ASSESSMENT EXPECTED ANNUAL DAMAGE COST OF LANDSLIDES IN THAILAND

Tohoku University Graduate Student Prem RANGSIWANICHPONG
Tohoku University Member So KAZAMA
Tohoku University Member Daisuke KOMORI

Introduction

Landslides often occur in Thailand as a consequence of heavy rainfall, especially in the northern and southern regions of Thailand (Rangsiwanichpong et al., 2015). In Thailand, Yumuang (2001) had studied about landslide and debris flow in Phetchabun province by geographic information system (GIS) and remote sensing techniques. Landslide damages are one of the most costly natural disasters in Thailand. A recent estimation of the total annual cost of landslide damage is excess of 100 million Thai baht and the frequency of the landslide events has increased sharply for the last decade (Soralump S., 2007). Therefore, an assessment landslide damage cost is one of important challenges, not only for Thailand but also around the world. The objective of this study is to estimate the expected annual damage of landslide in Thailand by the numerical integration with landslide hazard map using daily extreme rainfall daily data

Study area

The landslides occur frequently in Thailand due to the influence of monsoon rain. We used the daily rainfall data from 150 stations over Thailand by Thai Meteorological Department (TMD) for analyzing landslide hazard map in Thailand for 5, 10, 50, and 100 years return periods.

Methodology

In this research, we integrated the landslide damage, cost by urban area, agriculture area, aquaculture area, and forest area. The land price data between 2016 and 2019 was collected from the treasury department of Thailand for estimating urban area damage cost. The agriculture and aquaculture data in 2016 is collected by the ministry of agriculture and cooperatives of Thailand. The equations for calculating the agriculture and aquaculture are defined as in Eq. (1). The urban damage costs are defined as in Eq. (2).

$$D_{Ar,Aq} = \frac{production}{area} \times price \times P \quad (1)$$

$$D_u = \frac{Price}{m^2} \times P \quad (2)$$

Where D_{Ar} is the damage cost in agriculture areas, D_{Aq} is the damage cost in agriculture areas, D_u is the damage cost in urban areas, P is the probability of landslide. The expected annual damage (EAD) can then be calculated by integrating overall landslide damage probabilities and difference of return periods divided by the length of observation periods. The method is explained in equation 3 and more detail in Arnbjerg Nielsen and Fleischer (2009).

$$\text{EAD} = \frac{1}{2}\sum_{i=1}^{n}\left(\frac{1}{t_i} - \frac{1}{t_{i+1}}\right)(D_i + D_{i+1}) \quad (3)$$

Where t_i is the return period in i time, D is the landslide damage cost and n is the number of data.

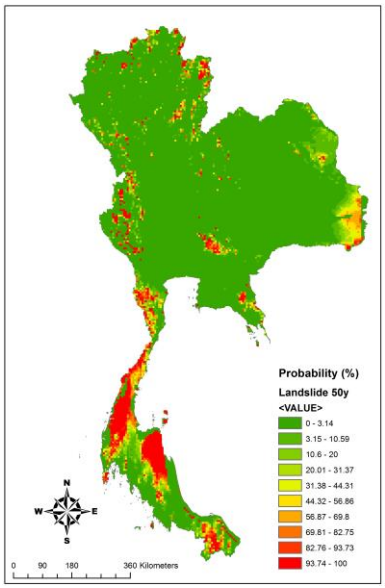

Fig 1. Landslide hazard map of Thailand

Key words: Damage Map, Disaster, Extreme rainfall

Tohoku University, 6-6-20 Aoba Aramaki, Aoba-Ku, Sendai 980-8579, Japan. Tel & Fax: +81-22-795-7455

We analyzed the probability of landslide in Thailand by multiple logistic regression. The equation for calculating the probability was shown in equation 4. (Kawague et al., 2010)

$$p = \frac{1}{1+\exp[-(\psi_0+\psi_h \times hyd+\psi_r \times relief)]} \quad (4)$$

Where P is the probability of landslide (%), ψ_0 is the interception, ψ_h is the coefficient of hydraulic gradient, ψ_r is the coefficient of relief energy, hyd is the hydraulic gradient (m/m), and $relief$ is the relief energy (m)

Result and discussion

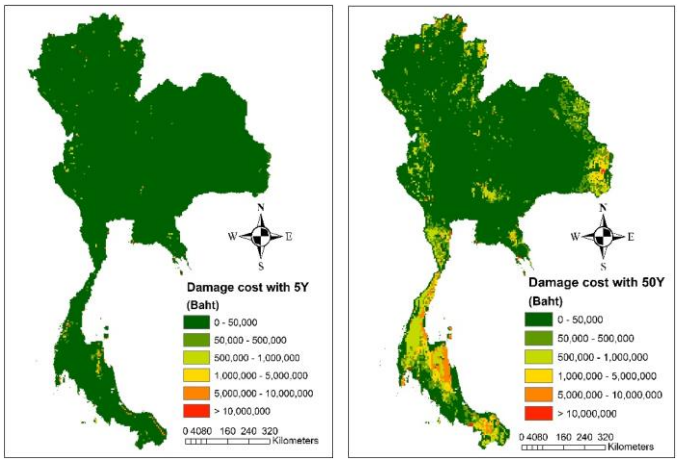

Fig 2. Damage cost by landslide in Thailand with 5 (Top) and 50 (Bottom) years return periods

The results of landslide hazard assessment found that in the northern and the southern region of Thailand have a risk from landslide events (fig 1).

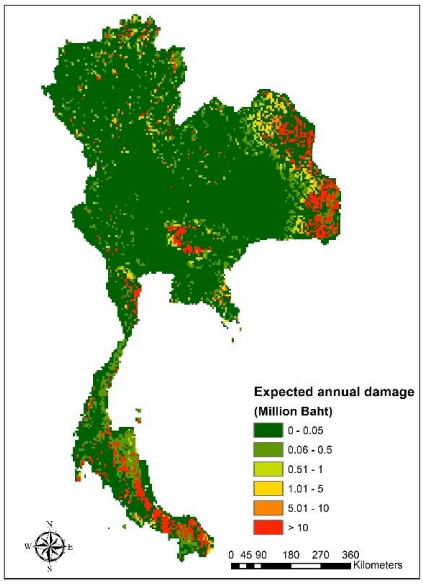

Fig 3. Landslide Damage Map of Thailand

We successively discussed the land use evolution models and the computed estimates for future landslide damage. The results showed that the damage cost by landslide would increase when the return period of rainfall increases. Furthermore, the landslide damage around 70% occurred in the agriculture areas (fig 2). Moreover, we analyzed the expected annual landslide damage by numerical integration method. The expected annual landslide damage cost is 6.8 million Thai baht per square kilometer (fig 3).

Conclusions

This study assessed the expected annual damage of landslide in Thailand using numerical integration method. From the results found that most damage of landslide in Thailand occurred in the agricultural areas, which are the important economic areas of Thailand. The damage cost will increase when the return period increases.

Acknowledgement

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