Geophysical Research Abstracts
Vol. 21, EGU2019-8957, 2019
EGU General Assembly 2019

Landslide Displacement Monitoring using Passive Radio-Frequency Identification Tags

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We introduce a new technique to monitor landslide surface displacements, using radio-frequency identification (RFID) passive tags [1]. Landslide ground deformation monitoring at a local scale requires accuracy, along with dense spatial and time resolution, and must operate in any weather conditions. There are already solutions available to track this motion, such as wire extensometers, differential GPS, optical laser, LIDAR, radar interferometers, or radar nodes. However, none of them offers at the same time a very low cost per point for dense monitoring, a cost-efficient station for studying small sites, and a continuous monitoring under difficult weather such as rainfall, fog, and snow. Previous RFID studies suggest that a dense network of passive RFID tags could be deployed on hectometer-scale landslides at low cost, to monitor 1D radial displacements with an accuracy of 1-2 cm in a variety of meteorological conditions [2, 3]

To test the performance of RFID, for five months, we monitored the displacements of 19 tags placed 5 m apart on a medium-sized landslide (Pont-Bourquin, Switzerland) and compared the results to those obtained with total station and extensometer data [1]. The RFID tracking, based on the observation of the phase-difference-of-arrival evolution, showed a better continuity and accuracy in time, compared to the wire extensometer. This was particularly true during rainfall or after a snowfall. In term of performances, the RFID technique reached a general accuracy of 1 cm, and 8 cm after a snowfall, at a distance up to 60 m between the moving tag and the fixed interrogator.

In conclusion, RFID displacement tracking appears effective for monitoring surface deformations on a landslide, with unpreceded spatio-temporal sampling, at a significantly lower cost than GPS or ground-based radar and with an overall 1-cm accuracy within a range of 60 m. It appears less sensitive to environmental conditions such as snowfalls compared to classic wire extensometers or optical methods. In the future, RFID tags could lead to new outdoor applications, such as on volcanoes or civil infrasctructure, and exploit their ability for sensing moisture, temperature or vibrations in addition to their displacement. Finally, the fast pace of technological developments in RFID should lead to considerable improvements to the technique in the near future.

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