Survey and Analysis on Evacuation Decision of Residents in Areas Where Tsunami Embankment Construction Is Proceeded

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INTRODUCTION

In the 2011 off the Pacific coast of Tohoku Earthquake Tsunami, embankments proved effectiveness in increasing evacuation time. On the other hand, embankments were destroyed by the tsunami, and the earthquake and tsunami, the scale of which far surpassed the assumptions based on our past experiences, caused widely spread severe damages. After the disaster, a couple of researches pointed out that residents‘ reliance on embankments and feeling of well protected might influence the decision making of evacuation from the tsunami. The occurrence probability of the Nankai Trough Earthquake within 30 years is expected to be 80% by the Headquarters for Earthquake Research Promotion, disaster prevention measures against earthquakes and tsunamis are an urgent issue for local municipalities being on the Pacific coast.

METHODS OF RESEARCH

The target area of this study is Hamamatsu city, Shizuoka Prefecture, Japan which faces to the Pacific. The target area is expected to suffer damage caused by the earthquake and tsunami along the Nankai Trough near future, and a tsunami embankment 13 meters high, 17.5 kilometers in length are under construction. However, in Hamamatsu having a large population and assets, as Figure 1 shows that the area inundated by tsunami will remain even after the tsunami embankment is constructed. This study conducted questionnaire survey in the coastal area of Hamamatsu concerning on residents' awareness of tsunami disaster and tsunami embankment under construction. Furthermore, the covariance structure analysis of evacuation decision making was conducted to take into account the effectiveness of the embankment.

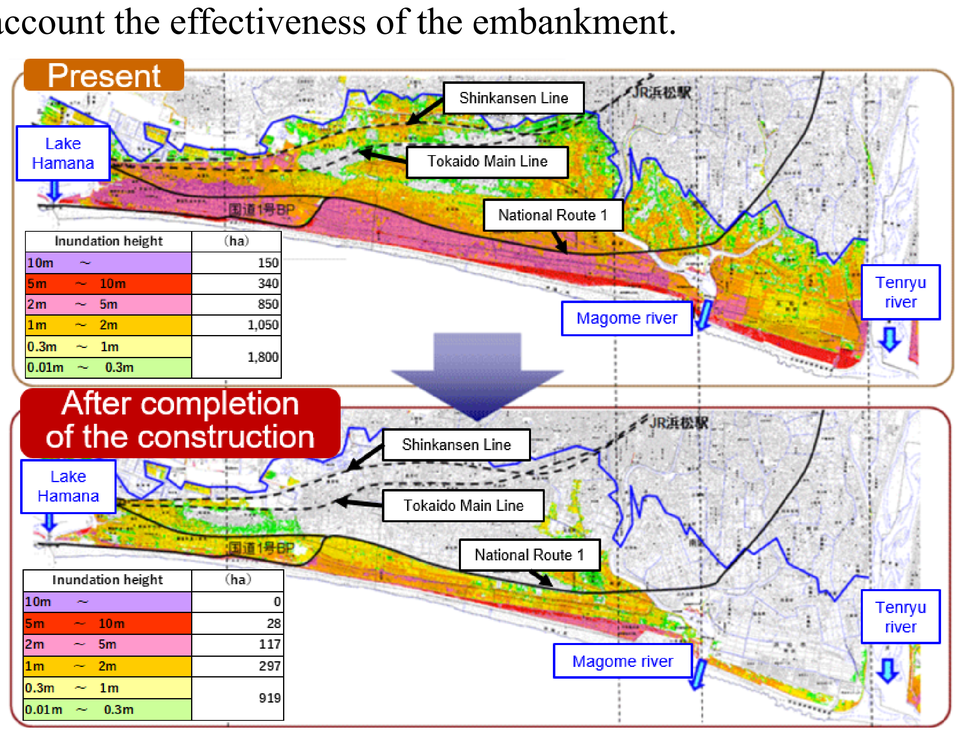

Fig.1 Effect of embankments against the Nankai Trough Earthquake tsunami in Hamamatsu

QUESTIONNAIRE SURVEY

A questionnaire survey on tsunami disaster prevention awareness was conducted around Maisaka and Nakatajima in Hamamatsu city and distributed to about 1,800 households. The number of respondents to the questionnaire was 830, and the collection rate was 46%. Table 1 shows the items of questionnaire questions. For the question items necessary for covariance structure analysis to construct an evacuation decision-making model, data without deficiency answers are considered as valid answers. The number of valid responses is 604. The followings are the findings from the analysis of survey data.

Table1 List of question items

Attribute information	Gender, Age, Family, Occupation, Housing structure, Number of floors of a building, Duration of residence
Evacuation behavior	Evacuation start time, Evacuation area, Tsunami height, Tsunami arrival time, Possibility of tsunami occurrence, Knowledge of Nankai Trough Earthquake
Tsunami embankment under construction	Evacuation behavior after construction , Tsunami height after construction, Anxiety, A sense of vigilance
Disaster measures	Disaster education, Disaster measures, Disaster drill, The designated evacuation area, Evacuation behavior (for outing), Hazard map, Daily conversation about disaster
Engagement with the coast	Frequency of visit, Purpose of use (2 seasons, before and after construction of tsunami embankment)
Relationship with the region	Relocation to a safe place, Reason for not moving, Reasons to live in the area

- Residents in 86% were conscious of evacuating at an early stage, and 84% were aware of an appropriate evacuation site.
- Residents who would not make an evacuation decision tend to have a feeling in safe, but more than 90% of residents make an evacuation decision.
- A large percentage of people who thought they would not evacuate believe embankment would not break at all. Thus, the reliability of the embankment may have an impact on evacuation behavior.

RESULTS AND DISCUSSION

Using the questionnaire results, we analyzed the evacuation decision-making process of residents in the area tsunami embankment construction is proceeded by covariance structure analysis. In order to construct the model, we first extracted latent factors by exploratory factor analysis. Then, we analyzed evacuation decision making by covariance structure analysis. Figure 2 shows the constructed model, the path coefficient of the analysis result, the goodness of model fit, and the significance level of each path coefficient. The square is th¥e observed factor and the ellipse is the latent factor. Those that are considered to be exogenous variables are indicated by thick lines, and others can be endogenous variables. The goodness of fit satisfies all the reference values shown in parentheses. The closer the path coefficient is to 1, the greater the correlation between factors. Figure 2 shows that “Risk perception of tsunami” has the largest impact on “Evacuation intention” with the pass coefficient of 0.41. The pass coefficient from “Risk perception of tsunami” to “Perception of embankment” was as high as 0.54, but the path coefficient from “Perception of embankment” to “Evacuation Intention” was 0.16. Therefore, it can be said that “Perception of embankment” has a smaller influence on “Evacuation intention” than “Risk perception of tsunami”.

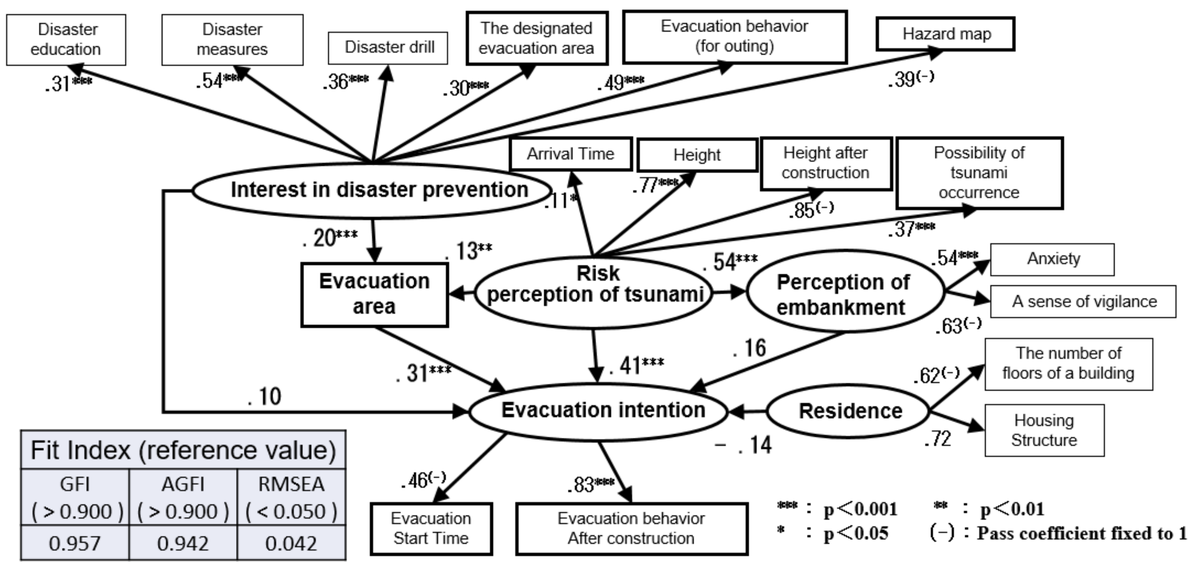

Fig.2 Evacuation intention structure model constructed by exploratory factor analysis and covariance structure analysis

CONCLUSIONS

The results of the questionnaire survey show that most residents are adequately aware of tsunami threat. The results of covariance structure analysis show that although decreasing the risk perception of tsunami increases residents' reliance on embankment and feeling of well protected, the perception of embankment has less direct impact on the evacuation decision making than the other factors.

REFERENCES

- Hatamura T.: Analysis of the factors that inhibit and promote evacuation behavior at the time of the tsunami attack, Waseda University, 70p., 2012.
- Kahoku Shinpo: Part 5: Pitfalls in Preparation (2) How building the Great Wall invited negligence, https://www.kahoku.co.jp/special/spe1151/20150207_03.html, 2013.
- Shizuoka Prefecture: Shizuoka Prefecture 4th Earthquake Damage Assumption Document, http://www.pref.shizuoka.jp/bousai/4higaisoutei/shiryou.html, 2013.
- Shizuoka Prefecture: Hamamatsu City Coastal Embankment Development Project, http://www.pref.shizuoka.jp/kensetsu/ke-890/bouchoutei/, 2018.
- Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E.: Multivariate data analysis (7th ed.). 11.Structural Equations Modeling Overview, Pearson Education Ltd., pp.541-597, 2014.

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