MONITORING SLOPE DEFORMATION BY MEANS OF SATELLITE-BORNE RADAR INTERFEROMETRY

Thomas Nagler and Helmut Rott
ENVEO, Environmental Earth Observation IT GmbH
Technikerstr. 21a, A-6020 Innsbruck, Austria.
Tel: +43 512 5074830, Fax: +43 512 5074839
E-mail: Thomas.Nagler@enveo.at

Abstract: Due to global coverage and regular repeat observation capability satellite-borne radar interferometry (InSAR) offers an efficient means for detecting and monitoring slope deformation. The methodological basis of InSAR for mapping displacements on the Earth's surface with millimetric precision is briefly reviewed, based on differential phase shifts in repeat-pass synthetic aperture radar (SAR) images. An important pre-condition for application of InSAR is temporal coherence of the radar backscatter signal. Whereas on surfaces with low vegetation and in built-up areas the radar phase is usually preserved over long time periods, the radar signal decorrelates rapidly in densely vegetated areas. This drawback can be overcome by using time series of repeat pass radar images if man-made or natural targets with stable backscattering phase are available. In forested areas stable targets are often completely missing. As example for InSAR application in these cases we report on the use of plate reflectors of 1m x 1m size, set up on a forested slope to monitor the landslide above a mountain village.

Examples on the application of InSAR to detect and map deformation of unstable slopes are presented. The satellite data base used for the analysis includes time series of SAR images from the European satellites ERS-1 and ERS-2, available since 1991, and data of the Advanced Synthetic Aperture Radar (ASAR) operating on Envisat, launched in March 2002. Various landslides, with movements of the order of centimetres per year were mapped in detail, and their temporal evolution over several years was analysed. The studied phenomena include mass wastes in high Alpine areas and landslides above traffic lines and inhabited areas. Interannual variations of slope motion were derived from multi-year time series of ERS SAR and ASAR data. The accuracy of the InSAR motion products was validated at selected sites in comparison to in-situ geodetic measurements. Possibilities and limits for applying the InSAR technique were studied. One limitation is that InSAR measures only the motion component in line-of-sight of the radar beam. In addition, for the application of InSAR in steep mountain terrain the radar look direction is important, because fore-slopes are strongly distorted. If the capabilities and constraints of SAR interferometry are adequately taken into account, it can be employed as an excellent tool for accurately mapping and monitoring surface displacement, an important indicator of slope stability. The InSAR method is of particular interest for regional surveys and for monitoring areas where few other data sources are available.