Study on Risk Assessment of Large-scale Landslide Disaster

Yuan-Jung TSAI[1*], Teng-Chieh HSU[2], Chjeng-Lun SHIEH[3] and Jen-Yuen CHENG[4]

[1] Researcher, Disaster Prevention Research Center, National Cheng Kung University, Taiwan
[2] Graduate student, Department of Hydraulic and Ocean Engineering, National Cheng Kung University, Taiwan
[3] Director, Disaster Prevention Research Center, National Cheng Kung University, Taiwan
[4] Engineer, Southern Region Water Resources Office, WRA, MOEA, Taiwan
[*]Corresponding author. E-mail: nagare_tsuchiishi@bousai-u.ac.jp

INTRODUCTION

Large scale landslide disasters have caused severe damages in Taiwan in the past years. As a result, it is an urgent task for the government and the research communities to reduce the loss. With the implement of mitigation work of large-scale landslide, hundreds of potential large-scale landslide area were identified in Taiwan since 2010. The topography features, geological conditions and situation of property and residents were used to evaluate the risk for each potential area in the first stage. Therefore, a lot of countermeasures and monitoring systems were setup to reduce the risk of potential large-scale landslide. However, the approach of risk assessment in the first stage did not consider risk distribution in a regional area, so that the effect of mitigation works and land-use managements cannot be estimate. In this study, we present a new risk assessment, which can evaluate the risk for each potential large scale landslides and can identify risk distribution in a regional area. Moreover, the presented approach considers the effect of mitigation works.

METHOD

In this study, risk is defined as the probability of potential loss. The risk is the function of hazard, exposure and vulnerability. The risk index approach, which can helps to understand the contribution of hazard, exposure and vulnerability to overall risk is used to analyze the risk of large scale landslide. Risk is expressed as in Eq. (1):

$$R = \sum_{i=1}^{n} f(H_i, V_i, E_i) \tag{1}$$

R is risk of large-scale landslide, H_i is hazard, E_i is exposure, V_i is vulnerability, and i represents each evaluated index. The hazard is evaluated with the velocity of landslide movement and deposited depth, which are evaluated numerically. Because of high water content of landslide mass, the landslide movement is considered as a continuous solid-liquid phase flow. This research simulated the process of landslide by the numerical model, which was developed by Egashira et al. (1997) and was modified by Miyamoto (2002). The exposure is evaluated with four kinds of land-use, such as building, road, agriculture land and forest. The vulnerability is evaluated with the loss curve of four kinds of land-use and the population composition, considering the distribution of population age. Consequently, the risk mapping is processed by GIS tools. The (**Fig. 1**) show the concept of the risk mapping in this study. First, draw the 2m x 2m square grid meshes on the case study areas. Second, we used the numerical model to analyze large scale landslide process, and then we have the influence area, deposited depth and movement velocity of landslide mass. Therefore, we can evaluate the hazard, exposure, vulnerability of each grid mesh. Third, use the Eq. (1) to evaluate the large scale landslide risk of all gird meshes. Finally, we can map the risk distribution in a regional area.

RESULT AND CONCLUSION

Typhoon Morakot, a medium-strength typhoon, invading Taiwan from August 5 to 10, 2009 with extremely high intensity and accumulative rainfall. The heavy rainfall pummeled southern and eastern Taiwan. In this research, the risk maps of four large-scale landslide, which were triggered by Typhoon Morakot were evaluated with the presented risk assessment approach. These cases are occurred at Shiao Lin Village, Xinkai Village, nearby Miao Chong Temple located at southern Taiwan, and Daliao Village located at eastern Taiwan. In this extended abstract we demonstrate the large scale landslide disaster in Xinkai Village, causing the deaths of 38 people and destroying 38 buildings.

The result of risk mapping before typhoon Morakot (**Fig. 2**) is verified by the sediment disasters loss statistics, which was taken by SWBC. The result shows the loss could be well quantify with the method. In addition, the study also discusses he relationship between land-use management and risk map (**Fig. 2**, **Fig. 3**). Comparing **Fig. 2** and **Fig.3**, we can find there are some different of risk distribution. The effect of sabo works are considered in the presented approach as well (**Fig. 4**). Therefore, the authority can reduce the risk of large-scale landslide by the mitigation work, such as land-use management and sabo work. Furthermore, the effect on land-use managements (**Fig. 3**), and sabo works (**Fig.4**), could also well described with the approach we presented.

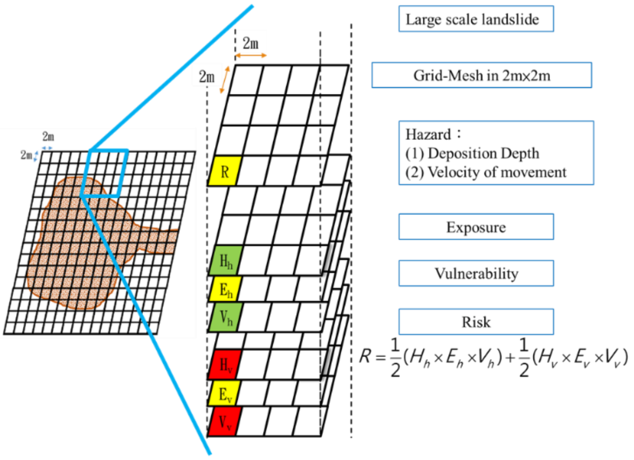

Fig.1 concept of risk mapping

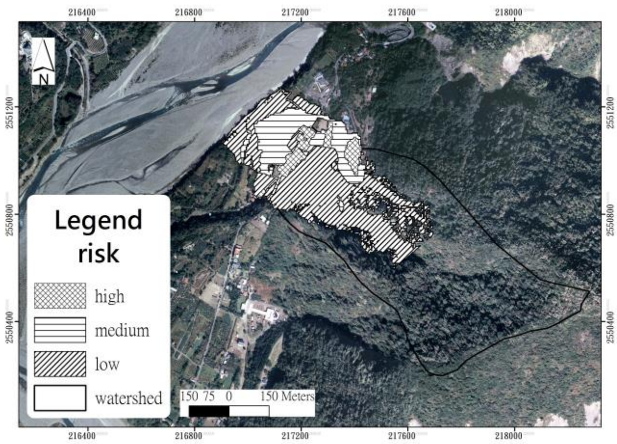

Fig.2 Risk map of Xinkai landslide in 2009

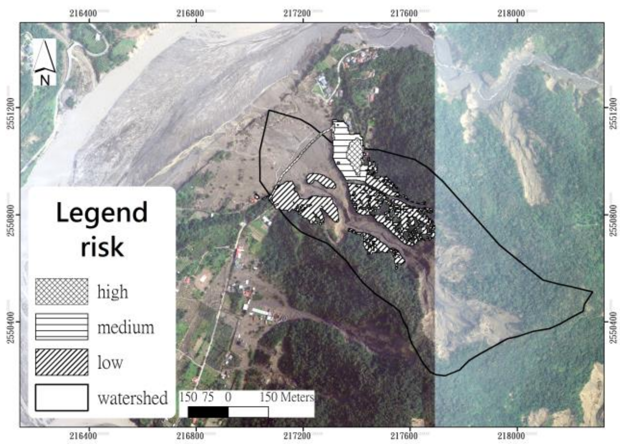

Fig.3 Risk map of Xinkai landslide in 2011

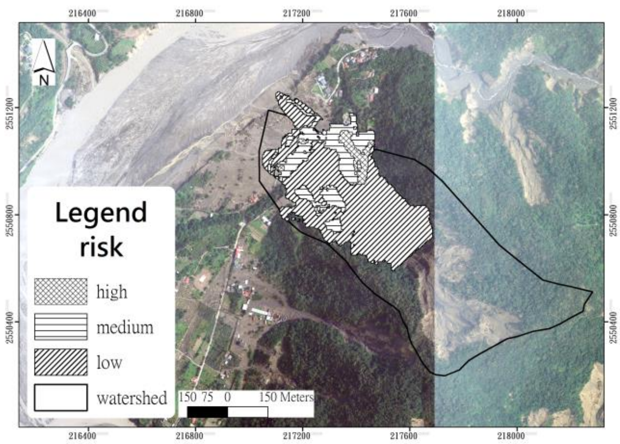

Fig.4 Risk map after building sabo dams

Keywords: risk assessment, large-scale landslide, landslide disaster mitigation