MAPPING URBAN SUBSIDENCE WITH TERRASAR-X DATA BY PSI ANALYSIS

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INTRODUCTION

TerraSAR-X is the first high resolution radar satellite carrying X-band SAR system in space aims mostly to facilitate the research and application of terrain related phenomena with high precision and short revisit cycle compared with the ongoing medium resolution SAR system, i.e. ERS and ENVISAT[1]. SAR interferometry (InSAR) is supposed to be one of the major applications of the sensor since it provides a relative high resolution data with different imaging mode and incidence angle. Displacement monitoring would benefit much from the advantage of the repeat cycle of only 11days and from the high ground resolution of 1-3m in azimuth and 1.5-3.5 m in range depending on the acquisition mode and incidence angle. This high spatial resolution and short repeat interval allow studies of highly localized surface displacements with a dynamic temporal evolution that have previously suffered from temporal or spatial decorrelation [2]. Although temporal decorrelation must be expected to be more problematic at X-band compared to longer wavelengths (C- or L-band), the high-bandwidth data will be more suitable to Permanent Scatterer (PSI) type analyseis [3] since more coherent target could be identified in high resolution data even in case of long time intervals. Thus, with TerraSAR-X data it is expected that non-uniform deformation of man made infrastructure such as bridges, highways and single high buildings, can be detected in detail by PSI analysis. In this contribution we present the result of urban subsidence and infrastructures deformation mapping with TerraSAR-X data by PSI processing and comparison of its properties to those of C-band interferograms. The paper will describe the first experimental PSI analysis with strip mode TerraSAR data for regional subsidence mapping as well as single infrastructures deformation investigation in China.

METHODOLOGY AND RESULTS

The area selected for this purpose is the city of Tianjin, located in the center of the North China Plain, which have been suffering serious subsidence due to long term groundwater pumping. The TerraSAR-X data sets used were provided by Infoterra Asia Pacific (EADS-China). The comparable ENVISAT data sets come from the ESA Project Cat.1-3863. The study area chosen is mainly suburban, but there are also some rural outskirts to compare with.

In the PSI data processing different types of pixel selection methods have been used, such as sub-look correlation and amplitude stability[4,5]. The joint application of these methods allowed the identification of different types of targets, from point-wise to distributed targets. Images pairs with space baseline smaller than 300 meters have been combined for interfromgrams stack generation. Totally 17 scenes TerraSAR-X data, acquired in the period from Mar to Oct 2009, with 3m range resolution have been gathered for the performing of PSI analysis. Meanwhile we

collected the ENVISAT data for comparison[6]. The average subsidence velocity map with an extent of 30*50 km have been generated from two data sets by PSI processing and the deformation history have been obtained by time series analysis of TerraSAR-X data. The results gives a detailed description of the progressive subsidence since the ground water withdraw is in a fast stage during the period of data acquisition. The test results show that the high resolution of TerraSAR-X SAR images can dramatically increase the PS density, especially in the built-up areas. Subsidence of the individual objects like buildings, street lamps and the linear infrastructures like high speed railway can be detailed monitored.

Comparison between both datasets shows the very similarity on the space changes and temporal evolution of the subsidence, i.e. the maximum subsidence areas are found in the same places and with similar rates. The main differences are highlighted on particular deformations that can be detected with TerraSAR-X, due to the high PS density, and can not be seen with ENVISAT data. For instance some buildings that were hardly identifiable in the ENVISAT results are clearly seen with TerraSAR-X. For well understand the better resolution for deformation mapping of individual infrastructure, the deformation of high speed railway have been compared between two data sets. The comparison result demonstrates the capability of TerraSAR-X data for localized infrastructure monitoring for its advantages of dense PS sampling and high temporal frequency. While the ENVISAT data is more suitable for regional investigation since its wide coverage and medium resolution.

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