降雨誘發山崩動態警戒模式與調查技術研發應用(4/4)

The study of rainfall-induced landslide dynamic warning system and innovative landslide investigation approach (4/4)

主管單位：經濟部中央地質調查所

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摘要

中央地質調查所於 104-107 年「降雨引致山崩潛勢評估模式精進與圖資更新」計畫已完成 157 幅 1/25,000 圖幅範圍之環境地質資料庫及降雨誘發山崩預警資訊系統。本(108-111)期計畫為了推廣使用計畫成果，擬增補臺灣中部高山區缺漏的 45 幅 1/25,000 圖幅範圍，將臺灣全島納入警戒範圍，擴大山崩動態警戒模式範圍及警戒對象。

去(110)年度計畫使用山崩與地滑地質敏感區變更計畫書之參據資料，建置及更新全臺 202 幅範圍之環境地質資料庫。為使山崩資料涵蓋空間範圍更完整，本(111)年度將增補 202 圖幅外圍零星坡地之資料。計畫成果將於今(111)年度出版成冊，預計將逐幅校稿，完成圖版設計、地圖圖徵編修等文字與顏色易讀性之調整，並完成圖集說明書，說明計畫成果。

前(109)年度計畫將前期(104-107)計畫建置之降雨誘發山崩預警資訊系統進行調整，並更名為降雨山崩即時系統。去(110)年度以前(109)年度完成之全臺斜坡單元山崩潛勢更新降雨山崩即時系統。本(111)年度將持續介接外部資料，確保系統資訊展示功能正常運作。

關鍵詞：環境地質資料庫、降雨山崩即時系統

Abstract

From 2015 to 2018, Central Geological Survey (CGS), MOEA, completed environmental geology database and built Rainfall-Induced Landslide Early Warning System during the project, “Improvement of Rainfall Induced Landslides Susceptibility”. This project is to promote the warning system and update the database that is deficient in high mountain areas, extending the warning area to save more lives and protect more livelihoods.

The reference data of geological sensitive areas was to establish and update the environmental geology database of the coverage of 202 sheets of Taiwan last year. To complete the landslide database in spatial coverage, this year, the environmental geology database will be expanded outward slightly to include the remaining slope area. The result of environmental geology database is going to be published. To finish the layout design, map features design and map legibility; we will schedule the proofreading and editing sheet by sheet before printing. And the landslide map guidebook is also going to be proofread and published.

Last year, we updated the Rainfall-induced Landslide Real-time System, which is established in the previous phase (2015 to 2018), and renamed the system to Rainfall-induced Landslide Real-time System (RiLRS). This year, RiLRS keeps adopting rainfall data, ensuring the functionalities work. Moreover, landslide susceptibility in slope unit was updated using last year’s data. The old version system is still available while the new system is under construction and testing.

Keywords: environmental geology database, Rainfall-induced Landslide Real-time System (RiLRS)

111 年度山崩調查觀測技術精進與應用(4/4)

Application of Innovative Technology for Landslide Investigation and Observation (2021) (3/4)

主管單位：經濟部中央地質調查所

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摘要

對於具大規模岩屑崩滑及岩體滑動潛勢之潛在山崩地區，往往具特殊地質條件，進而構成不同的山崩機制，並可能伴隨不同的邊坡滑動變形特性。雖促崩條件及崩塌規模不盡相同，但在豪大雨條件作用下，均可能誘發邊坡發生或再次發生滑動，引致嚴重災害，如南投縣廬山溫泉北坡及嘉義縣油車寮地區等，均屬於老崩塌地再次滑動現象。為避免邊坡災害無預警發生，除須掌握坡地的環境地質狀況及潛在山崩活動特性，亦須配合適當的活動性觀測技術進行觀測。本計畫延續前期計畫成果,持續相關技術資料蒐集及研發應用,以提昇整體防災應變能量。本計畫為四年期計畫，執行期間為 2019~2022 年，本年度(2022 年)為整體計畫第四年，整體計畫包括四大部分：1.潛在山崩地區調查、活動性觀測及地質安全評估、2.多尺度遙測技術應用於潛在山崩地區地表變形探討研究、3.地中調查觀測與物聯網之技術研發防災應用及 4.山崩活動性觀測成果智慧應用推廣及國內外技術交流。

本年度計畫針對西羅岸、忠治籃球場、廬山溫泉北坡、廬山聚落、定遠、壽亭、樣子寮及潮洲湖等 9 處具邊坡活動性之潛在山崩地區持續觀測，並根據長期觀測成果建立活動性評估方法。為瞭解潛在大規模崩塌之岩體變形特徵，本年度計畫以定遠地區為場址，進行新增地質鑽探及孔內試驗，並彙整前期調查成果，期以瞭解板岩區的山體變形特徵。

本計畫於廬山溫泉北坡、廬山聚落、定遠、壽亭地區進行 D-InSAR、GPS、UAS LiDAR 等多尺度遙測技術之應用及相互比對，研究結果顯示 D-InSAR 有助於瞭解大範圍地表變形,但 SAR 影像入射角與坡向、坡度之關係,影響分析結果，建議搭配不同儀器，檢核位移量及趨勢。

為研究地中活動性觀測技術之適用性，本計畫於忠治籃球場研究各式觀測技術，如地中觀測共構可行性及物聯網技術可行性，研究成果顯示測傾管與孔內伸縮計同孔共構方式尚屬可行，由於研究場址規模小、位移速度快，可再進一步於

較大規模之潛在山崩地區進行測試研究。

本年度計畫彙整整體計畫成果，完成「潛在大規模崩塌之調查及觀測技術手冊」彙編改版(二版)，並辦理「潛在大規模崩塌調查及觀測技術發展應用研討會」。

關鍵詞：潛在山崩地區、地質調查、孔內探測、遙測技術、活動性觀測技術

Abstract

For large-scale potential landslide areas with types of regolith slide and rock slide, there often are special geological conditions, which induced different landslide mechanisms, and may be accompanied by different slope sliding deformation characteristics and behaviors. Although the landslide factors and scale are various, however, these large-scale potential landslide areas all may happen sliding induced by the heavy rain conditions, resulting in serious disasters. To avoid unwarranted slope disasters, it is necessary to understand the landslide mechanism through in-situ investigations, and also to cooperate with appropriate active observation techniques with different environmental geological conditions. Due to the recent development of investigations and active observation technologies, the project continue to collect, develop and apply relevant technologies to enhance the overall disaster prevention and response energy. The execution period of this project is four years from 2019 to 2022. Objectives of the overall plan include (1) Potential landslide area survey, active observation, and geological safety assessment. (2) Multi-scale remote sensing technology applied to potential surface landslide deformation research. (3) The research, development, and disaster application of prospective survey and observation and Internet of Things technology (4) Smart application and promotion of landslide activity observation results and technical exchanges at home and abroad.

In the fourth execution period of this project, nine potential landslide areas with higher activity based on the previous work results are selected to continue the observation works, including Hisloan, Zhongzhi basketball court, the northern slope of Lushan hot spring, Lushan settlement, Dingyuan, Shouting, Taihe, Shetzuliao, and Chaochouhu area. Based on the long-term observation results, this plan attempts provide the method to assess landslide activity of study areas area. In order to understand the slope deformation characteristics of large-scale potential landslide area, geologic drilling and borehole televiewer survey are performed at the Shouting area in this project.

Moreover, this plan adopts multi-scale remote sensing technologies, including D-InSAR, GPS, and UAS LiDAR to research the application and compare the performance of each method in the study areas of the northern slope of Lushan hot spring, Lushan settlement, Dingyuan and Shouting study areas are. D-InSAR shows useful information for wide surface deformation, but the slope and direction of study area can influence the D-InSAR results, various observation methods were recommended to examine the results.

Research on the feasibility of various observation technologies such as co-construction subsurface observation and IoT technology are performed in the study area of Zhongzhi basketball court after the former periods of this project. In-situ observation results showed borehole co-construction method was feasible. Due to the small scale of the research site and the fast displacement velocity, further testing and research can be carried out in larger-scale potential landslide areas.

This year plan compile the overall project results, complete the compilation and revision (second edition) of “Investigation and observation technical manual of potential large-scale landslide area”, and hold the "Seminar on the Development and Application of Potential Large-Scale Landlside Investigation and Observation Technology". On the other hand, this plan makes a borehole extensometer mockup that can display the deformation process of borehole extensometer induced by landslide and visualize the deformation information for exchange of know-how.

Keywords: Potential landslide area, geological survey, borehole test, activity observation technology