Estimation of spatial risk on water-related disasters in Laos

Tohoku University Graduate Student Sengphrachanh PHRAKONKHAM
Tohoku University Member So KAZAMA
Tohoku University Member Daisuke KOMORI

1. Introduction

Natural hazards is one of the most dangerous and it can cause a lot of damage to human lives and social-economic. Hazard can happen a single or multi in potential areas. Therefore it is important for government to know understand the potential of risk from multi hazard of those area. Many studies have been attempted or estimated the risk for different hazards (debris, flood) on various zones used GIS as a powerful tool to integrate and analyse data from different sources. This study presents the results of estimation of spatial multi risk area from water-related disasters such as flood, climate change and landslide. In this study, we integrated 4 risk maps namely flood, landslide, climate change to flood and climate change to landslide to investigate the risk areas on a national scale.

2. 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 km^2 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

3. Methodology

3.1 Hazards

In this paper, the methodologies for generated hazard maps were separate into two parts: distribution hydrological model for flood hazards and landslide probability analysis. Distribution hydrological model was developed by Kashiwa et al (2010) under the structure proposed by Kazama et al. (2004). The model includes a direct flow and base flow model and uses to estimate the river flow. Direct flow is calculated using Kinematic wave concepts, which pursues meteoric

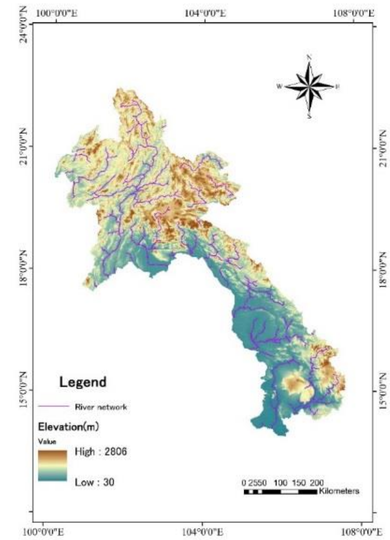

Fig. 1 Location and Topography of Laos

water runoff using a momentum equation and a continuity equation.

The landslide probability model was concern several significant physical parameters such as hydraulic parameters, geographical parameters. Among those parameter (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. For climate change we used around 7 GCMs daily rainfall data of 2 scenarios 2010 -2050 (2050s) and 2051- 2099 (2100s) for RCP 2.6 and 8.5. These were used to predict future hazard of both flood and landslide maps. In additional, we convert the water depth from the flood hazards to hazard index (Priest, 2008) and for landslide hazard map, we directly used probability as hazard index

3.2 risk and integration method

Key word: Risk, Hazard, flood, landslide, climate change; Department of Civil Engineering, TOHOKU UNIVERSITY, Hydro-Environment System Laboratory; Tel: 090-6626-2041; phrakonkham.sengphrachanh.t7@dc.tohoku.ac.jp

In this present study all of hazard maps are equally weight for creation of the integrated hazard maps. Risk is defined by the multiplying vulnerability indices with the hazard index from integrated hazard maps. Vulnerability indices were based on the land use data and classify into 3 categories: urban, agriculture and paddy field

4. Results and discussion

According to the results shown in Fig. 2, the damage cost were distributed around country but most of the risk areas occur in southern parts of Laos because many agriculture and paddy field were located in that areas. In addition, some areas around capital also have high damage cost.

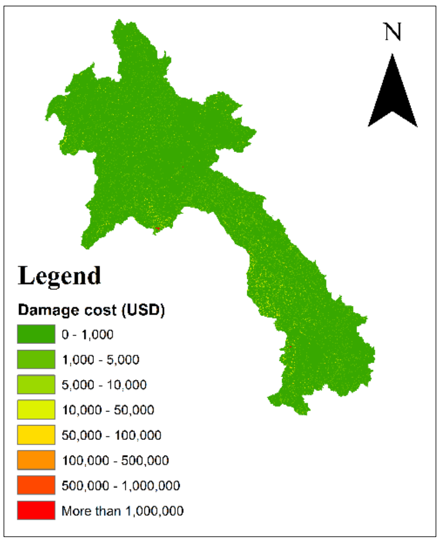

Fig. 2 Integrated risk map scenario 2050s RCP 2.6

Looking at the comparison between different scenarios of GCMs (fig. 3) the total damage cost in country scale are increased from 8.9 billion USD in scenario 2050s RCP 2.6 to 9.1 billion in scenario 2100 RCP 8.5. it is indicated that the climate change have direct impact to the increasing of damage cost in Laos

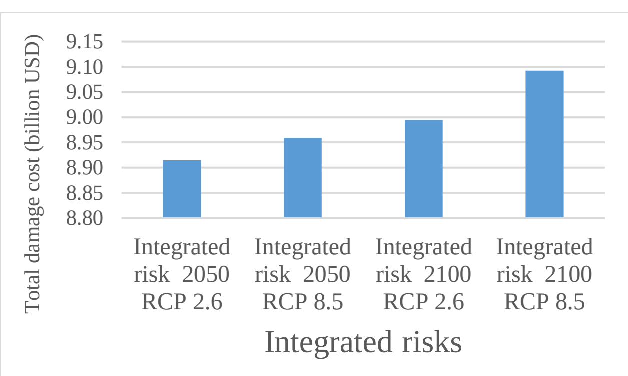

Fig. 3 The comparison of total damage cost between integrated risks.

It should be noted that these results are dependent on the equally weight of hazard to assess the risk maps, a more comprehensive weighting of hazards would require collaboration with authorities or expert in this field in order to define relations between each hazard. Nevertheless, an approach base on equally weight provide useful information for identify the sensitive areas to risk of multi hazard, it can be used as screening for future development for example.

Conclusions

This study was accessed risk of multi hazard in Laos. From the results the risk occurred mostly in southern part area of Laos. It is important for government to pay more attention to those area to prevent the impact of risk, 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 Environmental 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.

References

Kashiwa S., Asaoka Y., Akira Kazama. (2010). Flood analysis Modeling of snow melting and Estimation, *proceedings of the rivers Technology*, 16, 289 – 294.

Kawagoe S., Kazama S., and Sarukkalige P. R.: Probabilistic modelling of rainfall induced landslide hazard assessment, *Hydrol. Earth Syst. Sci*., 14, pp 1047–1061, 2010

Kazama So., Hyejin k, Sawamoto M. (2004). Uncertainty of morphological data for rainfall -runoff simulation. *Proceedings of the International Conference on sustainable Water Resources Management in the Changing Environment of the Monsoon Region*, 1, 400-406

Ono, K., Akimoto, T., Gunawardhana, L.N., Kazama, S., Kawagoe, S.: Distributed specific sediment yield estimations in Japan attributed to extreme-rainfall-induced slope failures under a changing climate. *Hydrol. Earth Syst. Sci.* 15, pp 197–207, 2011

Priest Sally.: building models to estimate loss of life for flood events, Integrated Flood Risk Analysis and Management Methodologies, Middlesex University, London, United Kingdom, 2008.

Shou, K., Chen, Y., and Liu, H.: Hazard analysis of Li-shan landslide in Taiwan, *Geomorphology*, 103(1), pp 143–153, 2009.