崩塌地動訊號自動化辨識技術精進及其應用之研究

Improvement and application of automatic landslide-quake identification technology

主管單位：農業委員會水土保持局
林冠瑋
Lin, Guan-Wei
國立成功大學地球科學系

摘要

大規模崩塌產生的地表振動訊號可被鄰近地震儀記錄下來，因此近年來地動訊號分析被廣泛用於邊坡塊體滑動的研究。從連續地動記錄中判別出崩塌訊號以往多是仰賴人工判讀，不僅過於曠日廢時，判釋結果也深受分析人員的經驗及主觀判斷影響。將機器學習技術應用到地動訊號的自動判釋，可更加快速且客觀的找出崩塌事件的時間點，大量減少在判釋崩塌事件的時間及人力成本。本計畫利用 642 個已知振動類型的地動訊號作為分類器的訓練樣本，藉由計算時間域及頻率域上的訊號特徵值，配合機器學習演算法，建立出連續地震記錄的自動分類器。將自動分類器運用於 2018 年及 2019 的颱風及豪雨事件，可以成功辨識出 6 個由崩塌所產生的地表振動訊號。分析崩塌地動訊號發現崩塌面積與包絡線面積，以及崩塌體積與平均地表速度大致呈現正相關，表示利用崩塌地動訊號有機會進一步用於評估崩塌量體。利用崩塌地動訊號提供的 93 個崩塌發生時間，進一步統計促崩降雨參數，結果反映出引發大規模崩塌並不需要極端的小時降雨量，長時間的持續降雨以及大量的累積降雨是引發大規模崩塌的主要因素。引發大規模崩塌的土壤水分指數統計結果顯示，需要大量的水分進入深層材料中才能引發大規模崩塌，且觸發大規模崩塌的前期降雨高於小規模崩塌。

關鍵詞：大規模崩塌、地動訊號、機器學習、訊號特徵值

Abstract

The seismic signals generated by landslides could be recorded by nearby seismometers. Using machine learning methods to create an automatic landslide-quake identification model, the time information of landslides can be gotten more quickly and objectively. This study used 642 seismic signals are treated as training samples of machine learning classifier. By calculating the attributes of signals in the time domain and the frequency domain, an automatic classifier for continuous seismic records is established. The automatic landslide-quake classifier was then used to auto-identify the landslide-induced signals occurring during typhoons and rainstorm in 2018 and 2019. Six landslide-quakes were identied by the automatic landslide-quake classifier. The analysis of the landslide-quakes

indicates that the landslide-quake is useful to evaluate the landslide magnitude. Using the 93 occurrence times provided by the landslide-quakes, further statistics on the triggering rainfall reflect that long duration and large cumulative rainfall are the main factors to cause large-scale landslide. The statistics of the soil water index showed that a large amount of water in deep material was required to cause large-scale landslide, and the antecedent rainfall that triggered large-scale landslides was higher than that of small-scale landslides..
Keywords：Large scale landslide, Seismic signal, Machine learning, Signal features