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Mapping mass movement processes using terrestrial LIDAR: a swift mechanism for hazard and disaster risk assessment

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The impact of disasters associated with mass movement processes has increased in the past decades. Either triggered by earthquakes, volcanic activity or rainfall, mass movement processes have affected people, infrastructure, economic activities and the environment in different parts of the world. Extensive damage is particularly linked to rainfall induced landslides due to the occurrence of tropical storms, hurricanes, and the combination of different meteorological phenomenon on exposed vulnerable communities. Therefore, landslide susceptibility analysis, hazard and risk assessments are considered as significant mechanisms to lessen the impact of disasters. Ideally, these procedures ought to be carried out before disasters take place. However, under intense or persistent periods of rainfall, the evaluation of potentially unstable slopes becomes a critical issue. Such evaluations are constrained by the availability of resources, capabilities and scientific and technological tools. Among them, remote sensing has proved to be a valuable tool to evaluate areas affected by mass movement processes during the post-disaster stage. Nonetheless, the high cost of imagery acquisition inhibits their wide use. High resolution topography field surveys consequently, turn out to be an essential approach to address landslide evaluation needs.

In this work, we present the evaluation and mapping of a series of mass movement processes induced by hurricane Ingrid in September, 2013, in Teziutlán, Puebla, México, a municipality situated 265 km Northeast of Mexico City. Geologically, Teziutlán is characterised by the presence, in the North, of siltstones and conglomerates of the Middle Jurassic, whereas the central and Southern sectors consist of volcanic deposits of various types: andesitic tuffs of Tertiary age, and basalts, rhyolitic tuffs and ignimbrites from the Quaternary. Major relief structures are formed by the accumulation of volcanic material; lava domes, partially buried volcanic cones, and slopes of pyroclastic deposits. Additionally, there are mountains and elevations of metamorphic and intrusive origin. The predominant hillslope materials in Teziutlán are poorly consolidated pyroclastic flows that favour rapid water saturation and enhance slope instability. Rainfall induced landslides in this region are not uncommon. Their consequences were particularly severe in the years 1999, 2005 and 2013. Rainfall derived from hurricane Ingrid in September, 2013, triggered 41 landslides on populated areas of Teziutlán, and involved 3 human losses and the evacuation of 139 people. Reoccurrence of landsliding in this area, where vulnerability levels of communities is high, certainly implies the need of establishing strategies for disaster risk reduction, among which, the use of terrestrial LIDAR can be regarded as a swift mechanism for landslide susceptibility, hazard and disaster risk assessments.