Multi Method Landslide Susceptibility Assessment for Spatial Planning of South Sulawesi Province in Indonesia

Abdul Rachman Rasyid

2017

SUMMARY

Nowadays, landslides are present in all continents and play an important role in the evolution of landscapes. Landslides also represent a serious hazard in many areas around the world. Preparing landslide maps is important to document the extent of landslide phenomena in a region, to investigate the distribution, types, pattern, recurrence and statistics of slope failures, to determine landslide susceptibility, hazard, vulnerability and risk, and to study the evolution of landscapes dominated by mass-wasting processes.

In 2016, according to National Disaster Management Authority (BNPB) Indonesia, the disaster that hit became a new record in quantity compare to the year before. The data shows up to November 2016; a total disaster for all categories is 2171, which 567 fatalities and 2770814 people affected to evacuate. On December, 7th 2016 morning, the earthquake struck Sumatera Island, especially Pidie Region. The data also shows around 25.4% landslide occurred from all types of disasters. http://dibi.bnpb.go.id/accessed 2016/12/14

Landslide susceptibility related with assumes that the past and present are keys to the future. The combination of two specific factors made the landslides probability present. Two specific of factors: predisposing factors (i.e. slope angle, strength of the material, vegetation cover, etc.) which place the slopes in a range of situations, from a completely stable to a marginally stable state; and triggering factors (i.e. rainfall event, snow melting, earthquake, sea storm, etc.) that are responsible for the onset of the failure.

The spatial planning provides spatial order and the basis for infrastructure upgrading, including re-examination and revision of land allocation policy, strengthening physical planning capabilities. Thus, spatial planning was applied of both regulatory and economic incentives to achieve land use optimization, recognizing that land is finite and fragile. In this research, landslide susceptibility study became a part on land use development regulations that integrated with spatial planning especially planning of vulnerable area.

The main objective of this doctoral research is to evaluate and address the shortcomings associated with the landslide hazard assessment in Indonesia related to spatial planning management. To achieve the primary objective, Bawakaraeng and Lompobattang

Mountain in South Sulawesi Province are selected, and a few studies were conducted with the following specific research objectives i.e (1) to develop a suitable methodology for landslide susceptibility map and identify the limitation based on available of data and complex of the area, (2) to apply the suitable model in research study for landslide susceptibility, especially in Bawakarang Lompobattang Mountain in South Sulawesi of Indonesia and implementing the landslide susceptibility map into watershed area, and (3) to explore quality and the level of accuracy of the statistical approach in study related to landslide susceptibility by using a different time period of landslide data inventories.

In creating landslide susceptibility maps at Lompobattang Mountain, this research shows the performance of Frequency Ratio (FR) and Logistic Regression (LR) models as well. Both the models show satisfactory results, although LR model using the equal number of landslide and non-landslide pixels shows slightly accurate results in total. The FR model is easy to apply, while LR model is a complex procedure. In this study also shows that predicting future landslides by using logistic regression could be the best choice than FR although the result will be more accurate on a larger scale, particularly at a topographic map and geological map.

At Lompobattang Mountain, the landslide susceptibility map (LSM) was applied in watershed scale to calculate the higher susceptibility in each watershed and sub watershed. The LSM that is produced using the Weight of Evidence (WoE) model recommends considering the sensitive natural factors such as slope angle and land use/land cover for spatial planning purposes. The landslide susceptibility map provides locations, which have a high probability of landslide occurrences and, which help to formulate to avoid the fatalities as preventive measures. In order to prevent any fatalities in future caused by landslide disaster, the availability of data regarding population will be helpful and the result from the planning decisions will be more comprehensive.

In a study of landslide susceptibility map, awareness to find a fit method and simple procedures of analysis became an obsession for the researchers. The validation stage compares predictive values with real data set to determine the degree of confidence of the model. By using the same population of landslide data set to create the model and validation as well, it determined how well the model fits the data but not how good the capability of predictive. The analysis which is carried out using landslides occurred in a

certain period to create the model and validation is performed by means of landslides occurred in a different period is the most reasonable. Then different landslide is employed to produce the LSM that is past landslide and use the rest as a future landslide for validation. This validation process was successfully implemented in the study that Bawakaraeng and Lompobattang Mountain include. In the past, to collected data based on a different time period are the most difficult to apply as it requires knowledge of the temporal distribution of landslides during sufficiently long time spans.

General summary of the four landslide models that used in the study is explained as follows: (1) Bivariate analysis is presented by frequency ratio and weight of evidence model relatively easy and simple to understand the process because no need of format data change except in case to calculate ROC curve. Microsoft excel software was used to compute the weight (2) Logistic regression (LR) model applied by using the training landslide and non-landslide points extracted the equation for landslide susceptibility index (LSI). The LSI from LR models can be understood easily because of the range of value from 0 to 1. Microsoft excel software was used to compute the relationship between landslide data inventories and landslide causal factors and SPSS software was used to extract the variable of the equation (3) Artificial neural network (ANN) is a computational model. The equation was extracted by using SPSS software and conduct trials and errors to get the best equation (4) Landslide data inventories that collected by using Google Earth interpretation more beneficial. One significant merit is it can identify the time period of landslide data (5) All models that applied for this study show the satisfactory result of validation based on AUC of ROC curve and landslides data for validation that fall in high to very high landslide susceptibility area.

This study is concerning on landslide susceptibility study to contribute to land-use planning management. Regarding prevention-oriented mitigation on spatial planning law of Provincial level is planning of the vulnerable area to the restricted area to the development. Meanwhile on the municipal spatial plan is the establishment of spatial patterns: conservation areas and cultivation. This study recommends the way to create landslide susceptibility map based on characteristic or type of geophysical as landslide causal factors in each area. Furthermore, statistical approach as shown throughout this study could be applied in the study related binary method such as land use change.