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Permafrost surface deformation and related hazards detection using InSAR technique in the Alpes de Haute Provence

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Radar interferometry (InSAR) is a measurement method using phase difference between two synthetic aperture radar (SAR) images from the same scene. The InSAR technique generates 2D displacement maps, called interferogram, allowing to detect and quantify target/radar distance variations between two acquisitions. Recent researches have shown that InSAR technique can be used to detect an quantify rock glacier deformation. Specific conditions are required to achieve reliable measurements of surface displacement : (1) short normal baseline component to avoid predominance of topography, (2) short temporal baseline component to minimize temporal decorrelation, (3) non-vegetated area and preferably free of snow cover.

The main objective of the project is to study the modification of permafrost as natural hazard using InSAR technique in the French Alps, especially in the Alpes de Haute Provence. Nowadays, the global warming or human activities have probably increased slope instabilities, debris flows or landslides risk. In 2006, an unimportant landslide occurred in the glacier du Berard. Nevertheless, permafrost phenomena – that might be situated in area at altitudes above 2400m asl – is sometimes close to human infrastructures. Consequently, making investigations and surveying becomes vital.

In this study, the detection of rock glacier, the quantification and validation of the observed surface movements as well as its temporal change are presented, using the InSAR technique with ERS-1 and ERS-2 SAR data to perform analysis at a regional scale. The database of original SAR images consists of 67 images (27 from ERS-1 and 40 from ERS-2). Therefore, the number of interferograms we could generate is given by the binomial coefficient C_{67}^{2}, which is the combination of 67 SAR images taken 2 by 2 without duplication, for a total amount of 2211. Taking into account that interferogram generation is time-consuming (4 hours each), and in order to select high quality interferograms under specific requirements, we use a particular process. First of all, the period from July to October appeared to be optimum for InSAR data acquisition because most parts of the rock glacier in that specific zone are free of snow at this time of the year. With this criterion, only 253 interferograms are selected. Finally, using normal baseline under a specific threshold this number is reduced to 20 interferograms.

We think that those results have the potential of establishing a permafrost map of the Alpes de Haute Provence and studying the derive surface displacements on creeping and unstable frozen slopes. Additional analyses of the relationships between permafrost, climate and mass movements – especially on snow cover characterisation using SAR data - are planned to improve our first intuitive selection method. Validation campaigns will also be carried out in the frame of the project.

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