Quantifying Risk of Natural Disaster Using Typhoon Damage Cases in Commercial Buildings

Ji-Myong Kim, Mokpo National University, South Korea

The IAFOR International Conference on Sustainability, Energy & the Environment
Hawaii 2020
Official Conference Proceedings

Abstract
Damages caused by natural disasters are increasing worldwide, and damages are increasing accordingly. Therefore, a number of international public organizations and global insurance companies are actively studying risk modeling models to predict and counter the risks of natural disasters. These organizations are working to increase the sophistication of the model, as it creates a strategy for risk transfer or preparation based on the risk quantification model as the risk of natural disasters increases. Nevertheless, many studies on natural disasters and economic losses have defined the main factors, but there is a lack of comprehensive study on the relationship between risk factors such as natural disaster indicators and building inventory using actual cases. This study examine the risk factors and amount of risk through statistical analysis of damage cases caused by natural disasters. Hence, the purpose of this study is to define the risk indicators and to define the relationship between the risk indicators using actual damage cases of Typhoon Maemi, a representative natural disaster cases in South Korea. Building inventory and natural disaster indicators were used for statistical analysis. The results and framework of this study reflect the vulnerability of the actual damage, vulnerability of the building to natural disasters as well as the vulnerability of the region, so that public agencies and insurance companies will have a practical way to develop natural hazard risk quantification models.

Keywords: Typhoon damage, Vulnerability, Commercial building, Statistical analysis

Introduction

Recent climate change has led to an increase in the occurrence of severe storms and soaring losses. Many developed countries are adopting insurance as a way to transfer the financial risks of extreme storms. Insurers use natural disaster models and historical loss records to predict and manage potential economic losses for individual buildings, regions and countries. The purpose of this study is to develop a building's local vulnerability function to assess damages caused by typhoons. In order to predict the loss reflecting local vulnerability, we will investigate the relationship based on the importance and significance of the typhoon loss, natural disaster index, and basic building information index, and present the damage function to prepare for future damage prediction and preventive measures. In this study, we used the insurance company's typhoon cicada loss record and limited the scope to residential buildings.

Data Collection & Analysis

In this study, the dependent variable was expressed as loss ratio, which is the insurance payment divided by the total construction cost, and typhoon information and building information were used as independent variables. Typhoon information includes the maximum wind speed and distance from the coastline, and the building information includes the total asset value of the building, the type of building (i.e., reinforced concrete frame, steel frame, wood, and steel roof), number of ground floor, and number of underground. Wind speed is an important indicator of the intensity of a typhoon, causing damage to floods, storms and landslides. The wind speed maps of the damaged buildings were collected based on the date of the accident and the geographic information system (GIS) based on the address information of the typhoon damage record. The distance from the center of the building to the coastline was also collected based on the address information using the geographic information system. The distance between buildings and shoreline correlates with vulnerability to storms (Highfield 2010). Basic building information such as total property value, building type, number of ground floor, and number of underground are also used as vulnerability indicators to suggest typhoon vulnerabilities according to basic building information. The total amount of building property has been confirmed through previous studies on the loss of typhoons that the loss of storms increases as the total amount of assets decreases (Kim 2017). The type of building is an important indicator of the typhoon vulnerability of buildings. In general, building heights are considered vulnerable to typhoons in the order of reinforced concrete, steel, stone, and wood (Khanduri 2003). Building height is also considered an essential indicator of quantification of vulnerability to storms. Building height is statistically correlated with the extent of financial losses. It can be used as a vulnerability index that quantifies the vulnerability of a building to typhoons (De Silva 2008).

Discussion

In the vulnerability function regression analysis for residential buildings, the Adj-R2 value is 0.613, and this model has an explanatory power of 61.3%. The indicators of the vulnerability of typhoon losses were found to be significant in terms of maximum wind speed, distance from shoreline, total property value, and ground floor number. The value of the VIF ranged from 1.031 to 1.210, indicating that there is no problem of multiplicity between variables.

Table 1. Result of regression analysis

Variables	Coef.	Beta Coef.	p >|z|	VIF
Typhoon Info.				
Distance from coast	-.021	-.238	.000	1.031
Maximum wind speed	.453	.498	.000	1.210
Basic Building Info.				
Underground floors	.019	.015	.689	1.057
Floors	.027	.109	.019	1.052
Construction type	.193	.129	.151	1.088
Total value of property	-2.123E-005	-.321	.000	1.071
Number of Observations	211			
F	46.721			
Adj-R^2	0.613			

Conclusion

Typhoons cause severe financial losses, and insurance companies, governments, and municipalities use the typhoon risk assessment model to estimate the level of damage. This study presents a statistical model using the typhoon damage record of insurance companies. The results and framework of this study can provide essential guidance for predicting typhoon losses in insurance and government policies. This study is limited to commercial buildings, but the scope of this study will be extended to residential and industrial buildings. However, the data used in this study are only damage from typhoons, and further studies using various categories of typhoons are required to support the results.

Acknowledgements

This research was funded by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2019R1F1A1058800)

References

Highfield, W. E., Peacock, W. G., & Van Zandt, S. (2010, October). Determinants & characteristics of damage in single-family island households from Hurricane Ike1. *In The Association of Collegiate Schools of Planning Conference,* Minneapolis.

Kim, J. M., Kim, T., & Son, K. (2017). Revealing building vulnerability to windstorms through an insurance claim payout prediction model: a case study in South Korea. *Geomatics, Natural Hazards and Risk*, 8(2), 1333-1341.

Khanduri, A. C., & Morrow, G. C. (2003). Vulnerability of buildings to windstorms and insurance loss estimation. *Journal of wind engineering and industrial aerodynamics*, 91(4), 455-467.

De Silva, D. G., Kruse, J. B., & Wang, Y. (2008). Spatial dependencies in wind-related housing damage. *Natural hazards*, 47(3), 317-330.

Contact email: jimy@mokpo.ac.kr