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Deformation monitoring of typical loess landslide case studies through combining InSAR and UAV

Qingkai Meng[1], Federico Raspini[2], Pierluigi Confuorto[2], Ying Peng[3], and Haocheng Liu[4]
[1]State Key Laboratory of Plateau Ecology and Agriculture,Qinghai University, Xining, China (mengqk@qhu.edu.cn)
[2]Earth Sciences Department, University of Florence, Florence, Italy
[3]College of Nuclear Technology and Automation Engineering, Chengdu University of Technology, Chengdu, China
[4]School of Water Resources and Electric Power, Qinghai University, Xining, China

InSAR is an advanced earth observation (EO) technique for retrieving past, subtle (millimetre-level) and continuous surface movements over a long period, which has been widely applied in landslide deformation monitoring and detecting precursory signals of deformation. However, limited by the maximum detected deformation gradient from two consecutive scenarios, singular InSAR has hampered the recognition application for high-speed slides or earth flows, leading to a misleading understanding of slope evolution. Being a high-resolution photogrammetry technology, UAV represents a suitable tool to detect meter-level displacement rates and estimate ground detachment. Thus, InSAR and UAV's synergic analysis can detect the kinematic variation of geographical and geomorphological features, corresponding surface displacements to cross-validation. In the present work, two representative cases illustrated how the combination of InSAR and UAV could be applied in loess landslide deformation monitoring. One case, located in Hongheyan, Gansu Province, China, was selected to reconstruct landslide morphology, identify deformation evolution behaviour and produce dynamic deformation zonation maps using 85 Sentinel-1A SAR images and three UAV fight surveys from pre-sliding to post-sliding. The integrated deformation results illustrate the slide of theHongheyan slope was triggered by heavy rainfall, became suspended owing to the topography effect after the occurrence, and reactivated recently. Another case, located in Qinghai-Gansu province, calculated two-dimensional displacements (vertical-horizontal) by decomposing the ascending and descending Sentinel-1 images to reclassify the regional slope failure type into the translational slide, rotational slide and loess flow based on deformation characteristic. Overall, multi-source information fusion is a new approach for landslide monitoring from regional-scale failure classification to specific-scale slope deformation evolution, giving the comprehensive understanding for local government or Civil Protection to take sufficient precautions for risk mitigation.