Study on Simple and Easy Estimation Technique of Evacuation Completion Ratio Considering Various Regional Characteristics

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1. Introduction

The "Strategic Innovation Promotion Program (SIP)" of the Cabinet Office need to a method of predicting human casualty by using tsunami inundation data obtained from real-time observation data obtained immediately after the earthquake.

For prediction of human damage caused by the tsunami, it is important to accurately predict the number of people who can't arrive at the evacuation place until tsunami reaching. In order to accurately estimate the number of incomplete evacuation, it is necessary to consider various regional characteristics, and Takahashi et al. (2016) suggest distance to evacuation place as a regional characteristic relating to evacuation.

To predict the number of incomplete people, two method is used. One is tsunami evacuation simulation, and another is a method using evacuation completion rate curves of time until inundation reaching. Simulation can take various regional characteristics into consideration, but it is difficult to apply to immediate damage estimation over a wide range because it takes long time to calculate. While the latter is suitable for extensive damage estimation, there are problems from the viewpoint of reflection of regional characteristics.

Therefore, we tried to create a function to estimate evacuation with considering regional characteristics.

2. Parameterization of Evacuation Awareness

In the past method, evacuation awareness is defined in several stages such as "high / low". Meanwhile, the actual situation of the tsunami evacuation from the Tohoku earthquake varies widely depending on the region.

Therefore, based on the evacuation start ratio (= the number of people who started evacuation actions / the number of residents in the inundate area) for each elapsed time indicated survey of Tohoku earthquake, we try to show the evacuation start ratio by the cumulative distribution function of the lognormal distribution with the elapsed time from the occurrence of the earthquake as the explanatory variable. Furthermore, we made it possible to calculate the evacuation start rate only with parameter λ.

3. Evacuation Speed Estimation

Simulation was conducted to reproduce the evacuation from the Tohoku Tsunami first for the 7 areas. The simulation evacuation completion ratio was within the range of the evacuation completion ratio estimated from actual evacuation, and it was valid for the simulation. Next, we conducted a tsunami evacuation simulation that changed the evacuation awareness and examined the evacuation traveling speed by evacuation means / age / generation time (day / night).

We examined the evacuation speed of 7 areas and set the average evacuation ratio of evacuation measures and age from 3 categories (youthful walkers, elderly walkers, and using cars).

4. Creation of Prediction Formula for Number of People Unable to Evacuate

In order to complete evacuation, it is necessary to start evacuation until "limit time" which is the time of reaching the tsunami minus the time taking for evacuation. The number of people who start evacuation by this "limit time" can be predicted from the lognormal distribution with the evacuation awareness as the explanatory variable in the previous section. Specifically, the number of evacuees completed by

multiplying the number of evacuees by age hierarchy / evacuation measures by the evacuation start rate within evacuation delay time is estimated.

5. Verification of Created Prediction Expression

In order to verify this prediction formula, we compared it with the result of the tsunami evacuation simulation. As a result, the error from the simulation result was about 50% or less. On the other hand, errors tended to increase in areas with a small inundated area.

Acknowledgment

References

I.Takahashi et al. 2016, Study on Local Characteristics for Prediction Method of Tsunami Evacuation, SSJ fall meeting.

Keywords: tsunami, evacuation, simulation, regional characteristics, prediction formula