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Title of the Session: Monitoring of land subsidence and landslide areas on different characteristic fields for urban risk management by satellite-based geodetic techniques

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Summary

This theme refers to means to detect and monitor various surface movements over different characteristic surfaces using satellite-based geodetic techniques. Among the various remote sensing techniques, Satellite Radar Interferometry (InSAR) is one of the most effective methods. It is important to assess the capability of the InSAR technique on detecting deformations over the earth surfaces. Monitoring earth surface before or after deformation because of natural or manmade reasons, InSAR gives significant deformation knowledge showing on maps called interferograms.

Context

Active deformation zones occurring on the earth, continue to threaten the life in the present and the future, as they have in the past. The main correlated disasters are earthquakes and landslides that are the reason of most human loss. The geological and multi-disciplinary research related to these kinds of disasters that occurred in the early 20th century has gained further momentum with events that affect people's lives significantly. At the same time that technological advances continue, different kinds of studies are being developed. For example, any occurred landslide which is examined by its formation mechanism and stages is an important event that attracts experts from many scientific branches and social actors: experts in geological engineering, geomatics engineering, civil engineering, remote sensing, environmental engineering and local government. On the other hand, earth and its surface are subject to various internal and external forces produced by the complex earth dynamics and by gravitation as well. Most of the observable physical changes on the earth surface are the result of natural phenomena, whereas some of them arise from human activities, directly or indirectly.

Satellite SAR Interferometry (InSAR) is quickly advancing, as a technology not only for monitoring of long-term terrain movements but also for the mitigation of land subsidence and similar natural risks. The aim of this theme is to raise awareness for the need to determine and monitor land subsidence areas (caused by the decrease of groundwater levels), landslides areas caused by high snow or rain, flood areas and other surface movements which have the potential to cause substantive damage to the buildings and human life. The use of Satellite SAR Interferometry can be an important asset in this connection.

In light of this information, I will try to explain how to generate deformation and risk maps for disaster planning in urban and also vegetated areas using InSAR techniques. It is important to know, which satellites and images are suitable for this method, and what types and amount of deformations can be visualized for planning disaster risk reduction.

InSAR technique uses phase differences between two different SAR images over the same area of interest. Which means Radar interferometer is a measuring technique that composes a certain map of earth through using phase differences of two images that have already been obtained by radar. The interferogram that is composed by pixel base phase differences is a contour line map of distance between earth and radar satellite. The maps in question have a unique pixel density (~100 pixel/km^2) and ~1 cm linear at the direction of radar (Massonnet and Feigl, 1998). SAR (Synthetic Aperture Radar operates with microwave frequencies. This feature enables the system to operate, being able to take images of geometric and electrical features of night and day surface in all kinds of air condition (Rosen and et al., 1998). The applications conducted by means of InSAR provide a different perspective whilst the obtained information helps to ensure improved readability and understanding of earth's structure and evolution. However, classic InSAR technique is often limited by temporal and geometrical de-correlation. In this situation we need to use Advanced InSAR techniques which means InSAR time series.

Synthetic Aperture Radar Intereferometer (InSAR) analysis of time series data has become an important scientific tool due to the extensive use of areas for the observation of displacements that are earthquakes, volcanic events, landslides and water level changes on the Earth instead of conventional InSAR (Osmanoğlu, 2011). Time series analysis is a product of the interferometric phase measurements. However, they observe the displacement in case the movement of the radar wave is more than half length of radar. Therefore, the first analysis must be subjected to an unwrapping process. The reason for the analysis is to obtain a physically meaningful result from the differential interferogram (Agram, 2010). The unwrapping processes can eliminate uncertainties by using specific algorithms and filtering methods; which are Persistent Scatterer Interferometry (PSI) (Kampes, 2005.2006), the Stanford Method for Persistent Scatterers (StaMPS) (Hooper et al., 2004), Short Baselines Interferometry (SBAS) (Lanari, et al., 2007) and Small Temporal Baseline Subset (STBAS).

In summary, using satellite-based geodetic techniques has become an important tool in disaster risk reduction. Especially time series of InSAR data that become an indispensable method to investigate many types of surface deformation in the mm scale.

References for further reading:

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