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Subsidence Monitoring at X-Band using a Polarimetric Ground-Based SAR Sensor

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The Conca Potàssica Catalana (The Catalan potassic salt basin) is located in the so called Central Catalan Depression, within the Ebre River Depression. This basin is made of a great saline unit. The potash salts have been traditionally exploited since ancient times, being still an important mining activity in Catalonia. The Enrique mine, located in the city of Sallent, was under exploitation until 1974. This mine has a maximum depth of 260 metres and in 1954 a cavity of approx 120 meters high and 40 meters wide was found while mining works were being done. This cavity have been caused by water circulation and is located under the South-East part of Sallent, in the neighbourhood known as Barri de l'Estació, close to the Llobregat River. Water floods in 1957 and 1962 forced to abandon this part of the mine, filling up the cavity with saturated salty water.

During the 90s the strong subsidence caused damages in the structures of most of the buildings and some of them had to be demolished. The rest are still under continuous observation. The Catalan Administration started an investigation to identify, quantify and model the subsidence phenomena in this area [1]. Within this program a multiple set of techniques has been applied: topographic leveling, geological mapping, geophysic prospection, extensometric measurements, drilling, orbital DInSAR, etc. in order to evaluate the risk of collapse.

In 2003 the SAR group of the UPC, jointly with the ICC, started studying the geological behavior of the district applying DInSAR techniques to ERS1/2 acquisitions. A new collaboration between both two institutions, funded by the Institut Geològic of Catalunya (IGC), started at the end of June 2006 and finished in July 2007. The aim was to attempt to improve both the spatial accuracy and temporal sampling of the deformation in this area using the innovative Ground-Based SAR (GB-SAR) system developed at UPC [2]. The developed GB-SAR works at X-band, which is able to detect millimetric displacements of reference targets [3], and has polarimetric and interferometric capabilities. The system is able to monitor small areas without any revisiting time constraint in a perfect zero-baseline configuration. Besides, the parallel use of optical sensors provides precise ground-truth measurements for the assessment and validation of the results.

In this paper, the measuring campaign the Research Laboratory (RSLab) of the Universitat Politècnica de Catalunya (UPC) has carried out in the village of Sallent will be presented. At first the UPC GB-SAR sensor will be briefly described, where its special properties related to design constrains, structure, resolution and accuracy will be highlighted. A description of the test site features and the subsidence phenomenon taking place in the area of interest will be also included. The key-role played by the choice of the sensor position among all the possible locations will be also pointed out. Hence, the entire processing chain applied to PolSAR data monthly acquired at X-Band for approximately one year will be described. In order to exploit the high number of available dataset, a temporal average of the single-look images daily acquired by the GB-SAR will be performed. The variation of the refractivity index during a whole day of monitoring activity introduces spurious effects that prevent from averaging directly the data. For this reason a coherence-based technique for the ground-based atmospheric artifact removal [4] will be first applied. Reference points located within the scenario, corner reflector or permanent scatterers (PS), will be then used for the system drift compensation. Once atmospheric artefacts are compensated and polarimetric calibration is performed, the CPT [5] technique will be used for the estimation of deformation velocity of the area under observation. A first attempt to analyze the benefits that the use of PolSAR data might provide with respect to a single-polarization study will be also carried out. For this purpose, the criterion used for the selection of reliable pixels will be modified. Two possible strategies, based on the use of the highest coherent channel of scattering matrix for the retrieval of the deformation information will be proposed. The results obtained in the two cases will be compared with the deformation map retrieved using the classical CPT approach. Finally, the advantages provided by the polarimetric analysis will be pointed out.

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