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新武呂溪流域的山崩與輸砂量在地震與颱風事件中的相對應關係

The relationships between landslide and sediment discharge in the periods of earthquake and typhoon events along the catchment of the Sinwulyu River

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摘要

本研究利用 SPOT 衛星影像，判釋新武呂溪流域於 6 個颱風時期及 2 次地震事件後的崩塌地分布狀況，並以溪流內之實測流量、雨量、輸砂量，以及 DTM 的地形分析，岩石的強度、不連續面分布等資料，來探討流域內的山崩和輸砂量在颱風與地震事件中的相對應關係。

研究結果顯示，六個颱風時期的山崩崩塌率介於 0.84%到 1.94%之間，崩塌率、新生率及重現率，都是以成功地震後之敏督利颱風爲最高、分別爲 1.94%、72.3%、66.5%。區域內山崩最高點的高程，大多分布於 1500 至 2500 公尺之間，在成功地震後有繼續往山頂發展的趨勢；山崩的坡度分布變化並不顯著，大多分布於 30°至 50°之間，但是在坡度陡峭的邊坡，其崩塌率出現明顯的上昇。在本區域的四個地層單位中，由於畢祿山層具有最低的岩石強度，平均 34MPa，因此其崩塌率最高，介於 1.74%至 2.56%之間；相對的，在大南澳片岩大理岩段具有最高的岩石強度，平均 102MPa，所以其崩塌率較低，爲 0.56%至 1.34%之間；大南澳片岩混合片岩段的單位體積節理數最多，平均爲 47.3N/m3，山崩的重現率也最大，介於 57.3%至 72..5%之間，兩者間具有一定程度的相關性。

本區域之常態化差異植生指標(NDVI)，分布於 0.44 至 0.53 之間，區域內各事件的崩塌率與植生指標之間的對應關係並不明顯。在輸砂量的統計方面，利用新武呂溪流域 1979 至 2005 年的實測值，以平均法和率定曲線法估算，可以得知平均年輸砂量約在 7.8 至 15.2 百萬噸之間。輸砂量主要是由颱風暴雨事件所供應，單一事件的輸砂量約佔全年輸砂量的 6.6%至 25.3%。在單位流量輸砂濃度的變化方面，集集地震後之量測值比地震前增加了 2.58 倍，在成功地震後又再增加了 1.18 倍，此結果顯示持續的地震事件，使得集水區內之地質材料變得更加鬆散，不僅崩塌率上升，進而提高了逕流的沖刷能力，並帶走更多的沉積物。

關鍵字：山崩、颱風、地震、岩石強度、常態化差異植生指標、輸砂量

Abstract

The hydraulic measurement, geomorphologic changes and geomaterial characteristics are utilized to analysis their relationships in their study. The various images of SPOT satellite were selected to count the landslide ratio in six typhoons and two earthquakes events along the catchment of the Sinwulyu River form 1996 to 2006.

The investigated results show that the landslide ratio ranges from 0.84% to 1.94% during the different disaster event. After the Chen-Gong earthquake (ML=6.6), the following Typhoon Mindulle resulted in heavy landsliding, including 1.94% of landslide ratio, 72.3% of new generative ratio and 66.5% of reactive ratio in the catchment. The elevation of most landslides ranges from 1500 to 2500 meters and keep rising after Chen-Gong earthquake. Besides, the landslides converge in the steep slopes ranging from 30° to 50°. The uniaxial compressive strength (UCS) of the Bilushan Formation is the lowest around 34MPa in all rock units, and the landslide ratio in the Bilushan Formation, ranging from 1.74% to 2.56%, is the highest. Comparatively, 102MPa of UCS in the Dananao formation is the highest and the landslide ratio in the Dananao formation, ranging from 0.56% to 1.34%, is the lowest. The Dananao formation has 47.3N/m3 of the joint number that causes the highest reactive ratio, ranging from 57.3% to 72.5%. There is a positive linear relationship and the statistically significance between the reactive landslide ratio and the joint numbers.

The Normalized Difference Vegetation Index (NDVI) in this region ranges from 0.44 to 0.53. There is week significance between landslide ratio and NDVI. The annual sediment discharge ranges from 7.8 Mt/y to 15.2 Mt/y by using the calculation of average method and rating curve method from 1979 to 2005. The sediment discharge in the period of rainstorm events occupied 6.6% to 25.3% of annual sediment discharge. The concentration of discharge increased 2.58 times in post Chi-Chi earthquake, and further increased 1.18 times after Chen-Gong earthquake. This result demonstrates that the colluvial sediments of hillslope resulted from the successive earthquakes not only caused the increasing of landslide ratio, but the rising of sediment discharge increased.

Key words: landslide, typhoon, earthquake, rock strength, NDVI, sediment discharge