Investigation of efficient tsunami evacuation using real-time disaster information

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1. Introduction

In recent years, due to the expansion of the offshore tsunami observation network in Japan and the development of high-speed analysis techniques to utilize the observed data, it is becoming possible to transmit more detailed real-time disaster prediction information. Just after the 2011 Tohoku-Oki Earthquake occurred, while the majority of voice calls were regulated, packet communication continued to be relatively connected and smartphones played an important role in information sharing. Therefore, it is expected that real-time disaster information obtained through smartphones can realize safer evacuation in the near future. In this study, in order to evaluate the effect and the challenge of providing real-time disaster information through smartphone in tsunami evacuation, a demonstration experiment was carried out.

2. Tsunami evacuation demonstration experiment

In the demonstration experiment conducted in the opportunity of the Kawasaki city's annual tsunami evacuation drill on December 9, 2018, we set up points where passing through was not permitted due to assumed damages caused by strong shake of earthquake, e.g., building collapse, fire, liquefaction, etc., and staff members were located with panels that said "impassable". When participants of the demonstration experiment encountered the impassable points, they posted the location of these points through a smartphone application, and the posted information was shared in real time on the application screen of other participants. The smartphone application was developed for this experiment and was distributed before the experiment. The number of participants who used the provided smartphone application was 84.

Evacuation behaviors were measured as time series data of position information by the position measurement function of smartphones. In the experiment, in order to evaluate the effect of real-time disaster information about the locations of above-mentioned impassable points on evacuation behaviors, 24 participants from the organizations conducting the demonstration experiment were divided into two groups. One of the two groups were not provided the posted information. As a result, in the group with disaster information, multiple evacuees succeeded in choosing an efficient evacuation route by reducing the number of encounters to the impassable points, and the effectiveness of the real-time disaster information was confirmed. However, when comparing the average value for each group, although the evacuation distance was slightly shorten in the group with the information, it did not lead to reduction in evacuation time, because the average walking speed was slower than the group without the information. The average walking speed that takes the standstill time into account was 4.9 km/h for the group without the real-time disaster information and was 4.7 km/h for the group with the information.

One of the estimated factors that lower the average walking speed is the standstill time to consider evacuation routes using the smartphone application at the branching points and at the places near the impassable points, or the action to post the impossible points. In the group with the real-time disaster information, among twelve people, nine people stopped for more than 10 seconds during the evacuation action.

3. Future work

One of the reasons why the average evacuation speed was decreased in the group with the real-time information is that the accuracy of the posted information was rather low and the standstill time to consider evacuation route was prolonged. In the questionnaire conducted after the evacuation drill, there were multiple opinions such as "With the wrong information, there were no passible road leading to the evacuation site". Among the 74 postings about the impassable points, 40 posts (54.8% of the whole) were accurate with an error of 20 m or less. In order to realize evacuation effectively utilizing real-time disaster information, it is important to evaluate the quality of information and consider information providing means that are easy-to-understand and lead to immediate determination of the next action.

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