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工程與非工程方法之土石流災害風險管理 - 以松鶴地區為例

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摘　　要　本研究旨在建置土石流風險分析流程，藉以分析土石流危險溪流影響範圍內之災害風險分布。依序分析土石流之危害等級、風險元素之易損性及社區之承受度，來計算土石流災害事件中可能造成的物質風險、生命風險與總風險值。首先，危害等級分析係針對不同重現期距之降雨事件，分別利用 FLO-2D 軟體進行模擬，將影響區域劃定為紅色與黃色危險區。第二，易損性分析包含以地上物為主的物質易損性與以人命為主的生命易損性。將淹沒區域之圖層套疊至土地利用圖層，可獲得物質易損性之分布情形，土地利用圖層在數化時被分為房屋、農地、林地、道路、橋梁及無直接損失等六種風險元素型式，並針對不同風險元素給予其單位面積的價值。再以損害因數(DF)代表不同風險元素實際災損值與其本身價值的平均比例，由此分析物質易損性。生命易損性則以生命價值(V)評估值、損害因數(DF)和居民在屋內的易損性(V_P)來進行量化分析。第三，由層級分析法(AHP)所建立之層級結構可知，社區承受度係由「居民個人抵抗災害能力」與「社區抵抗災害資源」兩部分所組成。因此，可由居民問卷、社區檢核表所得到的分數與各項目之權重來計算社區承受度(C)。最後，依據紅色與黃色危險區內的物質易損性計算結果繪製物質風險地圖；而將生命易損性與承受度(C)結合以評估生命風險，並與物質風險相加成總風險地圖。在物質風險、生命風險與總風險各方面分析結果，松鶴二溪均高於松鶴一溪。本研究亦對松鶴地區設置工程構造物與舉辦疏散避難教育訓練前後之風險進行分析，可得到不同措施的效益值；再將效益值與工程、疏散避難之成本進行益本分析，其中松鶴二溪之工程與本區之疏散避難益本比均大於 1。本模式可評估防災措施之經濟效益，作為各方案實施順序之決策參考依據。

關鍵詞：風險分析、危害分析、易損性、承受度、益本比。

Debris-Flow Disaster Risk Management for Structure and Non-structure Method in Songhe Community

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ABSTRACT　The purpose of this study is to establish debris flow risk analysis procedures by which the disaster risk distribution within the influenced scope of potential debris flow torrents are analyzed. This study analyzed the hazard grades of

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debris flow, the vulnerability of elements at risk, and the resilience capacity of a community to calculate the values of matter risk, life risk and total risk possibly caused by debris flow disasters. First, the hazard grade analysis was conducted using FLO-2D software to simulate the rainfalls of different return periods and divide the influenced areas into red and yellow hazard zones. Second, vulnerability analysis included matter vulnerability of matter above land and the life vulnerability of human life. Overlaying the submerged area's layer to the land-use layer obtained the distribution of matter vulnerability; under digitalization, the land-use layer was divided into six types of element at risk, including residential, farm land, forestry land, road, bridge and no-direct-loss. The value of the unit area was given against different elements at risk. Then, damage factor (*DF*) was used to represent the average ratio between the actual disaster loss value of different elements at risk and the values of elements at risk themselves, by which matter vulnerability was analyzed. Life vulnerability was carried out through quantitative analysis by assessment of life value (V_l), damage factor (*DF*) and the vulnerability of people in buildings (V_p). Third, from the framework established by Analytic Hierarchy Process (AHP), community resilience capacity consisted of two parts: "the ability of residents to resist natural hazard" and "the resources of the community for preventing from disasters". Therefore, the scores from residents' questionnaires and community checklist, as well as the weight of every item, were used to calculate community resilience capacity (*C*). Finally, according to the calculation result of matter vulnerability in red and yellow hazard zones, a matter risk map was drawn; next, life vulnerability and resilience capacity (*C*) were combined to assess life risk, plus the addition of matter risk into the total risk map. This study also carried out risk analysis before and after mitigation structures were installed and evacuation educational training was held in Songhe community to get benefitial value from different measures. Then, benefit-cost analysis was conducted based on benefit value and the cost of mitigation structures and evacuation in order to assess the economical benefit of disaster prevention measures as references for decision-makers in charge of the enforcement of various project.

Key Words: risk analysis, hazard analysis, vulnerability, capacity, benefit-cost ratio.