DEM OF THE VENETO PLAIN BY ERS2-ENVISAT CROSS-INTERFEROMETRY

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INTRODUCTION

Digital Elevation Models (DEMs) of flat lowlying coastlands are becoming even more important for environmental risk analyses, for example the development of effective plans for flooding protection.

The need of information at high spatial resolution over very large areas, of the order of 100×100 km^2, practically precludes the use of traditional methods (e.g., leveling and DGPS) due to their intrinsic limitation in covering wide zones and reduces the possibility of using Lidar because of its high cost. Starting from the last decade, space-borne radar sensors have been used extensively for this purpose. The most known is the SRTM (Shuttle Radar Topographic Mission) DEM which covers most of the land area between ±60° latitude (Rabus et al., 2003). This DEM was generated using single-pass interferometry and is widely available at 3-arc-seconds. In this work, we present the results obtained for the Veneto plain, Italy, using the space-borne SAR (Synthetic Aperture Radar) cross-interferometry (Wegmüller et al., 2009).

METHODS

Recent dedicated ERS2–ENVISAT tandem missions offer a unique opportunity to apply ERS–ENVISAT cross-interferometry (EET CInSAR) for the generation of precise DEM in relatively flat areas given the short 28 min repeat-pass interval and the 1.5–2.5 km long baseline. Four pairs of images acquired in winter 2007-2008 and 2008-2009 are processed. For each image pair, interferometric processing consisted of co-registration at sub-pixel level, spatially adaptive azimuth and range common band filtering considering the baseline and frequency offset as well as the azimuth spectra effects, generation of the interferograms and removal of topographic phase.

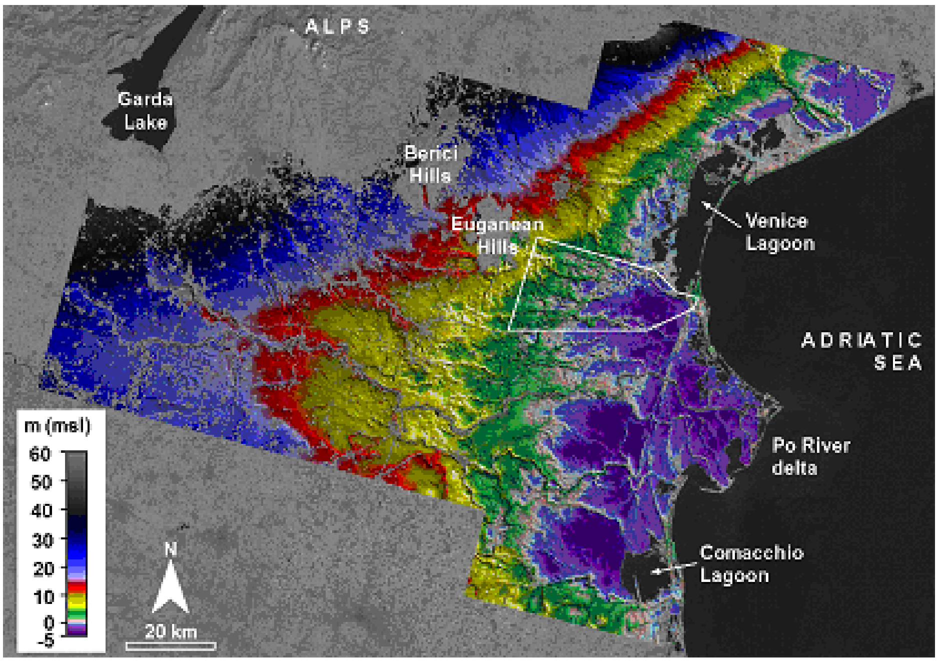

Figure 1 – DEM of the Veneto plain obtained ERS2-ENVISAT cross-interferometry.

All images were finally geocoded to 20×20 m^2 pixel size and shown in cartographic projection. The final DEM is derived by averaging the four DEMs obtained by each pair. Lastly, the DEM was calibrated a-posteriori using a few kinematic DGPS surveys carried out for the purpose.

RESULTS AND DISCUSSION

The investigated area extends from the mouth of the Tagliamento River to the north, that of the Reno River southward, and the Garda Lake 150-km inland from the Adriatic coastline. The elevation ranges between +60 m and -5 m above mean sea level (Fig. 1). The ERS2–ENVISAT DEM reveals impressively the geomorphological features crossing the plain, such as the beach ridges and paleo-river beds elevating above the surrounding lowlying interdistributary areas. However, the DEM coverage achieved was not complete. Decorrelation prevented the application of the technique over water, forests, urban areas, and elevated zones such as the Euganean and Berici Hills.

For the eastern territory of the Adige-Euganeo Water Reclamation Authority, Figure 2 compares the cross-interferometry outcome and the SRTM DEM oversampled to the same 20-m resolution. The picture highlights the significant less noise that characterizes the former with respect to the latter. The EET CInSAR has a significantly higher sensitivity than SRTM and consequently fine structures are better visible. The ERS2–ENVISAT DEM is compared in Figure 2c with the elevation model of a kinematic DGPS survey carried out as of 2002 in a peat farmland at the margin of the Venice Lagoon. It is well visible how cross-interferometry is able to capture the major elevation changes, with the DGPS outcome that is generally located within the ±0.2 m standard deviation characterizing average DEM. Conversely local variations, such as the road embankment at B site, are underestimated.

The DEM is currently under improvement by adding discontinuous localized anthropogenic features, e.g. river embankments, road banks etc., that can not be detected by EET CInSAR. This last step will allow to produce a final outcome that will be effectively used by the river and land reclamation authorities managing the area.

ACKNOWLEDGEMENTS

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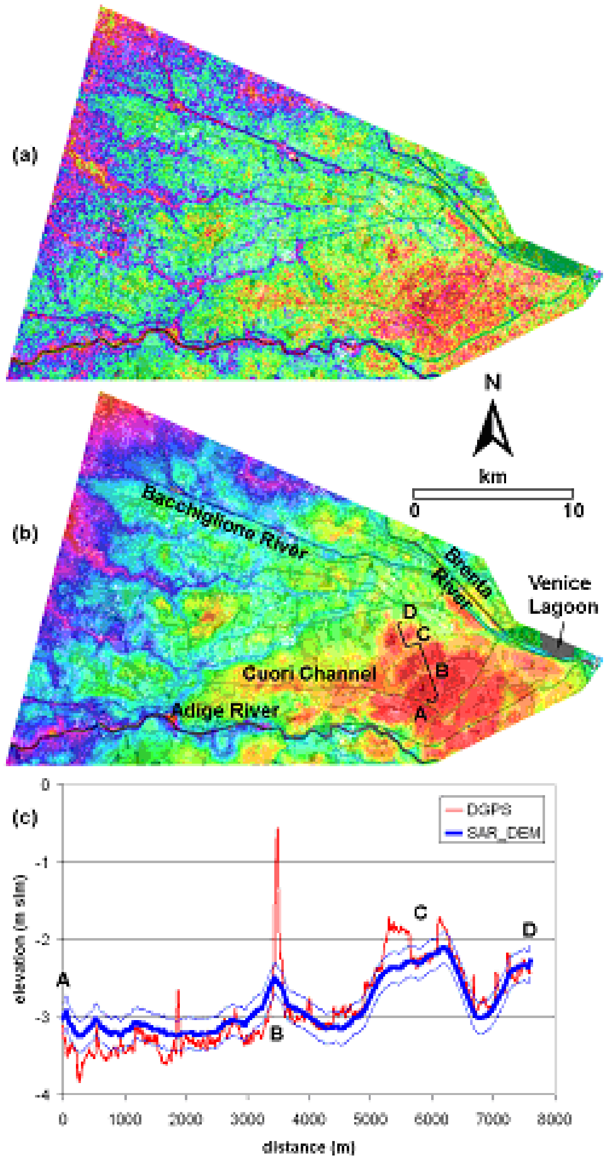

Figure 2 – (a) SRTM DEM and (b) DEM from ERS2-ENVISAT cross-interferometry for the eastern territory of the Adige-Euganeo Water Reclamation Authority. The trace of the area is shown in white in Figure 1. One colour cycle (e.g., from red to red) corredpond to a variation of land elevation equal to 10 m. (c) Comparison of ground elevation along profile A–D of (b) as derived from a kinematic DGPS survey carried out in 2002 and the ERS2-ENVISAT DEM.The thick and thin blue lines represents the average and the standard deviation, respectively.

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