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Monitoring natural and anthropogenic subsidence in the northern Adriatic area by space and terrestrial techniques.

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At local to regional scales, land-surface deformations (subsidence or uplift) can be driven by numerous effects, e.g. natural and/or anthropogenic fluid withdrawal, river and coastal erosion and deposition, and landslides. These deformations are in conjunction with deformations caused by loading effects due to atmospheric pressure variations, continental water storage variations and oceanic circulation, as well as by solid Earth tides. It is well known that the northern Adriatic area, including the eastern Po Plain, is affected by natural long-term subsidence. This has been greatly enhanced, during the second half of last century, by anthropogenic factors such as the overpumping of water and gas from the underground reservoirs. Induced subsidence rates, with peaks up to 60-70 mm/yr, were recorded in the 1970's in the Ravenna area on the Adriatic coast. The adoption of groundwater control policies since the beginning of the1980's has resulted in a noticeable decrease in the subsidence rates during the last two decades. Vertical crustal movements can be monitored to high accuracy by space geodetic techniques such as GPS and InSAR, the combination of the two allows us

to measure space and time-continuous deformation. The GRACE mission data can be used to study, among other phenomena, continental water variation, including groundwater. High accuracy terrestrial gravity data such as those collected continuously by superconducting gravimeters and episodically by absolute gravimeters are also valuable for monitoring both secular and seasonal water-level variations in aquifers. We present a network encompassing northeastern Italy, which extends from the Apennines to the southeastern Po Plain and, along the Adriatic coast, to the Venice area and Trieste. Our initial results have primarily concentrated on parameterizing the land subsidence by comparing and combining GPS, terrestrial gravity, local environmental parameters and InSAR, We update the time-series and extend the analysis to include GRACE gravity field observations in an effort to better understand the process of subsidence.