Flood Hazard Mapping in Japan

Mr. Kenzo Hiroki
Head, Flood Disaster Prevention Division
Disaster Risk Management Center
National Institute for Land and Infrastructure Management, Japan

Introduction

What is a flood hazard map? How is it made and used in Japan? And, what are the considerations in preparing and using the map? There are various uses of a flood hazard map. This presentation discusses mainly the flood hazard map that provides all the necessary geographical information essential for the safe, orderly and efficient evacuation of local residents. It also emphasizes the importance of hazard mapping in disaster mitigation and preparedness, and in increasing the survival probability of flood victims. I shall describe also: What will happen generally when flood comes? What will happen to the residents? What will happen to officials or managers who deal with disaster response?

The case of residents

Generally, residents are not well aware of any slight possibility of facing an emergency during floods. Without having any detailed information on when and where from a flood is coming, they would resort to staying home. Furthermore, without any knowledge or guidance on the immediate and correct reactions to an evacuation warning, residents would rather choose to remain at home even when they are exposed to danger.

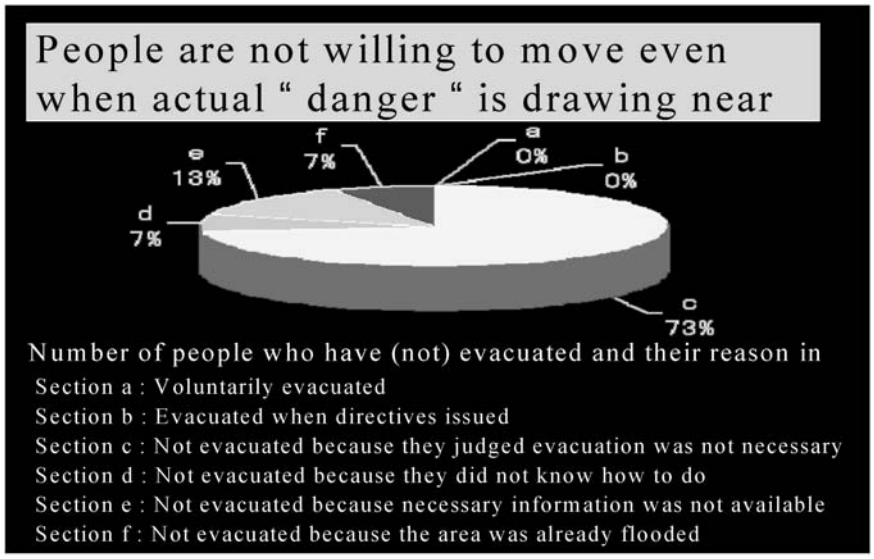

Figure 1: The number of people who have and have not evacuated and their respective reasons.

In **Figure 1**, the people's reactions toward the evacuation warning, in the case of the northern part of Japan, are interpreted. In section A, there was no voluntary evacuation of residents. In section B, no one evacuated even when the evacuation order was issued. The aforementioned attitude is often observed everywhere in Japan. Generally, an average of less than 10% of the total residents evacuated when the order was issued. Therefore, this specific statistics of the case of the northern part of Japan shows the typical attitude of Japanese people toward the evacuation order even in an emergency.

Furthermore, the reasons why the residents were not responsive to the evacuation order are explored: In section C, the residents did not evacuate because they believed that they were safe despite the floods. In section D, the residents did not evacuate because they lacked proper guidance or information on evacuation. Lastly, in section F, the residents did not evacuate because the area was already flooded and therefore, it was already too late to evacuate. In the case of section F, it was often reported that it was too late for the residents to realize the imminent need for their evacuation.

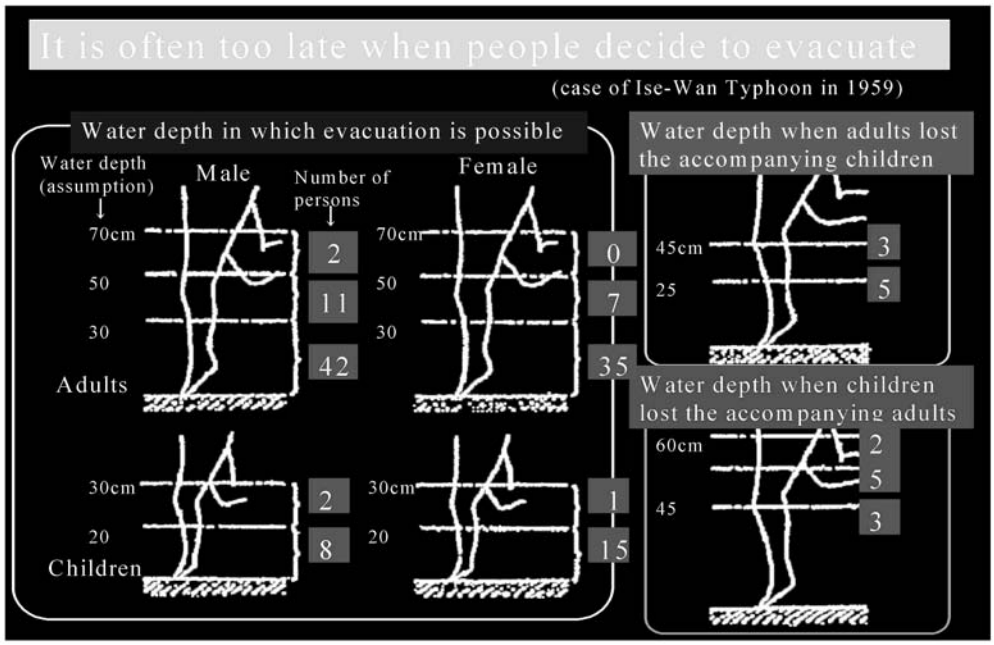

Figure 2 : It is often too late when people decide to evacuate.

An example of this case is the 'Ise Bay Typhoon' which hit the central part of Japan in 1959 and killed more than 6,000 people. **Figure 2** indicates who actually evacuated at a given water level. When the water level was less than 30cm., 42% of the people walked to evacuate. At 50 cms. water level, only 11% evacuated; at 70 cms. Water level, only 2%; and over 70 cms. water level, evacuation had become impossible. For the case of children, only 8 % could manage to evacuate when the water depth was less than 20 cms.; and only 2 % when the depth was less than 30 cms. Moreover, five adults lost their accompanying children when the water level was less than 25 cms; and three other adults when the water reached 45 cm. For the case of the children, they lost their parents when the water depth was less than 45 cms.; and 7 other children in less than 60 cms of water level.

Furthermore, a typical behavior of the residents, which often hinders immediate and efficient evacuation is the behavior of carrying belongings during evacuation. Most of the residents tend to bring their belongings to a shelter and about half of them resorted to giving up their belongings. Generally, less than 5% of the residents evacuate without carrying any belonging.

With the foregoing statistics on the state of evacuation during the Ise Bay Typhoon in 1959, Japan, it is not difficult to picture the difficulty of conducting safe and swift evacuation, especially for the residents.

The case of disaster management officials

There is no exaggeration in mentioning that not only the residents of disaster-stricken area but all people nationwide believe that unerring and immediate response can be always received from their respective municipalities and governments during disasters. Therefore, disaster response managers, especially in the disaster-stricken area, are responsible for controlling the unprecedented and tense emergency situation. When a disaster occurs, they have to deal with misinformation and appeals for help from everywhere. To triage various needs for taking the necessary actions is the most important concern for disaster managers and officials even though they may not know the actually happening in the field. In order to avoid or lessen a chaotic state of emergency, a hazard map has been created as a tool. It led to preventing the recurrence of disastrous tragedies by addressing essential information.

Experiences

About five years ago, as a disaster response manager, I experienced a big flood in the northern part of Japan. Through my personal experience, there are three points which disaster response managers must always consider and tackle before issuing an evacuation order:

Firstly, disaster managers have very limited time to gather, analyze and transmit the information of emergency. Comparing the time lapse in the issuance of evacuation order: 20 years ago, it took almost half a day to issue an evacuation order after a river bank had breached; whereas today, with the advanced technology, particularly for mass-media, it would only take about 30 minutes from the time a dike is breached for media to cover live and broadcast nationwide the disaster situation. The broadcast of pictures of the affected areas within 30 minutes often put disaster response managers in a very tense situation, compel them to make necessary decisions, and often cause them to receive tremendous amount of questions and criticisms such as 'slow response of the government' in spite of a promptly issued evacuation order.

Secondly, disaster response managers are required to judge the credibility of information received by their office because those information are usually confused during disasters. Then thirdly, there is always the problem of trade-off between accuracy and collection time of information. Obtaining more accurate information requires much more time to confirm its credibility, and, in so doing, it often becomes too late to take the appropriate actions. On the other hand, there is a possibility of disseminating wrong information to the public when the process of reconfirmation is not sufficient enough in a short time. Therefore, making an immediate judgment and taking proper actions to every reported information could be defined as the most crucial and indispensable task of disaster response managers.

The case of Abukuma River Flood of 1998

In the Abukuma River Flood of 1998 in Japan, with the rainfall of 1,268 mm., 80% of the annual precipitation of the affted region was concentrated within a week. As seen in **Figure 4** 'Precipitation and change in water level', the 50 mm. to 90 mm. of consecutive rainfalls within a few hours, peaking twice in a week, had caused a sudden rise in the water level and had caused the river to overflow.

Through my experiences as a disaster response manager, I have learned that there are four crucial concerns that need to be handled promptly and simultaneously by disaster response managers when the above mentioned types of disasters occur in Japan. These are: 1) give

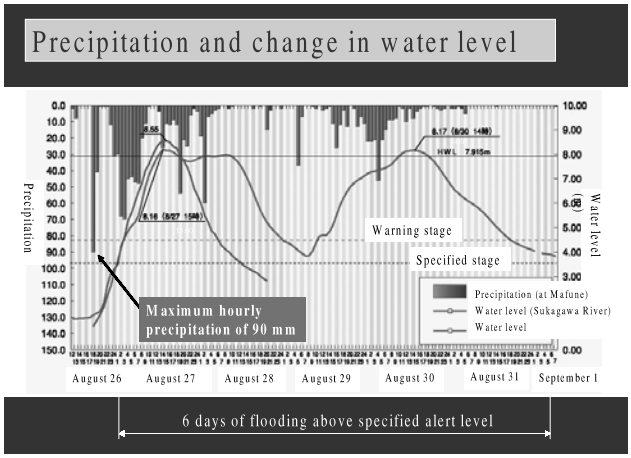

***Figure 4** 'Precipitation and change in water level'

appropriate response directives to critical areas; 2) communicate with respective local governments; 3) discuss with supervising organizations; and 4) manage the mass-media relations to ensure accurate disaster news coverage.

Flood hazard map

A flood hazard map is effective not only for disaster response and preparedness-oriented officials, but also for residents in terms of preparation for safe evacuation. To achieve safe and immediate evacuation in the case of flood, both officials and residents need to train themselves physically and mentally by grasping full detailed meaning of a flood hazard map, such as exact location of shelters, safe routes of evacuation, and location of hazardous areas.

According to the survey of the 'Effectiveness of Flood Hazard Maps' conducted by the Katada Laboratory, Faculty of Engineering, Gunma University, Japan, there is about one hour time difference in evacuation between the residents who have seen a flood hazard map and those who have not seen it. Moreover, the residents who have seen the flood hazard map had a more efficient and orderly evacuation which was 1.5 times more effective than those who have not seen it.

With the proven results of the effectiveness of flood hazard map, making a complete flood hazard map and disseminating it to residents becomes a main concern for municipal authorities, prefectural governments and the Japanese government. There are about 300 flood hazard maps in Japan as of March, 2003, and the number of map is still increasing.

The procedure of making a flood hazard map in Japan

Flood hazard map is basically compiled and produced by the municipalities, although river authorities are under the jurisdiction of the central or prefectural governments of Japan. There are fundamentally six phases in making a flood hazard map. They are: 1) collecting and classifying the information, 2) setting-up the basic conditions, 3) drawing up the historical flood map or the predicted flood area map, 4) drawing up the evacuation scenarios, 5) establishing the evacuation criteria, and 6) producing the flood hazard map.

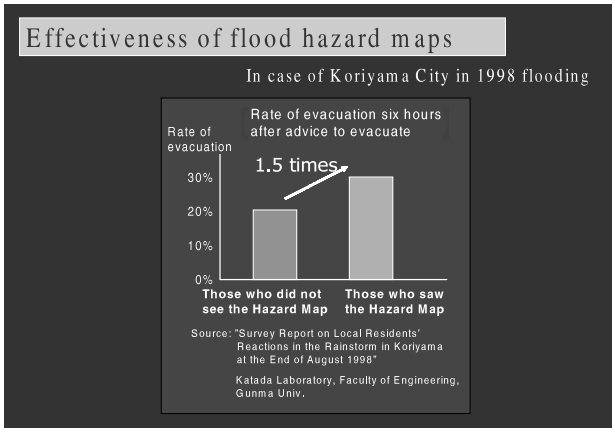

***Figure 5** 'Effectiveness of Flood Hazard Maps'

In explaining in greater detail the most important phase of setting up basic conditions of flood hazard map, there are three points that need to be determined, which concern the fundamental conditions of the target flood to be hypothetically described on the map. They are the

magnitude and area of target flood and size of map. In terms of magnitude of target flood, they are 1) design flood, 2) the largest flood occurred in the past, and 3) flood that may have a possibility of occurrence once in several years. In terms of areas to be mapped, they are 1) possibility of inundation areas and its surrounding areas, and 2) neighboring areas and municipalities of target flood areas. In addition to the aforementioned set-up basic elements, the scale and size of map should be determined. The scale of 1/10,000 to 1/15,000 is generally employed to fulfill a condition of identifying not only individual houses but also the evacuation routes. The extent of inundation is also necessary. The handy sizes of A0 to A1 are often used in Japan.

Example of historical flood hazard map

Drawing up a historical flood hazard map initially involves conducting a preliminary survey to classify flooded areas by topographical features; reviewing newspaper articles and documents on previous floods to understand the tendency of flood occurrence; and interviewing all residents in the flood-prone areas for verification. Then, after finalizing the collected information on the estimated extent of inundation, the process of drawing a historical map can be set up.

Example of flood simulation

For flood simulation, it is necessary to collect various data: hydrological data such as hydrograph of the target flood and data of dike-collapse; meshed data of floodplain like ground level and ground roughness according to its land use and based on the mesh size of 250m for calculation; and other data of flood plain like drainage channels, banks, and pumps. Thereafter, put the collected data into a flood simulation model of one-dimensional or two dimensional models based on the equation of continuity and the equation of motion. Furthermore, the process of determining the areas to be flooded, assuming a place of levee of breaking, and hypothesizing all the breaking points by calculation, need to be well conducted.

Additional information on the flood hazard map

Having completed and disseminated the flood hazard map to the respective local governments and public does not satisfy a practical usage of the hazard map itself. It is because the usage and meaning of flood hazard map may not reach the residents by its distribution alone. Therefore, in addition to the flood hazard map, there are five more elements that need to be accompanied with the map. These are 1) guidance to the flood hazard map, 2) information source for residents, 3) emergency take-out kits checklist, 4) instruction of flood mechanism, and 5) guidance to evacuation warnings. Instruction of flood mechanism and guidance to evacuation warnings are the most important information which need to be received by residents. By letting residents become well informed about the flood mechanism and the guidance to evacuation warnings, residents will have a clear picture of their surroundings and acquire the correct conducts and knowledge of evacuation points when flood hits their residential area in the future.

Inadvertent effects of hazard maps

Being well prepared for disasters by making various kinds of hazard maps and conducting the respective trainings based on the map may sometimes have inadvertent effects on the residents. It is due to the fictionalization of hazard maps. Actually, only one disaster can be described on a map, therefore, residents may tend to interpret a future disaster will be the same disaster as

described on the map. In fact, unpredicted future disasters can be more or less. It will not be definitely the same as the one on the map. Furthermore, similar interpretations by residents are often observed such as hazard map as an indication tool of 'disaster-free area'. By interpreting a hazard map as an indication of 'disaster-free area', residents' attitude towards disaster preparedness shows an apparent difference. For example, residents who live in an area of unalerted zone tend to assume that they are safe because their houses are not indicated on the map. However, this trend of inadvertent effects could be overcome by enlightening and enhancing the consciousness of residents on hazard maps at the community level.

Conclusion

The above mentioned situational statistics of the various evacuations and my personal experiences lead me to conclude that the triage of various needs for taking necessary actions in a situation of emergency is the most important concern not only for disaster response managers and officials but also for the residents who live in the hazardous area. Also, having an accurate flood hazard map is an important requisite to an efficient triage of emergency needs.

Moreover, disaster response managers or officials should handle four critical concerns: 1) giving appropriate response directives to critical areas, 2) communicating with respective local governments, 3) discussing with supervising organizations, and 4) managing the mass-media relations to ensure accurate disaster news coverage. Making an accurate flood hazard map can be described as the main basic task.

In making the most reliable flood hazard map, there are fundamentally six phases: 1) collecting and classifying the information, 2) setting up the basic conditions, 3) drawing up the historical flood map or the predicated flood area map, 4) drawing up the evacuation scenarios, 5) establishing the criteria, and 6) producing the flood hazard map. Therefore, in addition to the flood hazard map, there are five more elements that need to be accompanied with the map: 1) guidance to the flood hazard map, 2) information source to residents, 3) emergency take-out kit checklist, 4) instruction on flood mechanism, and 5) guidance to evacuation warnings.