Topic 5. Study and prediction of geohazards for environmental security of the European cross-boundary energy supply infrastructure

Natural hazards monitoring using spaceborne interferometry techniques

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The large scale of energy supply infrastructure and its cross-boundary character makes very difficult the process of accurate monitoring of stability of both the infrastructure and the supporting geomorphologic environment. Installing ground-based monitoring systems like GPS and inclinometers on such large areas will involve an apriori knowledge of areas of risk to choose the best local areas where the systems will be installed. Beside the complexity of installing and maintaining such a large network, experience shows that many areas considered safe won't be monitored because a decision to install the devices on the higher risk areas must be made.

Remote sensing comes as a natural alternative that can cover all the areas of interest, removing the need to apriori classify areas by risk levels. It will be shown that many areas considered safe from a geotechnical point of view were proved to have a high risk after remote sensing measurements were made.

The important information for establishing the risk of a disaster is not to monitor the disaster itself as it happens and can be seen using optical systems; it is rather to detect the ground instability or infrastructure deformation when these are in the elastic mode and no disaster happened yet. For this SAR (synthetic aperture radar) systems are very important because they are capable to measure with sometimes millimeter accuracy slow deformations that could build up and generate a natural (landslide, ground subsidence) or man-made disaster.

Therefore, remote sensing using SAR systems is an ideal tool for initial detection of risk and an optimal indicator for the areas where the ground-based monitoring systems should be installed. Also, remote sensing is a good indicator of risk where geotechnical work was done to improve infrastructure stability and after a short period of ground-based monitoring the area was deemed safe and the monitoring instrumentation was removed.

A number of such risk areas (new and consolidated from geotechnical interventions) detected with remote sensing will be presented. An area surrounding a waterdam was monitored in points indicated by geotechnicians to be of a high risk; also the waterdam itself was deemed safe, being monitored with elastometers, gravimeters and a few GPS stations, therefore remote sensing was considered useless. A number of TerraSAR-X acquisitions in High Resolution Spotlight mode were scheduled on the whole area (water dam and surrounding villages and mountain slopes) and were processed with InSAR (Interferometric Synthetic Aperture Radar) techniques. The results confirmed the potential of the SAR systems to measure the risks in known hazard areas and also to detect new and unexpected ones. A number of landslide activities affecting the water circulation in the lake and also the roads surrounding the area were detected and measured. A number of unexpected risks were detected; one was right on the waterdam, at the contact with the mountain slope, where a transversal motion (across the waterdam) was measured. A seismic fault was known to be nearby and InSAR proved that it is still active. Another area that exhibits motion measured by InSAR was a landslide that was seen to have regular features suggesting man-made structures. After a visit on the site it was clear that the area was of a known landslide affecting the waterdam structure where geotechnical stabilization work was done in the form of large concrete walls . Unfortunately, it was proved with InSAR that the concrete walls are also moving, increasing the load on the waterdam and therefore making the things worse.

The high resolution of the used SAR data (less than 1 square meter per pixel) makes it an ideal tool for detecting and monitoring very local deformation processes that can affect the energy support infrastructure. The periodic character of monitoring (11 days, 6 days with the future Sentinel mission) is superior to any periodicity of ground-based measurement or maintenance activities.