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# Large networks of artificial radar reflectors to monitor land subsidence in natural lowlying coastal areas

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Deltas, lagoons, estuaries are generally much prone to land subsidence. They are also very sensitive to land lowering due to their small elevation with respect to the mean sea level, also in view of the expected eustatic sea rise due to climate changes. Land subsidence can be presently monitored with an impressive accuracy by Persistent Scatterer Interferometry (PSI) on the large megacities that are often located on lowlying coastlands, e.g., Shanghai (China) on the Yangtze River delta, Dhaka (Bangladesh) on the Gange River delta, New Orleans (Louisiana) on the Mississippi river delta. Conversely, the land movements of the portions of these transitional coastlands where natural environments still persist are very challenging to be measured. The lack of anthropogenic structures strongly limits the use of PSI and the difficult accessibility caused by the presence of marshlands, tidal marshes, channels, and ponds yield traditional methodologies, such as levelling and GPS, both time-consuming and costly. In this contribution we present a unique experimental study aimed at using a large network of artificial radar reflectors to measure land subsidence in natural coastal areas. The test site is the 60-km long, 10-15 km wide lagoon of Venice, Italy, where previous PSI investigations revealed the lack of radar reflectors in large portions of the northern and southern lagoon basins (e.g., Teatini et al., 2011). A network of 57 trihedral corner reflectors (TCRs) were established between the end of 2006 and the beginning of 2007 and monitored by ENVISAT ASAR and TerraSAR-X acquisitions covering the time period from 2007 to 2011 (Strozzi et al., 2012). The application has provided general important insights on the possibility of controlling land subsidence using this approach. For example: (i) relatively small-size (from 0.5 to 1.0 m edge length) and cheap (few hundred euros) TCRs suffice to be clearly detectable from the radar sensors because of the low backscattering intensity of the surrounding area; (ii) the network must be established resembling a sort of levelling benchmark network, i.e. with the TCRs placed keeping to a value of about 1.0-1.5 km the maximum distance between the TCRs or between an "artificial" and the adjacent "natural" reflectors to reliably resolve the radar phase ambiguities in the presence of atmospheric artifacts. Moreover, our experiment provided new information in order to improve the knowledge of the regional and local processes acting in the Venice Lagoon. We found that the northern basin of the lagoon is subsiding at a rate of about 3-4 mm/yr, while the central and the southern lagoon regions are more stable. At the local scale, i.e., the scale of the single salt marshes, significant differences have been detected depending, for example, on the nature and the architecture of Holocene deposits (Tosi et al., 2009).

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