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Elementary Analysis of the Mechanism of Xishan Landslide Based on Pixel Tracking on VHR Images

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Abstract: The geometric and kinematic characterizations of landslides are key factors for understanding the mechanisms of landslide movement. Recent developments in remote sensing techniques provide powerful tools for landslide deformation studies. The objective of this paper is to present an efficient method for monitoring the horizontal ground displacement and strain field of active landslides from space-borne optical images, which were analyzed with a digital image correlation technique. This method was evaluated on a series of images acquired on the Xishan landslide in China over the period between 2010 and 2013. These imageries included ZY-3 and WorldView-II images. These were Very High Resolution (VHR) satellite imageries and were orthorectified with a high resolution DEM interpolated from Unmanned Aerial Vehicle (UAV). By using sub-pixel correlation on before- and after-event orthoimages, it was possible to compute the displacement field with high planimetric resolution. Furthermore, a strain analysis was performed to characterize the deformation and displacement regime of the landslide. Validation of the computed strain field analyzed the relationship between the deformation and the faults detected in the field. This approach can facilitate displacement measurements. It could, therefore, offer promising potential for operational applications, for instance, early warning of geo-hazards.

Keywords: landslide, deformation monitoring, Very High-Resolution Imagery, digital image correlation, strain analysis

1 Introduction

Landslides are major natural hazards that threaten infrastructures and human settlements. Reliable decisions should be made on the basis of a deep understanding of the landslide behavior. Deformation monitoring of landslide surface is essential to provide information on the geometry of the ruptured fault and understand tectonic and geomorphological processes.

Landslide slope displacement as a type of surface deformation is correlated with different phenomena (Watson et al 2004) such as piezometric level changes. Historical analysis demonstrates that the rise of water table level is often followed by displacements in the sliding area as a result of changing pressures and stresses on the body of the landslide (Baroň et al 2012). Furthermore, strain of objects can be expressed using the stress field. This measurement is independent with respect to rigid body motions, evidencing real relative surface variations. Accordingly, the estimated strain allows the identification of zones characterized by different kinematics (Teza et al 2008).

Several instruments are available for deformation monitoring on landslide surface. Field measurement, such as Global Positioning System (GPS), is one of the most common methods for measuring displacement (Mora et al 2003); this

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