Unzen Volcano : the 1900-1992 eruption

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20. Decision Making Process of Both the Administration Bodies and the Inhabitants for Evacuation during the Eruption of Mt. Fugen in Unzen

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Introduction

Mt. Fugen in Unzen erupted in the middle of November 1990 after 198 years of silence. There have been two recorded eruptions of Mt. Fugen, one in 1663 and the other in 1792. It is known from the records that 14,500 inhabitants were killed when Mt. Mayuyama collapsed due to an earthquake (Ohta, 1991) during the 1792 eruption. This fact led to the concern of local government officials at the beginning of the 1990 eruption that the mountain would once again collapse. On 3 June, however, a pyroclastic flow occurred which resulted in the death or the injury of 54 people.

From around the beginning of July 1990, signs of an eruption (a volcanic tremor) of Mt. Fugen have been monitored by the Shimabara Earthquake and Volcano Observatory of Kyushu University, which has been making observations around the Shimabara Peninsula since 1962.

Dr. Kazuya Ohta, who is a professor of volcanology at Kyushu University, reported the situation at Unzen to the Ministry of Education of Japan in 1990. Based on that report, the Ministry of Education decided to provide financial support to enable researchers to visit Shimabara in order to monitor volcanic activity in Unzen.

Process of Mt. Fugen disasters and the government counterplans

Phase 1 (From 17 November 1990 to 28 February 1991):

Mt. Fugen finally erupted on 16 or 17 November. On 17 November the Nagasaki Prectural Government, the Shimabara Branch of the Nagasaki Prefectural Government and the Shimabara City Government each organized departments to cope with the situation.

At that time, their main concern was possibility of the mountain collapsing. An evacuation plan for such a collapse was officially made public.

Phase 2 (From 1 March to 25 May 1991):

The Nagasaki Prefectural Government organized a committee which was composed of persons of learning and experience to study how to cope with the situation.

The committee came to some conclusions regarding the situation. These were as follows:

(1) It was supposed that if there was fairly heavy rain, then there would be a high probability that debris flows would follow.

(2) It was supposed that Mt. Fugen would probably show a series of eruptions over two or three years, and would spew out lava. It was, therefore, thought that attention should be paid to observing Mt. Fugen's volcanic activity.

(3) It was supposed that volcanic mud flows would occur.

(4) It was supposed that the side of the mountain might collapse.

(5) It was also supposed that Mt. Mayuyama might collapse.

(6) It was supposed that cinders or ash would not reach the residential districts because they are more than 3 km away from Mt. Fugen.

The committee proposed to set up warning

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systems to monitor debris flows by wire sensors which were set up across two rivers on 29 March.

On 15 May, a debris flow occurred and this was detected by the wire sensors. A warning was given by sirens and firemen drove around some areas issuing warnings using the fire engines' loudspeakers. Some residents in Shimabara City (Fig. 20-1) were advised to evacuate. 461 residents followed that advice. From the day of the first flow until 30 June, this was repeated around ten times (Table 20-1).

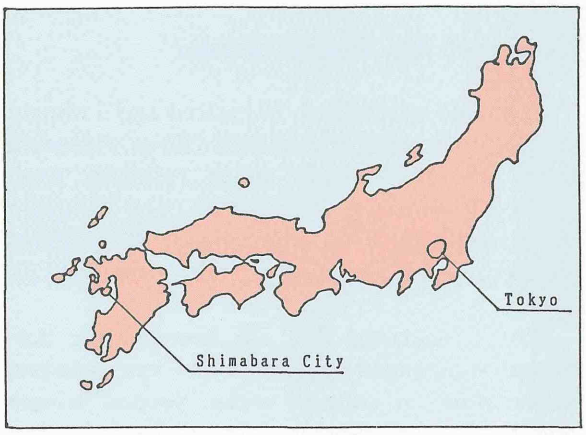

Fig. 20-1. Location of Shimabara City in Japan.

Phase 3 (From 26 May to 15 September):

On 24 May, the first pyroclastic flow occured, and this extended 1 km down from the crater. 1,293 residents had been evacuated following warnings to evacuate because of a fear of floods and debris flows. From 24 May, pyroclastic flows occurred frequently. On 26 May, the local governments advised evacuation and 1,559 residents followed this advice, but one resident unfortunately got burnt by the pyroclastic heat. On 3 June, a pyroclastic flow hit a residential area (Fig. 20-2) and killed 40 people. These were mostly people from the media. Almost all of the residents had been evacuated and so received no injuries. The local governments then decided to force the residents to evacuate from those areas which were thought to be dangerous.

More than 6,000 residents were obliged to evacuate for a long period of time.

Phase 4 (From 16 September—):

On 16 September, the local government decided to reduce the number of areas, from which residents were obliged to evacuate.

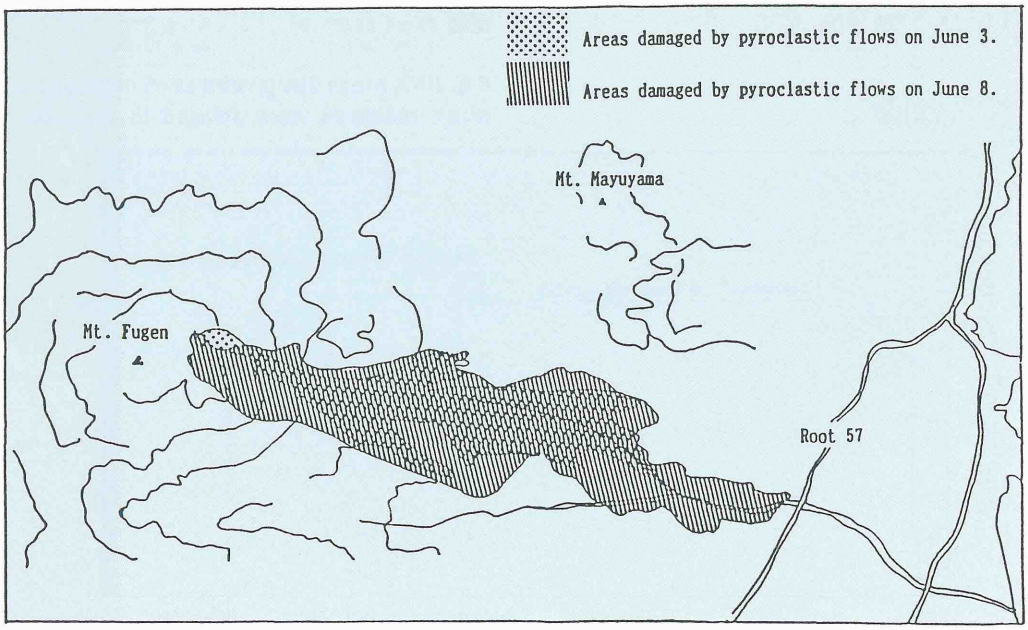

Fig. 20-2. Areas damaged by pyroclastic flows on 3 and 8 June (in the rough from Yoshimura, 1991a,b)

Extent of Mt. Fugen disaster

40 people were killed, 10 injured and 3 remain missing on account of pyroclastic flows. Areas off limits and areas from which residents were advised to evacuate were spread over 35 square kilometers (Fig. 20-3). More than 6,000 residents were evacuated for a long period of time (Fig. 20-4).

It was estimated that 338 houses were destroyed or damaged by pyroclastic flows, mud and debris flows or volcanic rocks. Several bridges and roads were destroyed by debris flows.

Monitoring and warning systems

The Meteorological Agency's Unzen Observatory is one of the administrative organizations of the government which has been established to observe the activity of Mt. Fungen in Unzen. The Shimabara Earthquake and Volcano Observatory of Kyushu University is monitoring the volcanic activity of Mt. Fugen from an academic point of view. These institutions have each set up seismic monitoring systems, magnetic force monitoring systems, air pressure monitoring systems, heat monitoring systems, water level monitoring systems etc. (Figs. 20-5, 20-6).

The Nagasaki Prefectural Government has set up a thermal camera and a long range TV camera system to observe volcanic activity as it occurs and has also set up wire sensors to detect debris flows.

At the beginning, terminals of the observatory systems of each organization were positioned in each institutions.

There was a direct (hot line) facsimile system between the meteorological station and the

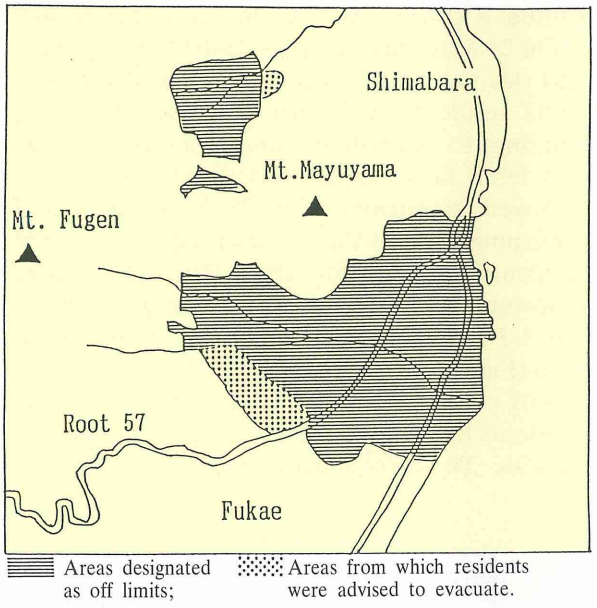

Fig. 20-3. Areas designated as off limits and areas from which residents were advised to evacuate.

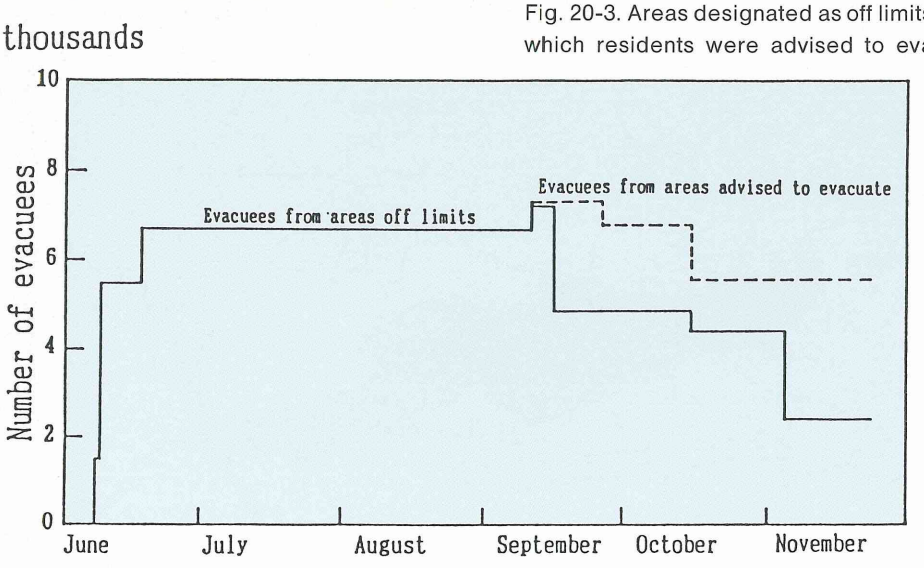

Fig. 20-4. Population of evacuees.

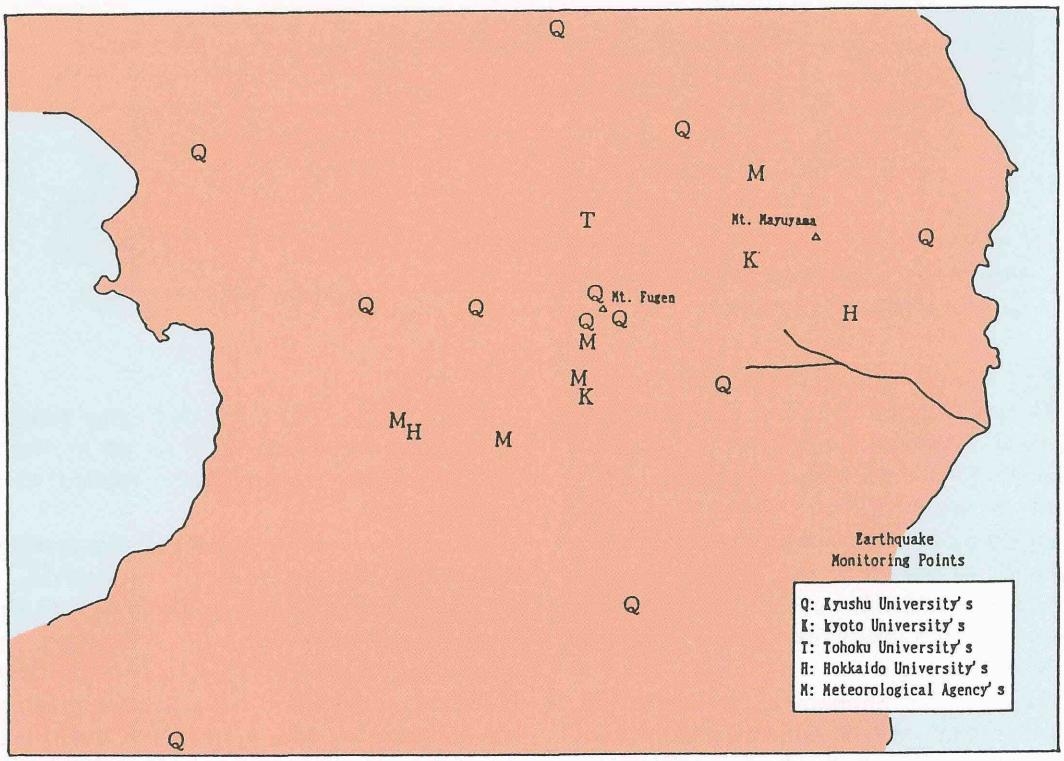

Fig. 20-5. Monitoring systems (A).

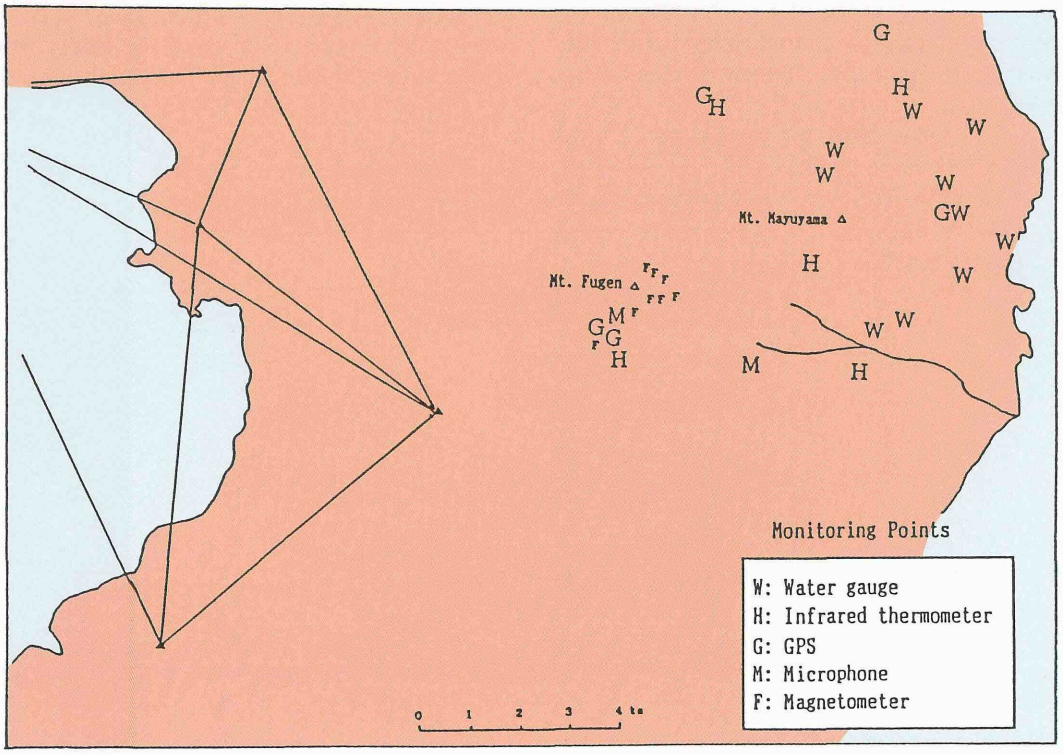

Fig. 20-6. Monitoring systems (B)

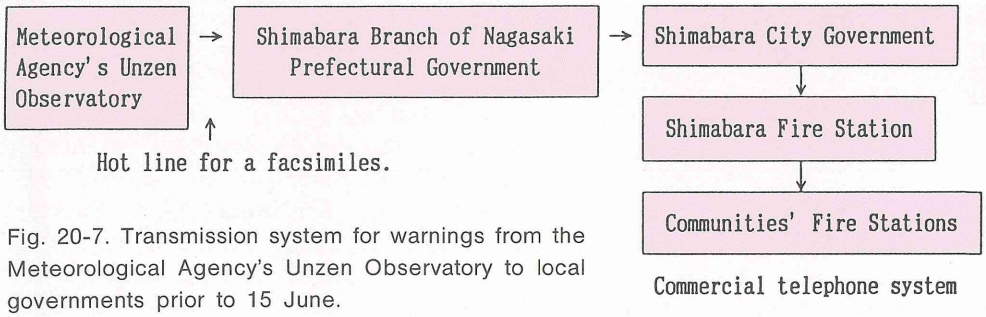

Fig. 20-7. Transmission system for warnings from the Meteorological Agency's Unzen Observatory to local governments prior to 15 June.

Shimabara Branch of the Prefectural Government. Communication between each organization of local government was achieved using the commercial (NTT) telephone system (Fig. 20-7). This led to some delays, confusion or even transformation of messages which were conveyed from mouth to mouth at the beginning, when warnings from officials of the Meteorological Agency's Unzen Observatoy were being conveyed by telephone.

At present, the Shimabara Branch of the Nagasaki Prefectural Government, local governments, the Shimabara Police Station, the Shimabara Fire Station, and the Shimabara Earthquake and Volcano Observatory of Kyushu University each have hot lines for facsimiles from the Meteorological Agency's Unzen Observatory (Fig. 20-8).

TV-monitors, which are displaying pictures of Mt. Fugen and which were set up by the Self-Defence Forces, have been supplied to each organization.

Local governments organized a committee to decide on the methods of evacuation. This committee is composed of the mayor of Shimabara City, the chairperson of Shimabara Earthquake and Volcano Observatory of Kyushu University and others. Subsequent to meetings of the committee, the mayor has been making decisions on how to proceed. When he decides to force inhabitants to evacuate, the message is then announced using the loudspeakers attached to cars or fire engines and using the public address systems. In addition, there is now also a wireless

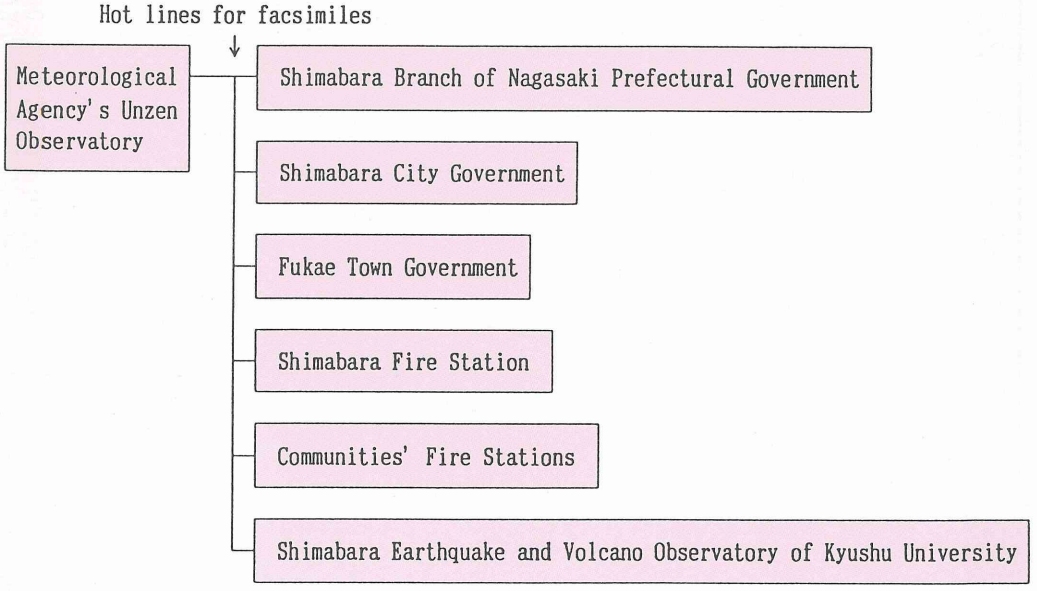

Fig. 20-8. Transmission system for warnings from the Meteorological Agency's Unzen Observatory to local governments after 15 June.

emergency broadcasting system by which all the inhabitants of the Shimabara area are able to receive messages by receivers which are on loan to all homes.

Local government's risk management

The Meteorological Agency issues warnings based on their observations, but their warnings are given in scientific terminology which is of course the language of scientists or persons of learning and experience. Local government officials were initially unable to understand such terminology. This led to the transformation of messages when the warnings were conveyed from mouth to mouth. It is even said that at one point, one official forgot to convey a message because he had not been able to understand its meaning. Fortunately, these problems have not caused any difficult situations so far. Needless to say, warnings should be conveyed to inhabitants in words which they can understand.

Nowadays, warnings from the Meteorological Agency's Unzen Observatory can be sent to the local government rapidly using hot lines, and local government officials are then able to make them public using the wireless public address system.

Inhabitants' decision making for evacuation and risk management

According to our questionnaire which was carried out in August 1991, there were few people who evacuated their homes simply according to their own judgment. Around 70% of the evacuees decided to begin evacuation on the advice of the city government. It is apparent that many inhabitants of Shimabara did not evacuate in emergency situations by their own decision alone.

Receiving disaster warnings

According to our inquiries, around 30% of Shimabara's evacuees received advice to evacuate from the city government through the public address systems mounted on cars, around 18% of the evacuees were warned by sirens, and around 18% of the evacuees were warned through the neighborhood communication associations.

Around 32% of the evacuees thought that a disaster warning would surely come to them through the neighborhood communication associations, whereas around 27% thought that they would receive a warning through the public address system.

Learning that warnings had been issued by the Meteorological Agency's Unzen Observatory

According to our inquiries more than 40% of the evacuees were notified through TV news broadcasts that a warning had been issued, around 26% were notified through the public address system of the city government, and around 23% were notified through neighbours.

Learning of the places for shelter

Most (around 50%) of the evacuees had learnt of the places for shelter through the loudspeaker announcements from cars, around 17% had learnt from their neighbours and around 13% had already known them.

Obtaining information on the situation

Most (around 80%) of the evacuees obtained information mainly through TV broadcasts, around 60% through newspapers and around 45% through leaflets from the city government. 55% of the evacuees relied on information from the government committee for predicting volcanic eruptions, around 49% from the city government, around 36% from the Shimabara Earthquake and Volcano Observatory of Kyushu University and 33% from the Meteorological Agency's Unzen Observatory. Around 32% considered information from the city government useful, followed by broadcasts, 31%; newspapers, 16%; and the Shimabara Earthquake and Volcano Observatory of Kyushu University,

Table 20-1. A record of the warnings to evacuate.
(from the Shimabara City Government records and the Shimabara Fire Station records)

15 May	At 2:30, warnings were given to the residents of Kitakamikoba-machi, with similar warnings for Minamikamikoba-machi at 3:00, and for Shiratani-machi, and part of Tenjinmoto-machi at 3:30 to evacuate because of a fear of mud and debris flows following heavy rain. These warnings were lifted at 9:00 the same day. 416 residents (95 families) followed the advice. There were no injuries or deaths.
19 May	At 13:43, warnings were given to the residents of Kitakamikoba-machi, Minamikamikoba-machi, Shiratani-machi, Tenjinmoto-machi, Fudanomoto-machi, Kitaantoku-machi, Kamata-machi, Nakaantoku-machi, Minamiantoku-machi, and Hamano-machi to evacuate because of a fear of mud and debris flows. These warnings were lifted at 14:46 on May 20. 1,218 residents (381 families) followed the advice. No one was injured or killed.
21 May	At 2:59, warnings were given to the residents of Kitakamikoba-machi, Minamikamikoba-machi, Shiratani-machi, Tenjinmoto-machi, and Fudanomoto-machi to evacuate because of a fear of mud and debris flows. These warnings were lifted at 5:55 on May 21. 456 residents (121 families) followed the advice. No one was injured or killed.
24 May	At 19:23, warnings were given to the residents of Kitakamikoba-machi, Minamikamikoba-machi, Shiratani-machi, Tenjinmoto-machi, Fudanomoto-machi, Kitaantoku-machi, Kamata-machi, Nakaantoku-machi, Minamiantoku-machi, and Hamano-machi to evacuate because of a fear of mud and debris flow. These warnings were lifted at 3:10 on May 25. 864 residents followed the advice. No one was injured or killed.
26 May	At 13:05, the mayor of Shimabara City declared that the areas of Kitakamikoba-machi and Minamikamikoba-machi were off limits because of a fear of pyroclastic flows. 404 residents (96 families) evacuated. At 13:05, warnings were given to the residents of Shiratani-machi, Tenjinmoto-machi and Fudanomoto-machi to evacuate because of a fear of mud and debris flows. These warnings were lifted at 7:00 on 1 June. 670 residents (156 families) followed the advice. At 17:30, warnings were given to the residents of Kitaantoku-machi, Kamata-machi, Minamiantoku-machi and Hamano-machi to evacuate because of a fear of mud and debris flows. These warnings were lifted at 7:00 on May 27. 497 residents (138 families) followed the advice.
3 June	At 16:13, the mayor of Shimabara City declared that the areas of Shiratani-machi, Tenjinmoto-machi and Fudanomoto-machi were off limits, with similar announcements for Kitaantoku-machi, Kamata-machi, Nakaantoku-machi, Minamiantoku-machi and Hamano-machi at 17:03, and for Nita-machi, Kadouchi-machi and Kinoshita-machi at 18:13 because of a fear of pyroclastic flows. 1,142 residents (309 families) evacuated.
8 June	At 19:00, the mayor of Shimabara City declared that the areas of Umezono-machi, part of Minamikueyama-machi, part of Funadomari-machi and part of Chichibugaura-machi were off limits because of a fear of pyroclastic flows. 311 residents (103 families) evacuated. The total number of evacuees on June 3 and 8 was 1,453.
10 June	At 10:25, warnings were given to the residents of Minamisenbongi-machi and Kitasenbongi-machi to evacuate because of a fear of mud and debris flows. These warnings were lifted at 18:05. 305 residents (89 families) followed the advice.
30 June	At 17:55, warnings were given to the residents of Minamisenbongi-machi and Kitasenbongi-machi to evacuate because of a fear of pyroclastic flows, with similar announcements for Shin' yama-3-chome and Shin' yama-4-chome at 18:30 because of a fear of mud and debris flows. These warnings were lifted at 7:00 on July 1. 333 residents (110 families) followed the advice.
30 August	At 18:00, the mayor of Shimabara City declared that the areas of Minamisenbongi-machi and Kitasenbongi-machi were off limits because of a fear of pyroclastic flows. 585 residents (153 families) evacuated.
10 September	At 18:00, warnings were given to the residents of Kamiorihashi-machi to evacuate because of a fear of pyroclastic flows. 74 residents (19 families) followed the advice. The total number of evacuees on September 10 was 7,134.
15 September	At 12:00, warnings were given to the residents of Chichibugaura-machi, Minamikue-machi, Funadomari-machi, Kamiorihashi-machi, Hamano-machi, Minamiantoku-machi, Kitaantoku-machi, Nakaantoku-machi, and part of Kamata-machi to evacuate because of a fear of pyroclastic flows. The number of evacuees on this day was not written down in the records.
25 September	At 12:00, it was declared that Chichibugaura-machi was no longer off limits. The volcanic activity of Mt. Fugen remains high.

around 10%. However, most of the residents (around 57%) wanted to acquire more information of a scientific nature, and only 22% of the evacuees felt satisfied with their information.

At the end of August, most of the residents felt that it was likely the volcanic activity from Mt. Fugen would continue at a high level, while around 9% of them supposed that the volcanic activity would wane. Around 70% of them remained anxious about pyroclastic flows and debris flows, leading to around 63% of them intending to continue their evacuation. Around 26% of them wished to return to their homes.

State of near panic

On 3 June, pyroclastic flows happened frequently and one of the flows killed many people and burned many homes. Shimabara City department officials trying to cope with the situation became close to panic. Many inhabitants began to evacuate from Shimabara City in a state of near panic. Roads were jammed with cars driven by inhabitants who wanted to escape the city. Inhabitants found themselves confused.

On 7 June, a rumor that Mt. Mayuyama would collapse ran through the city. It is said that this rumor was founded on a comment by a scholar that there was a crack on the face of Mt. Mayuyama.

On 8 June, a pyroclastic flow covered areas which were not areas from which residents were obliged to evacuate. Volcanic ash and rock hit some of the residential areas of Shimabara City. The department trying to cope with the situation was overcome by confusion.

On 9 June, rumors that Mt. Mayuyama would collapse and a seismic wave would result, ran through the city. Roads were jammed with cars in which inhabitans hoped to evacuate.

On 12 June, an eruption emitted volcanic ash and rock which once again hit the residential areas. It was made public by the Meteorological Agency's Unzen Observatory that a large change had been observed on the inclination gauges and that the inhabitants of the Shimabara Peninsula should pay attention to the situation. It was reported that this produced such confusion in both journalists and some inhabitants that they left Shimabara City. From that time such situations of near panic occurred often.

Problems and proposals

(1) On information management for the disaster prevention officials: At the beginning, readings of the observation apparatuses and messages were not given directly to the city government and others. This resulted in delays, transformation and even the disappearance of some messages, when messages were conveyed from mouth to mouth.

Warnings were often given in technical terms which city officials could not understand at the beginning.

Messages and readings of the observation apparatuses should be given directly to the disaster prevention officials in order to avoid delay or transformation.

The average capacity for short-term memory is 7 ± 2, so people can not exactly memorize all of the words they hear. It is therefore recommended that officials should require the receiver to write down all of the messages to be conveyed.

Disaster prevention officials of local governments should be educated or else experts should be called in to direct them.

(2) On the information management for inhabitants: At the beginning, not enough information on volcanology was given to the residents. Newspapers, radios and televisions all passed on the greatly differing predictions of numerous scholars to the general public. Sometimes, inhabitants were understandably confused, leading to feeling of panic.

Of course, scholars should have the right to make predictions freely in their own society, but in situations such as this, in order to avoid confusion and panic among the public, they should be cautious as to what is passed on to the general public through the media.

Residents or residential leaders should be educated in order to understand the true situation. Otherwise, large numbers of people will want to return to their homes as soon as volcanic activity from the mountain appears to them to be waning.