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# CHARACTERISTICS OF HUMAN DAMAGE CAUSED BY HEAVY RAINFALL DISASTERS IN JAPAN FROM 2005 TO 2007

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*Abstract* The development and analysis of a database that will aid in the mitigation of human damage (that is, deaths or missing persons) caused by natural disasters are very important, and a method for performing these tasks has been established in Japan. First, we developed a victim database for heavy rainfall disaster events from 2005 to 2007, and the victims were classified based on whether they were dead or missing. In the present study, we estimate whether any loss was mitigated by the use of disaster information. It was estimated that, in the period studied, 49% of potential deaths were prevented. Disaster information is a useful disaster mitigation measure, but there is a limit to its effect.

**Key words**: heavy rainfall disaster, deaths or missing persons, disaster information, disaster mitigation.

## 1. Introduction

Analyzing the causes of death in a natural disaster is important to improve the effectiveness of disaster prevention efforts. In Japan, there have been several studies on the causes of death during earthquakes (Kobayashi 1981; Cabinet Office 2007). There have also been several studies on the human damage caused by heavy rainfall disasters, such as the case studies of the "Nagasaki heavy rainfall" (Matsuda *et al.* 1984 and others). However, since the mid-1980s, little attention has been paid to the causes of death in heavy rainfall disasters. It is likely that the reason for this lack of attention is that no rainfall disasters have occurred since the Nagasaki event, in which many people were killed. To mitigate the human damage caused by heavy rainfall disasters, it is important to further improve non-structural measures, especially the availability of disaster information, such as warnings, hazard maps, communication systems and others. In Japan, the nature of disaster information has changed very much in recent years, and so it is necessary to analyze human damage under present-day circumstances. The purposes of this study are:
1) To construct a death or missing persons database based on the data for recent heavy rainfall disasters.

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2) To estimate the number of deaths that were prevented using disaster information.

I have completed several studies with these same purposes (Ushiyama 2006, 2007). In this study, I would like to show the results of analysis based on data from 2005 to 2007.

## 2. Methodology

Table 1 shows the target disaster events of this study. These represent all of the heavy rainfall disaster events in which deaths occurred from January 2005 to November 2007. An outline of disaster statistics from the Fire and Disaster Management Agency (FDMA) was used to provide basic data. Detailed information on the victims was collected from national newspapers, local newspapers and the web pages of the prefectural offices, municipality offices and others.

In addition, field surveys and interview surveys were performed in areas that had been seriously damaged. Three field surveys were conducted from 2005 to 2007. In the case of Typhoon No.0514, Miyazaki city, Takachiho town and Hinokage town in Miyazaki prefecture were researched in October 2005. In the case of the heavy rainfall disaster in July 2006, Okaya city, Tatsuno town and Suwa city in Nagano prefecture were researched in July 2006. Hishikari town, Ookuchi city and Satsuma town in Kagoshima prefecture were researched in August 2006. In the case of the heavy rainfall disaster of September 2007, Morioka city and Shiwa town in Iwate prefecture were researched.

**Table 1** Subject events of this analysis

| Hazard | Number of deaths |
|---|---|
| Heavy rainfall due to stationary front in July 2005 | 12 |
| Typhoon No.0514 | 29 |
| Heavy rainfall due to stationary front in July 2006 | 32 |
| Typhoon No.0613 | 9 |
| Heavy rainfall due to stationary front in July 2007 | 5 |
| Typhoon No.0709 | 3 |
| Heavy rainfall due to stationary front in September 2007 | 4 |
| Total | 95 |

## 3. Results

### Classification of causes of death

No method for classifying the deaths caused by heavy rainfall disasters has been established in Japan. In the "Japan Statistical Yearbook," published by the Ministry of Internal Affairs and Communications, deaths by natural disaster are classified into the following categories: "typhoon," "storm," "strong winds," "high tide," "earthquakes," "volcanoes" and "tsunamis." However, there are several problems with this classification. One is that the difference between a "typhoon" and a "storm" is not clear. A classification by hazard, such as a flood or sediment disaster, was needed. In addition, among the deaths that occurred in the most recent heavy rainfall disaster in Japan, some people were killed due to careless behavior. A classification that takes this into account was also needed. Therefore, in this study, we made the following classifications:

1) "High waves": Death by sea waves along the coast, e.g., death caused when a person was inside a house destroyed by high waves, or death caused by being struck by a wave during work or when visiting an area.
2) "Strong winds": Death related to strong winds, e.g., death occurred due to being blown from a roof by strong winds, or being crushed by a tree felled by strong winds.
3) "Active accident": Deaths resulting from the victim approaching the dangerous area instead of evacuating, or death after falling into an irrigation canal while patrolling a paddy field or irrigation canal (Photo 1).
4) "Flood": Death due to flood flow or inundation, e.g., drowning in a house, or being carried away by floods while driving a car or walking (Photo 2).
5) "Sediment disaster": Death due to debris flow, slope failure or landslide (Photo 3).

**Photo 1** Yabukawa, Morioka city, Iwate prefecture. A man (59 years old) washed away by the river on September 18, 2007. Although the river was swollen, the flood did not reach the right side of the road. It is likely that he fell into the river accidentally.

**Photo 2** Hatafuku, Shiwa town, Iwate prefecture. A man (64 years old) washed away by flood flow on September 18, 2007. He was operating his motorbike. When the accident occurred, water was flowing toward the left-hand side from the right-hand side.

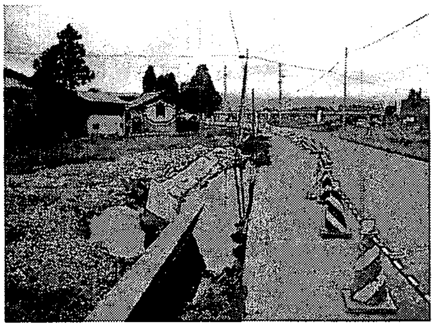
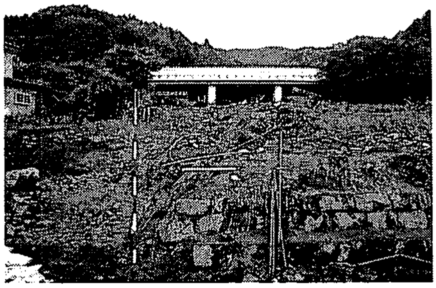


**Photo 3** Kawaghishi-higashi, Okaya city, Nagano prefecture. Debris flow that struck and killed a man (75 years old) His house was located near the center of the photograph. He tried to escape, but was unable to.



"Active accident" is the classification that is original to this study. This classification was defined in order to distinguish these deaths from those due to "floods" and "sediment disasters". Passive victims may be considered to be those persons who, for example, stayed indoors, not realizing that their houses would be flooded and that they would drown. Moreover, people who drowned while driving their car or walking were attempting to run away from the danger, and can also be considered "passive" victims. On the other hand, generally persons who died after falling into an irrigation canal while patrolling a paddy field or other area can be classified as "flood victims." As we have seen, there have been many such victims recently. Such victims must have known that a swollen irrigation canal could be dangerous, but still went to the dangerous area and died. They are thus "active victims." Of course, there are various reasons for their behavior, but the behavior of "passive victims" and "active victims" can be considered to differ. Therefore, the methods for preventing human damage must also differ. For these reasons, the classification "active accident" was introduced.

Figure 1 shows the classification of causes of death from 2005 to 2007. The numerical values in this figure, and in all of the figures, indicate the number of deaths, and are not percentages. The majority of victims were killed in sediment disasters in this period, as in recent major heavy rainfall events in Japan (Cabinet Office 2003). There were many "active accident" type victims, as in the heavy rainfall disaster caused by typhoon No. 0423 (Ushiyama 2006). The "high wave," "strong wind," and unknown categories are combined in "others." The number in each of these categories was small.

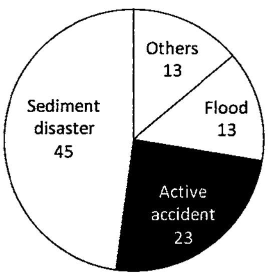



**Fig. 1** Number of deaths and their causes.

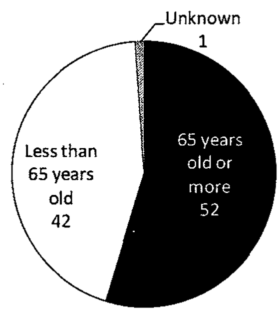



**Fig. 2** Number of deaths by age.

**Relationship between cause of death and attributes of victims**

To examine the relationship between cause of death and age, I first totaled the victims according to age (Fig. 2). Forty-two victims were under age 65, and 52 were over age 65, the typical age considered to be elderly. This figure shows that the majority of victims in recent heavy rainfall disaster events were elderly people. We can say with a fair amount of certainty that the victims of heavy rainfall disasters were unevenly distributed among elderly people. However, it is necessary to examine this issue from another point of view as well.

Figure 3 shows the relationship between cause of death and age. The death rates of elderly people (over 65 years old) made up about 60% of the total deaths in the “active accident” and “sediment disaster” classifications. On the other hand, the death rate due to flood among non-elderly people (under 65 years old) made up about 70% of the total. This resembles the distribution found in the heavy rainfall disaster due to typhoon No. 0423 (Ushiyama 2006).

Figure 4 shows the relationship between the cause of death and the location of the victim. Most victims killed by sediment disasters were killed in their houses (indoors). All victims killed by active accidents were killed outdoors, and most of them died near their residences. All victims of floods were killed outdoors. Almost all of them were washed away by floods while driving or walking far from their residence areas.

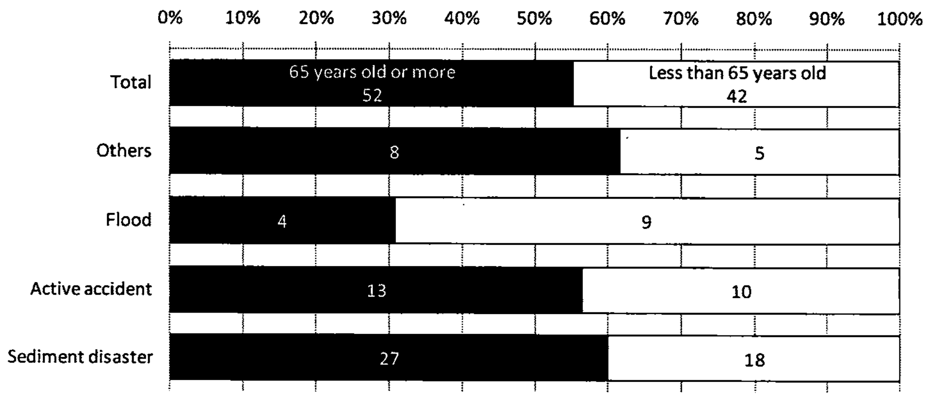



**Fig. 3** Death toll by age and cause of death.

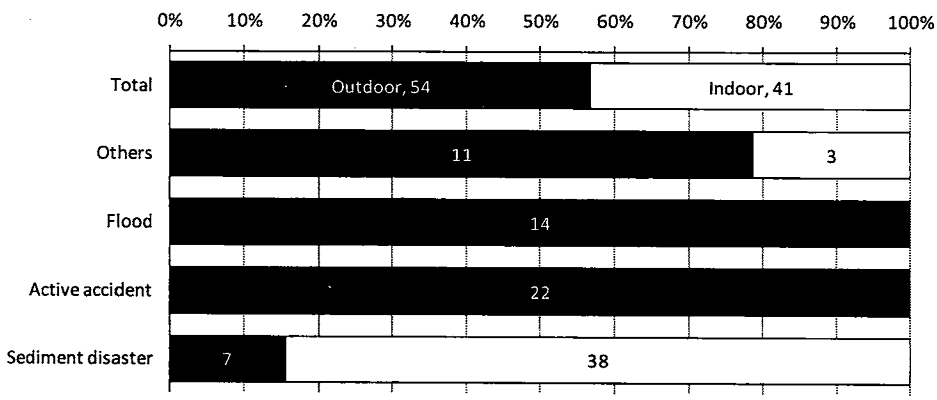



**Fig. 4** Death toll by location and cause of death.

**Possibility of human damage mitigation by using disaster prevention information**

I attempted to estimate how much human damage can be mitigated when disaster prevention information, such as rainfall forecasts, real-time precipitation data, hazard maps and other tools, is used. The number of potential victims of floods, sediment disasters and active accidents whose deaths were prevented was estimated.

First, the victims of flood were classified based on the location where they were killed. The locations were classified as follows:
(1) In their homes.
(2) Outdoors near their homes or residence areas.
(3) Outdoors far from their residence areas.

It is possible that the victims who died in locations (1) and (2) could have been saved if the following necessary conditions had been satisfied:
(a) By viewing a hazard map, they understood that they were in danger near their houses.
(b) Real-time precipitation or river water level information was gathered and disseminated through the Internet, radio and other means.
(c) The present precipitation or water level was understood to have reached dangerous levels for the region.

The information contained in (b) is now disseminated in Japan, and hazard maps of floods have been released in nationally administered rivers to the public via printed matter or web pages. Of course, it is not easy to satisfy the three conditions listed above, but it is not impossible.

On the other hand, it could be very difficult to save victims in location classification (3) above. They were killed far from their residence areas. Most of these victims were making trips by car or walking for commuting purposes or on business. Therefore, it is likely that hazard information would not be useful to them, even if they could see hazard maps for their residence areas. It is not impossible to disseminate information about real-time rainfall and river water levels by mobile phone and other methods, but most people do not know how to gather information on real-time rainfall and river water levels or how to use this information to help them remain safe. In addition, the present information on flood forecasts does not show the inundation depths inland (away from rivers).

Figure 5 is a diagram of the results of the above estimation. In this period, 14 persons were killed by flooding. Judging from the above criteria, it was estimated that 1 victim could have been saved by the additional information. This was the sum of victims in location type (1) (0 persons) and victims in location type (2) (1 person). It would have been difficult to save the victims in location type (3), 13 persons, using hazard information. Nine of them were not elderly people. That is, people are vulnerable to disasters regardless of age when they are in transit. It is necessary to develop an information transmission method or system for people who are traveling, using not only IT but all available technology.

Forty-five persons were killed by sediment disasters, and 37 persons were killed inside their homes or in neighboring houses. Although 7 persons were killed outdoors, 3 of them were killed beside their homes. That is, 40 victims were in location type (1) or (2). Therefore, it is possible that the victims could have been saved if the necessary conditions (a), (b) and (c) listed above had been satisfied. Judging from the above, in the case of victims of sediment disasters, 40 persons could have been saved by obtaining hazard information.

Twenty-three persons were classified as "active accident" victims. As we have seen, the victims who died due to an "active accident" were defined as "persons who died because they approached the dangerous area by themselves instead of evacuating." Since these people approached the dangerous area of their own free will, it is probable that they would not have made a different choice if they had received disaster information. Therefore, it is unlikely that these victims could have been saved, even if all necessary conditions had been met.

Refuge guidance at the time of a disaster is often considered to be helpful for elderly people. However, in this period, 13 of the 23 victims who died from an "active accident" were elderly people. It is possible that this number could not have been reduced, even if an evacuation guiding system for elderly people had been in place. Nonetheless, it is important to provide the elderly with information and support so that they do not become victims of an "active accident."

The thick line in Fig. 5 is a connector related to disaster prevention information. In this period, 41 persons were classified on the lower side of the connectors. It is possible that if the proposed disaster prevention information had been used, a maximum of 41 persons (49% of all) would have been saved.

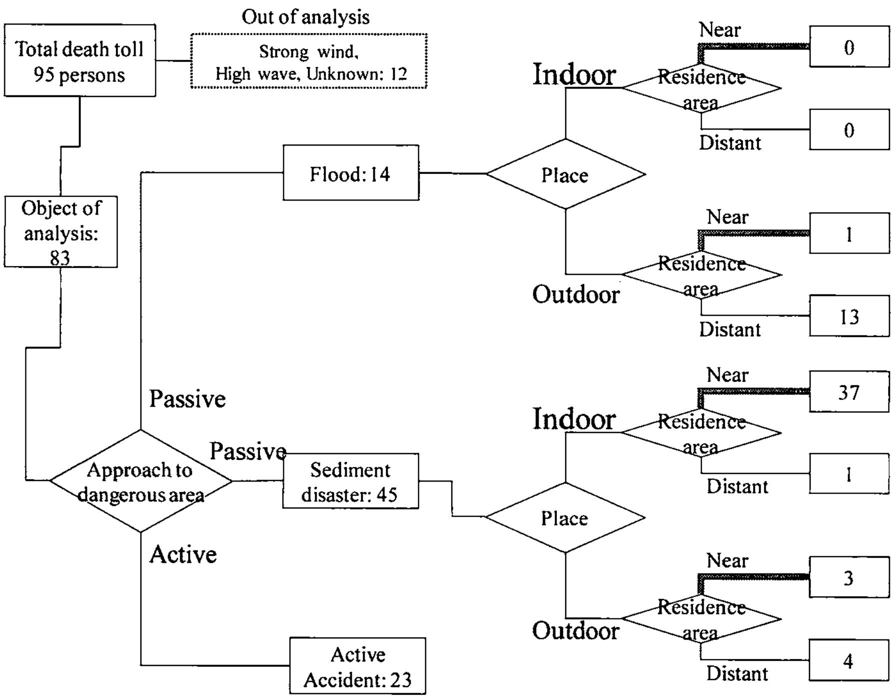



**Fig. 5** Flow chart analysis of causes of death in heavy rainfall disasters from 2005 to 2007.

## 4. Conclusions

The importance of non-structural measures has recently been increasing in Japan. Disaster information, such as warnings and hazard maps, is the most typical non-structural measure. While the expectations for the usefulness of such information are high, it must be noted that there is a limit to the effect of disaster information. Based on the analysis in this study, it is estimated that if the available disaster prevention information had been used, a maximum of 41 persons (49% of all victims) would have been saved. However, in the case of T0423, the estimated percentage is only 39% (36 persons) based on the results of my earlier study (Ushiyama 2006). Further research and analysis into the causes of death due to heavy rainfall disasters would clarify the issues that need to be addressed.

## Note

This paper is a revision of an earlier study by Ushiyama (2007).

## Acknowledgements

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(* : in Japanese with English abstract)