論 文 の 内 容 の 要 旨

論文題目　**Evaluation of landslide inventory, classification and susceptibility assessment based on case studies in Japan and China**

（斜面崩壊の分布図作成、分類、発生しやすさの評価－日本と中国を例に）

氏　　名　　竇 傑

Landslides are one of the most widespread geological hazards affecting mountainous regions all over the world. In recent years, extreme weather has brought about many weather-related disasters worldwide, causing significant casualties and economic losses. In hilly terrains such as in densely populated regions of China and Japan, there are always the risks of landslides that cause multiple fatalities and serious consequences by extreme rainfall or serious tremors. Concerted efforts of the government and the general public are crucial in enhancing the community's resilience against landslide disasters and reducing the potential loss of life and damage to properties. Hence, expeditious construction of landslide inventory maps and prediction of landslide occurrence have become an important but challenging issue.

This research mainly presents the results of testing the strengths and weaknesses of contemporary landslide inventories and susceptibility mapping techniques, to facilitate the construction of accurate regional landslide susceptibility maps for varying geo-environments, through case studies in Japan and China. Three main topics were selected based on extensive reviews of literature and considered as the most important to improve landslide susceptibility mapping. The details of three specific tasks are listed as below:

1) Landslide inventories are often prepared by manual analysis of post-event aerial photographs or satellite images. This is time-consuming and may lead to misinterpretations. This work presents an improved automated model for rapid preparation of landslide inventories. The experimental results indicated that the proposed integrated method demonstrates higher classification performance than the stand-alone object oriented image analysis (OOIA) technique for detecting landslides. The area under curve (*AUC*) of the receiver operating characteristics (ROC) was also higher than that of the simple OOIA, indicating the high efficiency of the proposed landslide detection approach. The case library created using the integrated model can be reused for time-independent analysis, thus rendering our approach superior in comparison to other traditional methods, such as the maximum likelihood classifier.

2) Many previous studies successfully evaluated susceptibility of landslides in a wider area, however prediction of landslide types in to deep and shallow slides which are crucial for risk analysis has rarely been conducted. This work examines the differences in landslide depth, volume and the risk imposed between shallow and deep-seated landslide types. Shallow and deep-seated landslide prediction is useful in utilizing emergency resources by prioritizing target areas while responding to sediment related disasters. Ten factors, including elevation, slope, aspect, curvature, lithology, distance from the nearest geologic boundary, density of geologic boundaries, distance from drainage network, the compound topographic index (*CTI*) and the stream power index (*SPI*) derived from the DEM and a geological map were analyzed using support vector machine (SVM) technique. Iterated over 10 random instances the average training and testing accuracy of landslide type prediction was found to be 89.2% and 77.8%, respectively. The overall accuracy of SVM does not rapidly decrease with a decrease in training samples. The trained model was then used to prepare a map showing probable future landslides differentiated into shallow and deep-seated landslides.

3) Different studies use different numbers of causative factors for the development of susceptibility maps. The selection of the causative factors so far largely remains random and subjective. Selection of essential factors improves the prediction accuracy of landslide susceptibility mapping (LSM). This work proposes a rule-based statistical method for an objective selection of causative factors fitting to differently triggered landslides. The certainty factor (CF) model was then applied to select the best subset from the original available factors. Using all factors and the best subset factors obtained, landslide susceptibility maps were produced using statistical index (SI) and logistic regression (LR) models. The susceptibility maps were validated and compared using landslide locations in the validation data. The prediction performance of two susceptibility maps was estimated using *AUC*. The result shows that *AUC* values for the LR model (0.817 for Niigata and 0.837 for Dongjiang) are slightly higher than those obtained from the statistical index (SI) model (0.801 for Niigata and 0.794 for Dongjiang). Our findings can help to understand the main causative factors with landslide occurrence.

These spatial-temporal aggregation and scenario models for detecting and evaluating landslide susceptibility, which could be adopted as a prototype for warning systems in the other similar landslide-prone areas. Additionally, the optimization of causative factors such as slope angle, and lithology can be used in other susceptible regions, especially for data scarcity areas. Moreover, the susceptibility maps could assist urban planners, designers, civil engineers and earth scientists to specify where a problem may exist and to determine what type of failure may occur at the hazardous regions in the future.