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An experimental method for the investigation of shallow landslide instability precursory signals using a semi-distributed optical fiber strain sensor

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Shallow landslides are land instability phenomena which endangers lives and property during intense precipitation events. Once activated, they can swiftly evolve into debris flows of destructive nature. After the identification of possible land instability, a proper monitoring system is to be designed, preferably characterized by an early warning module. Such systems are generally related to excessive costs which are often not justified considering the rather widespread nature of the phenomena and the induced damage that is expected. In this work, we present an attempt to develop a fiber-optic instability strain sensor based on an innovative low-cost interrogating technology, which would permit to evade the use of costly interrogators, often not feasible for field use. For the purpose, we carried out a series of controlled laboratory scale experiments where fiber optic sensors were positioned within a shallow uniform sand layer. Each one simulated the onset of a shallow instability in an artificial channel, instrumented with a rainfall sprinkler system. In order to investigate the drivers of initial instability signs and put the fiber optic sensor readings in relation to the ongoing processes, the experimental work incorporated additional sensing instruments: a TDR probe, a goeresistivity meter and videocameras. Experiments were carried out under various initial conditions as well as forcing precipitation of different intensity in order to explore how those affect the process. A clear difference between cases could be observed both visually and through the behavior of the fiber optic sensor in the terrain. Moreover, the sensing cable indicates first signs of instability with a time lag before actual collapse could be visually identified. The benefits of this particular system comprise its low cost with respect to conventional fiber optic sensor interrogators and thus lead to the possibility to incorporate numerous sensors at different points of interest. This result encouraged the progression of this work with further experiments and possible exportability of the system on field.