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Research paper

A Study on Evacuation Behavior of Evacuees in Case of Utilization of Disaster Information Map

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Abstract

In 2015, the University of Cambridge Centre for Risk Studies measured estimated damages that could be brought about by catastrophes and natural disasters in the following decade and suggested Korea's capital, Seoul, was the third most dangerous region among a total of 301 cities around the world. According to the study, the biggest risk factor of Seoul was typhoon, one of natural disasters, and the city could suffer damages worth 44.7 billion dollars over 10 years. Korea, located in the sphere of influence of Northwestern Pacific typhoons, is subject to frequent damages led by summer torrential rains, let alone typhoons. To respond to such disasters, the country is focusing on structural measures such as sewer rehabilitation and installment of drainage pumps and rain detention storages. Those structural measures, however, often become of no use due to poor maintenance or malfunction, and extreme weather events sometimes take place above a predicted range. As there is a need for a discussion on nonstructural measures that employ data on inundation risk, this paper attempts to explore the utilization of disaster information map, one of the most representative nonstructural response measures, and the consequent evacuation behavior presented by evacuees.

Keywords: *Evacuation, Behavior, Disaster information map, Flooding*

1. Introduction

Extreme weather events occurring around the world are making immense effects on human lives. Flooding and inundation led by typhoons and torrential rains, in particular, cause not only considerable property damages, but also numerous death tolls. In 2015, the University of Cambridge Centre for Risk Studies measured estimated damages that could be brought about by catastrophes and natural disasters in the following decade and suggested Korea's capital, Seoul, was the third most dangerous region among a total of 301 cities around the world. According to the study, the biggest risk factor of Seoul was typhoon, one of natural disasters, and the city could suffer damages worth 44.7 billion dollars over 10 years [1].

Korea, located in the sphere of influence of Northwestern Pacific typhoons, is subject to frequent damages led by summer torrential rains, let alone typhoons [1]. To respond to such disasters, the country is focusing on structural measures such as sewer rehabilitation and installment of drainage pumps and rain detention storages.
Those structural measures, however, often become of no use due to poor maintenance or malfunction, and extreme weather events sometimes take place above a predicted range. So, in particular with respect to flood hazards, including torrent processes and hyper concentrated flows, technical guidelines have been developed and implemented in individual countries during recent years [2]. More over city change into mega-scaled and complicated, way-finding issues seem to be more important and critical [7].

As there is a need for a discussion on non-structural measures that employ data on inundation risk, this paper attempts to explore the utilization of disaster information map, one of the most representative non-structural response measures, and the consequent evacuation behavior presented by evacuees.

2. Experimental Details

This study is aimed at analysing efficiency of a disaster information map when it is employed in an actual disaster situation, as well as evacuation behavior exhibited by the participants. As there are a number of difficulties in performing a study on victims of an actual flood damage, this present study was conducted on ordinary adults in a target area which has been inundated before.

According to 「Guidelines on Hazard Map Creation, etc.」, released by the National Emergency Management Agency of Korea, disaster information map is created to help citizens evacuate themselves from an area where an inundation is expected, in order to prevent and reduce damage from storm and flood [9].

In addition, disaster information map contains evacuation tips, shelters, and evacuation routes and other information people can use in the event of a disaster, based on inundation trace map and inundation expectation map, and is categorized into three types – disaster information maps for evacuation utilization, disaster prevention information, and disaster prevention training - depending on the purpose of its use.

Disaster information map should be created based on inundation trace map and inundation expectation map, which are completed beforehand, and it should satisfy the following requirements.
1) It should include inundation information.
2) It should contain evacuation plans (information).
3) It should be drawn by local government heads and, when necessary, be shared with ordinary citizens.

A disaster information map, a plan that offers evacuation control data such as expected damage zones, shelters and evacuation routes, is one of the most representative measures to prevent a disaster, but there could be escape obstacles that are not indicated on the map or factors that may interrupt people from obtaining information from the map and act on it. Nevertheless, not enough research have been done to explore how well people acquire information and act on it in the process of recognizing the information and taking actions in the event of an actual evacuation situation.
As such, this study sought to investigate and analyze the efficiency and behavioral characteristics of people when they tried to escape an actual place where there is a disaster information map and a designated shelter based on information provided by the disaster information map. As the study attempted to look into information delivery capability of disaster information map and the efficiency, it selected people who had never lived in the target area and had never been near the shelter as subjects of the experiment.

Figure 1: Disaster information map at target area [8]

The purpose of this evacuation experiment is to examine the efficiency and behavior characteristics of people who try to look for shelters by consulting a disaster information map only. As such, it was performed on those who had never been to the target area before, and a filming device was utilized to analyze evacuation routes, times, and speeds. More specifically, the subjects were asked to look at a disaster information map installed in the target area, wear a filming device (model: Hero3 manufactured by Gopro), and walk to a shelter following a designated evacuation route. The Table3 describes the evacuation route designated on the disaster information map. Dongchon Resort, located in Hyomok-dong, Dong-gu, Daegu, was determined as the target area of this study. Dongchon Resort consists of gradual slopes along the Geumho River and steep cliffs and hills formulated by erosion, and the Geumho River runs through the resort from east to west.

Table 1: Types of disaster information map [6, 8]

Type	Characteristics
Disaster information map for evacuation utilization	A map that marks details of an evacuation plan such as evacuation tips, shelters, and evacuation routes so that local residents could directly utilize it in the event of a disaster
Disaster information map for disaster prevention information	A map mainly for administrative purposes, used when encouraging local resident to evacuate an affected area and beginning disaster-preventing activities
Disaster information map for disaster prevention training	A map that is created for the purpose of raising local residents' awareness of disasters and providing relevant training programs, based on the disaster information map for evacuation utilization

Source: Guidelines on Hazard Map Creation, etc. 2015

Table 2: Definition of inundation information and evacuation information [6, 8]

Description	Content
Inundation information	Information necessary in predicting river flooding or a possibility of inundation in accordance with geographical characteristics, and raising citizens' awareness on danger related to flood damage
Evacuation information	Information on shelters to be used in the event of a flood, on issuance of an evacuation recommendation or direction, and information necessary for resident evacuation such as risk factors in evacuation routes

Source: Guidelines on Hazard Map Creation, etc. 2015

Table 3: Inundation experience of the target area [8]

Date of inundation	**Cause of inundation**
September 2003	Typhoon
July 2011	Torrential rain
September 2012	Flooding
July 2014	Typhoon

Table 4: Current status of evacuation route [8]

Description	Evacuation route
Distance (m)	900m
Number of junctions	8

Since it is situated on a low-lying zone, it is a habitually inundated area where flooding takes place every year when a torrential rain falls down.

3. Results and Discussion

'Guidelines on Hazard Map Creation, etc.' stipulates an evacuation route should avoid an area that involves a potential risk, a steep slope, and a road that is surrounded with concentrated housing and, therefore, might interrupt people's evacuation activities. Therefore, the designated evacuation route was a relatively safe route that excluded a risk factor in the course and, in the event of a disaster, it's vital to follow a pre-designated route for a safe evacuation.
As a result of the experiment, 7 (43.75%) out of a total of 16 participants successfully evacuated themselves through the designat-

ed route, whereas the rest 9 (56.25%) deviated from the designated route, thereby leading to an evacuation delay.

Table 5: General information on subjects of efficiency analysis experiment [8]

Description		Number	Percentage
Gender	Male	10	66.7%
	Female	6	33.3%
Age	20-29 years old	12	75.0%
	30-39 years old	4	25.0%

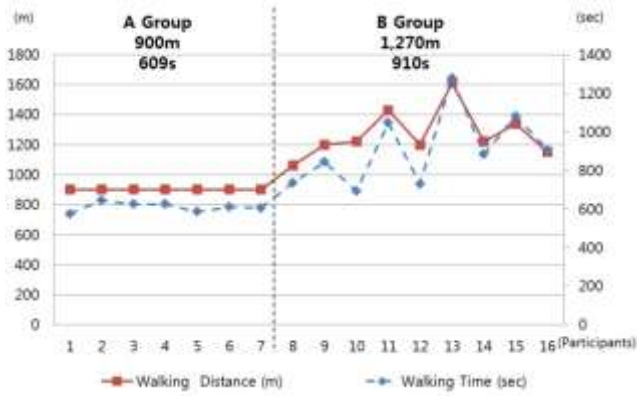

Figure 2: Evacuation route distances and walking speeds of participants [8]

The findings of this experiment indicate that there is no relationship between the time spent in attending to a disaster information map and the efficiency of evacuation, and one's memory or spatial perceptual ability makes greater influence.

Group A, who escaped through the designated route, and Group B, who deviated from it, recorded the same average walking velocity of 1.48m/s.

While it took 609 seconds for Group A to follow an evacuation route that was 900m-long on average, Group B spent an average of 910 seconds to walk a 1,270m-long evacuation route.

In other words, Group B walked an average of 370m more than the designated 900m-long evacuation route, which took them five more minutes on average.

Figure 3: Wrong evacuation route chosen by participants

Participant 13, especially, completed the evacuation after walking 1,610 meters for 1,278 seconds, thereby demonstrating a 78.89% increase in terms of evacuation distance and a 122.26% jump in terms of evacuation time, when compared to the average figures of Group A.

Participants made wrong choices of direction at five junctions out of eight junctions- once at Junction No. 1, six times at Junction No. 2, zero time at Junction No.3, twice at Junction No. 4, zero time at Junction No. 5, once at Junction No. 6, zero time at Junction No. 7, and once at Junction No. 8.

When compared to the designated route, participants made a total of 11 mistakes, and they came back to a given junction seven times after doing a reassessment, accounting for 63.6% of the entire choices of a wrong path. On the contrary, 36.4% of participants who made a mistake did not return to where they made a wrong choice and escaped to a shelter by following a different route.

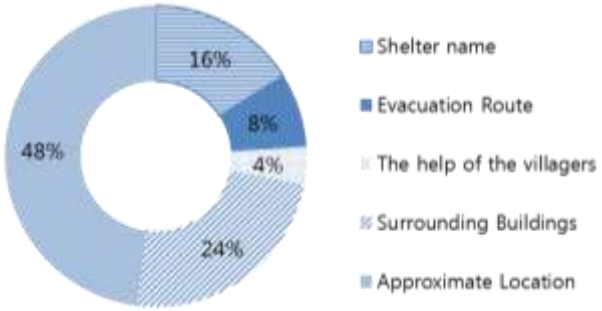

Figure 4: Results of interviews on evacuation methods [8]

After the experiment was completed, an interview was performed on the participants, 72% of whom responded that they arrived at the destination by looking at nearby buildings or by figuring out locations or directions, and only 8% answered that they depended their own memories on the evacuation route only.

4. Conclusions

Creation and supply of a disaster information map is highly essential to reduce human casualties in the event of a disaster.

In Korea, however, disaster information maps are not widely used, and there has been little research on recognition and efficiency of the maps, thereby leading local governments, charged with drawing the maps, to adopt separate formats of map creation.

As such, this study was designed to examine the recognition and efficiency of disaster information map by looking into the use of disaster information map and evacuation behavior of evacuees.

First, an evacuation route designated in the disaster information map a path that excludes a risk-prone zone, steep slopes, a road that is near concentrated housing and, therefore, could block one's evacuation. It's a relatively safe route that takes risk factors in evacuation into consideration.

While following such a designated evacuation route is considered important for the safety of evacuees, nine people (56.25%) out of a total of 16 participants deviated from the designated route and took more time in escaping.

Next, the evacuation experiment found that participants selected a wrong direction the most often at the second junction as it offered the largest number of choices. This suggests simplicity should be considered when determining an evacuation routes

This study suggests standards for disaster information map creation and evacuation route selection as well as a direction for further related research, and is expected to serve as a useful database for manufacture of future disaster information maps.

Acknowledgement

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