

Evaluation of Landslide hazard map using probability model in Laos PDR

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Introduction

Landslide is one of the most dangerous natural hazard, it can cause a lot of damage to hazard area. It is important for government and people who live near mountainous area to know understand the potential of hazard of those area. Therefore, to evaluate the distribution of landslide hazard over Laos, in this study uses a probabilistic model based on multiple logistic regression analysis. All data are obtained in digital format with 1km x 1km spatial resolution such as rainfall, landuse type and elevation and applied to a probabilistic model base on the multiple logistic regression method to evaluate the possibility of landslide. The results shown that most of landslide were occurred around mountainous area in central and southern part of Laos. These results can be used to support local government for making the management plan for future development and prevent the impact and damage to both human life and social

Study area

The Laos PDR, or Laos, is situated in the middle of South East Asia. The country is landlocked, so it has no direct access to the sea and has common borders with China, Vietnam, Cambodia, Thailand and Myanmar. The country is located in the Center of the Indochinese peninsula, located between Longitude 100 to 108 degree East and latitude 14 to 23 degree North (fig. 1), with a total area of 236,800 km² with Mekong river flows through almost 1,900 km of Lao territory from the North to the South and it forms a natural border with Thailand on over 800 km

Methodology

The model concern several significant physical parameters such as hydraulic parameters, geographical parameters. Among those parameter hydrological parameters

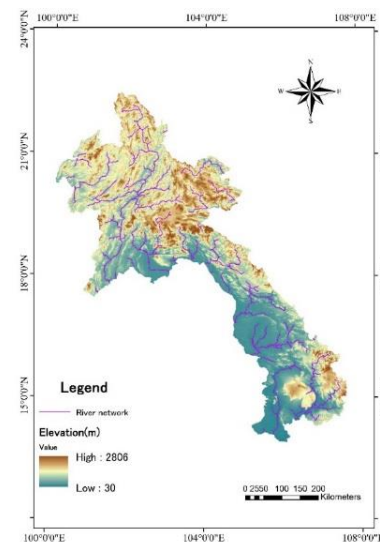


Fig. 1 Location and Topography of Laos

(hydraulic gradient) is the most significant factor in the occurrence of landslides. Probabilistic method is the backbone of the statistical analysis. In addition, probabilistic method is the possibility to use over a large area that numerous natural slopes exist (Shou et al., 2009). Hence, in this study, statistical approach was used for evaluation. Due to the lack of data in Laos, data from Thailand (Kawagoe et al., 2010; Ono et al., 2011) was used for this study on Laos.

$$p = \frac{1}{1 + \exp[-(\beta_o + \beta_h \times \text{hydro} \times \beta_r \times \text{relief})]}$$

Where, p is the event probability of a landslide, which we consider to be the hazard index of a landslide, β_o is the intercept, β_h is the coefficient of the hydraulic gradient, β_r is the coefficient of relative relief, hydro is the hydraulic gradient and relief is the relative relief.

Results and discussion

According to the results shown in Fig. 2, most of the hazard areas illustrated occur in the central to southern parts of Laos. In addition, from the records of landslide

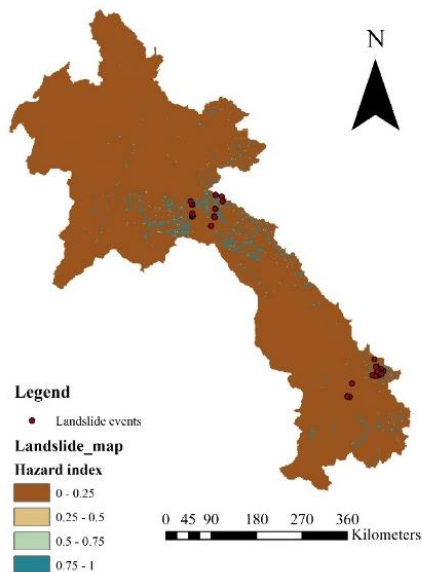


Fig 2 Landslide historical events compare to landslide hazard map

events in Laos, landslide events are closely related to the probability of exceeding specific levels of rainfall. The results reveal that low hazard areas cover 94.67 %, medium hazard areas covers 0.23 %, intermediate hazard areas cover 0.21 %, and high hazard areas cover 4.88 % of the total area. We divided the intermediate and high hazard areas according to the land use types. We found that 91.01 % of the intermediate hazard total area is located in forests, 5.61 % is located in agriculture areas, and 3.17 % is located in urban areas. In addition, 95.76 % of high hazard areas are located in forests, 4.07 % are located in agricultural areas, and only 0.16 % is located in an urban area. The landslide hazard map was validated from Google Earth Image because the lack of historical record events in Laos. Around 33 landslide events were found from the Google Eath image and we compare those landslide events with the landslide map, from the results 22 events (66.67%) were located in high hazard area (0.75-1.0), 8 events (24.24%) located in intimidate hazard area (0.5-0.75) and 3 events (9.09%) were located in low hazard area. after that we use Receiver Operating Characteristic (ROC) to find the Area Under Curve (AUC) for validation (AUC = 97.31%). From the results of AUC, the landslide map can be consider good accuracy.

Conclusions

This study was accessed probability of landslide in Laos using probability model. From the results the landslide occurred mostly in mountainous area of central and southern part area of Laos. It is important for government to pay more attention to those area to prevent the impact of landslide sediment, this study also can provide essential data for future development plan.

Acknowledgement

This research was partially supported by the Ministry of the Ministry of Education, Science, Sports and Culture, Grant in Aid for Scientific Research (B), 2015-2017 (15H05218, So Kazama). The Authors are grateful to The Environ-mental Research and technology Development Fund (s-14) of the Ministry of the Environmental, Japan and supported by Advancing Co-design of Integrated Strategies with Adaptation to Climate Change (ADAP-T) of JST/JICA, SATREPS.

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