A Review of Remote Sensing and Ground-Based Techniques for Landslides Detection, Fast Characterization, Rapid Mapping and Long-Term Monitoring

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European countries are exposed to numerous geohazards, such as landslides and rockfalls, which endanger inhabitants and infrastructures. The European project FP7 "SafeLand" wants to develop innovative mapping and monitoring methods in order to improve regional assessments and early warning systems (SafeLand European project, 2009). More specifically, Area 4 addresses the technical and practical issues related to monitoring and early warning for landslides. During the last decade, different monitoring and remote sensing techniques underwent rapid development. In order to summarize these scientific and technical advances, the University of Lausanne, in close collaboration with 12 European institutions, is leading the deliverable 4.1: *"Review of Remote Sensing and Ground Based Techniques for Landslide Detection, Fast Characterization, Rapid Mapping and Long-Term Monitoring"*.

The core of this review consists of two main chapters. Chapter 3 summarizes the different techniques and methods (e.g. Ground-Based and Space-Borne optical images, Aerial and Terrestrial Laser Scanning, Radar Interferometry, Ground Based and Airborne Geophysical investigations, Geotechnical Ground-Based monitoring systems and Global Positioning System) from a theoretical point of view. The structure of this chapter is illustrated in Figure 1. Each technique described in the deliverable has benefited of the expertise of specialized research groups. Chapter 4 shows the main applications of these techniques to landslides, through the synthesis of different case studies. To this end, each partner provided different examples which summarize the state-of-the-art of a given technique for different hazards in several situations. As an example, Figure 2 shows a combination of Aerial and Terrestrial Laser Scanning for rockfall characterization.

This review seeks to represent a common reference for the different deliverables of Area 4 of the SafeLand European project, specifically for the D 4.3, D 4.4 and D 4.8 (*"Creation and updating of landslide inventory maps, landslide deformation maps and hazards maps as input for QRA using remote sensing technologies"*, *"Guidelines for the selection of appropriate remote sensing technologies for monitoring different types of landslides"*, *"Guidelines for monitoring and early-warning systems in Europe – Design and required technology"*).

References

SAFELAND European Project(2009–2012): Living with landslide risk in Europe: Assessment, effects of global change and risk management strategies. Grant agreement No. 226479. www.safeland-fp7.eu.
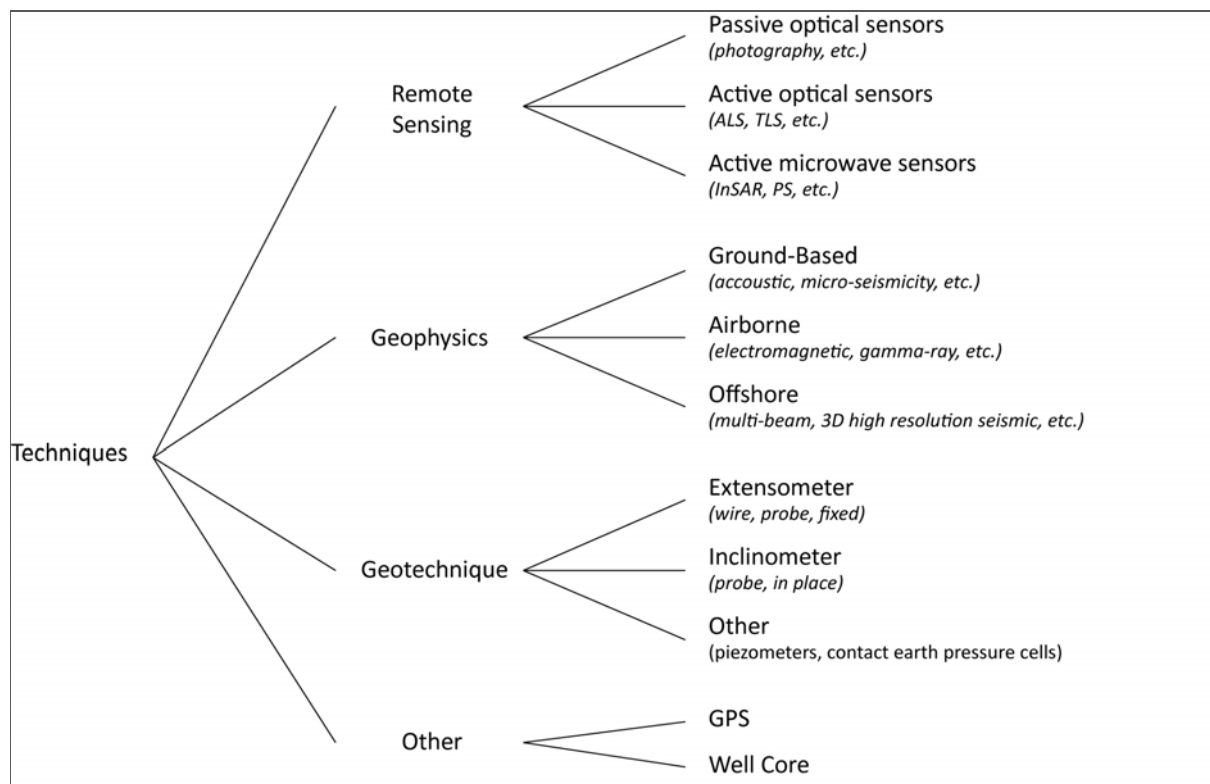
Fig. 1: Structure of the major chapter of the deliverable exploring the state-of-the-art and the theory of remote sensing and ground based techniques applied to landslides detection, fast characterization, rapid mapping and long-term monitoring.
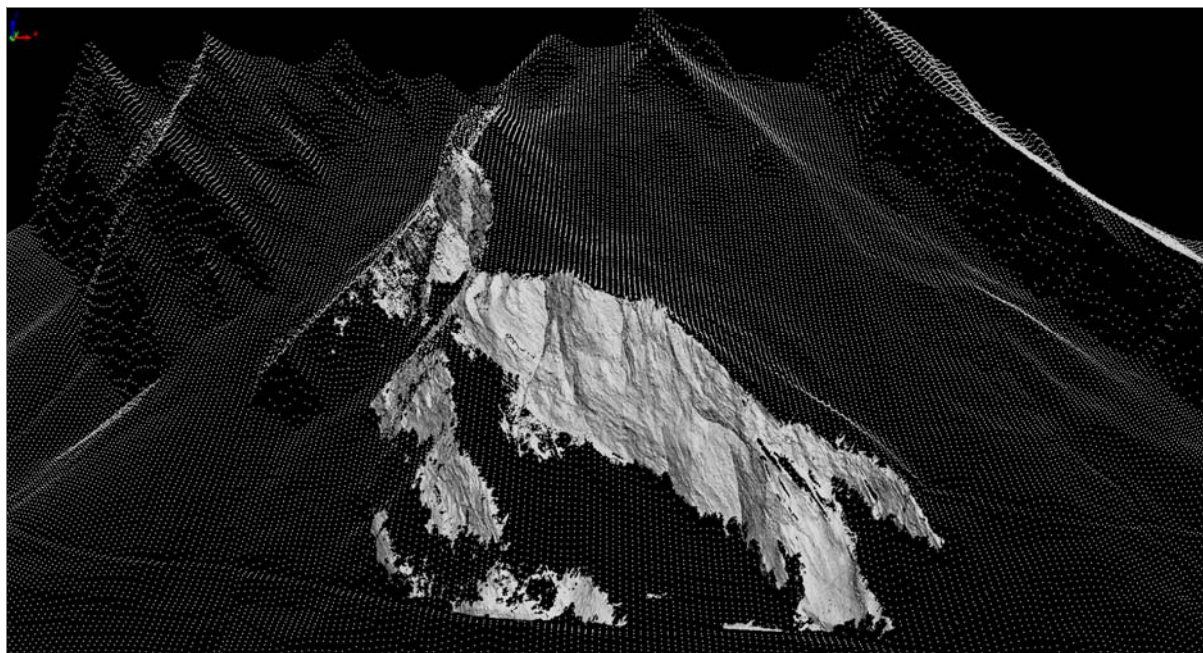

Fig. 2: Example of a remote sensing method applied to structural characterizations and rockfall assessment: frontal view of the suspected unstable cliff with a 10 cm resolution point cloud acquired by Terrestrial Laser Scanning (© IGAR UNIL) wrapped on a pre-existing 2 m resolution DEM from Aerial Laser Scanning (MNT-MO © GEO VS).