

# Long term differential interferometry for early detection and warning of landslide hazards

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The increasing impact of man on the environment and urbanisation of areas susceptible to slope failures, coupled with the ongoing change in climate patterns will require a shift in the approaches to landslide hazard reduction. Indeed, there is evidence that landslide activity and related socio-economic losses are increasing throughout the world. Because of this and since urbanisation of hillslopes prone to failure will likely continue in the future, the prevention efforts and protection of new and existing developed areas via traditional in situ monitoring and engineering stabilisation works may not be considered economically affordable. Furthermore, in most cases ground control systems are installed post-factum and for short term monitoring, and hence their preventive role is limited. Considering the global dimension of slope instability problems, a more effective approach to landslide hazard reduction seems to be via exploitation of Earth Observation (EO) systems, with focus on long term monitoring, early detection and early warning. Within this scenario the application of space-borne synthetic aperture radar differential interferometry (DInSAR) is particularly attractive because of its capability to provide both wide-area and spatially dense information on surface displacements. Since the presence of slow deformations represents evidence of potential slope failure hazard, DInSAR can be used to provide a preliminary distinction between conditions of stability and instability. Furthermore, thanks to the regular revisit schedule of radar satellites and the millimetric precision of the advanced multi-temporal DInSAR measurements, such as the Permanent Scatterer (PS) technique (PSInSAR), a long-term monitoring of small displacements is feasible. We offer some practical examples to illustrate how, following the initial, regional scale assessment of ground deformations, advanced DInSAR methods can be applied to focus on those areas where there is a potential hazard and where more detailed investigations may ultimately be required. Although the identification of threshold conditions of relative stability or instability is difficult, the long term, regular monitoring from space offers a unique possibility for detecting precursory deformations associated with the initiation of instability. The PS derived information on the temporal evolution of deformations, and in particular on movement rates can also be of much value for the assessments of the severity of potential failures. Finally, it is believed that thanks to the wide-area coverage, regular schedule and improving resolution of space-borne sensors, the EO can help to foster the desirable shift from a culture of repair to a culture of awareness and prevention.