris Flow before the Debris Flow Occurred?	(%)
Knew that it was the terrible disaster which caused serious damage.	23.6 (17).
Thought of it as dangerous as landslide	29.2 (21).
Knew the word but not the meaning	44.4(32).
Had never heard even the word.	1.4(1).
No answer	1.4(1).
N	72

Table 5.10 Inhabitants' Senses in the Debris Flow Occurrence

What did You think it was When the Debris Flow Occurred?	(%)
Thought it was a debris flow.	6.9 (5).
Thought something had exploded.	6.9 (5).
Thought an airplane had crashed.	6.9 (5).
Didn't know what had occurred.	56.9 (41).
Wasn't aware of it.	22.2 (16).
Others (specifically)	8.3 (6).

Table 5.11 The Warning Signs Experienced Directly

What Phenomenon did You Experience Directly	(%)
Saw the water of the river decreased rapidly.	16.7 (12).
Saw driftwood flow in the river.	8.3 (6).
Heard the sound that stones flowed to the river.	40.3% (29).
Saw the water of the river was unusually muddy.	9.7 (7).
Heard the rumbling of the earth, "Ghooo! ".	31.9% (23).
Others	9.7% (7).

of the signs installed along the river or so on. But there was no immediate sense of crisis among inhabitants because they had no knowledge about the debris flow itself.

5.5 Warning signs

According to the interview of Mr. Furukawa, the head of Harihara Area citizens' hall, at 11:40 p.m., about one hour before the disaster occurred, the sounds of rumbling of the earth, "Ghooo!", and stones hitting each other, "Gott!, Gott!", were heard from the direction of the mountains. It was an important warning sign of the debris flow. In hindsight, this would have been the last and biggest chance for evacuation. Other signs of the debris flow were "The water of the river decreases rapidly.", "Driftwood flows in the river", and so on. We asked inhabitants whether they experienced any of these warning signs. In this question we asked them to indicate those they experienced directly, and not those heard from other people indirectly. Then, it was found out that many people experienced the important signs. 31.9% of the respondents heard the rumbling of the earth, 16.7% of the respondents saw that the water of the river decreased rapidly, and 8.3% saw that driftwood flowed in the river.

Therefore, many inhabitants couldn't link the signs with the danger. It must be that inhabitants lacked knowledge about debris flow. Concretely speaking, it was said that they lacked the following.

(1) Knowledge about danger of the debris flow.

(2) Knowledge about the warning signs of the debris flow.

5.6 The Public Information System of Municipality

Education activities of the municipality play a big part in the improvement of the inhabitant's knowledge. Izumi Public Works Office of Kagoshima Prefecture made a "Hazard Map of Sediment Disasters" for inhabitants in 1996. It was mentioned in the map that the character of debris flow, some signs of it, the place of the dangerous stream of debris flow and so on.

The map mentioned "Evacuate if you see or hear these signs". For example, "The sound of rumbling of the earth, and stones hitting each other is heard", "The water of the river decreases rapidly though it has been raining", and "The water of the river becomes unusually muddy and driftwood flows to the river. "It was a good pamphlet made from the viewpoint of disaster prevention. But this hazard map wasn't distributed to each home. It seemed that many inhabitants knew that Hariharagawa River was specified as the dangerous stream of debris flow.

But this knowledge wasn't related to the disaster prevention because they did not have knowledge about the danger, and warning signs of the debris flow.

Disaster managers should inform them of not only the dangerous area but also the danger of the disaster itself, and the knowledge of the signs as a future disaster prevention activity

6. Lessons from the Debris Disaster.

The reasons Izumi city didn't give the formal evacuation warnings were that

(1) the city focused on the sediment disasters of southern part of the city and the flood disaster of Komenotsugawa River, so the northern part of the city became a blind point; and

(2) the city didn't feel any great danger in the basin of Hariharagawa River though there were 41 dangerous streams of debris flowing in the city.

On the other hand, reasons that an inhabitant didn't evacuate were that

(1) inhabitants felt relief when the rain stopped and the water level fell because their attention was only on flood damage; and

(2) inhabitants did not know about the debris flow, so they were not able to link the warning signs with debris flow, which they hadn't experienced.

Disaster managers must learn two points from this debris flow disaster. First, It is important for disaster managers to educate inhabitants about disasters on a daily basis. Of course it is also important to know hazard map showing that the place where inhabitants live has what kind of danger. But it is also very important for disaster managers to disseminate the knowledge about the danger and warning signs of disasters.

Second, disaster manager should prepare information transmission systems by which inhabitants in disaster areas who observe disaster warning signs can inform the municipality. In this case many people saw or heard these signs. If the headquarters for disaster countermeasures had received this information, the headquarters might have given evacuation warnings before disaster occurred.

The Debris Flow in IZUMI, 1997 and Dissemination of Disaster Information

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The Debris Flow in City of IZUMI occurred at 0:40 am. on July 10,1997. Residents could not escape from the debris flow, and 21 people died.

In order to examine the mental state of the residents before the disaster, a questionnaire survey and interview survey were carried out.

According to the surveys the following points were found.

(1) Because residents worried about flood ,after the rain stopped they felt relieved.

(2) The residents didn't know the danger of debris flow.

(3) Many residents found the signs of possible debris flow. But because they didn't have the knowledge about the signs, they couldn't escape from the disaster.

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