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Land subsidence in the Yangtze River Delta, China revealed from multi-frequency SAR Interferometry

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Land subsidence is a major worldwide hazard, and its principal causes are subsurface fluid withdrawal, drainage of organic soils, sinkholes, underground mining, hydrocompaction, thawing permafrost, and natural consolidation. Land subsidence causes many problems including: damage to public facilities such as bridges, roads, railroads, electric power lines, underground pipes; damage to private and public buildings; and in some cases of low-lying land, can increase the risk of coastal flooding from storm surges and rising sea-levels. In China, approximately 48600 km2 of land, an area roughly 30 times of the size of the Greater London, has subsided (nearly 50 cities across 16 provinces), and the annual direct economic loss is estimated to be more than RMB 100 million (∼$12 million). It is believed that the Suzhou-Wuxi-Changzhou region within the Yangtze River Delta is the most severely affected area for subsidence hazards in China.

With its global coverage and all-weather imaging capability, Interferometric SAR (InSAR) is revolutionizing our ability to image the Earth's surface and the evolution of its shape over time. In this paper, an advanced InSAR time series technique, InSAR TS + AEM, has been employed to analysed ERS (C-band), Envisat (C-band) and TerraSAR-X (X-band) data collected over the Suzhou-Wuxi-Changzhou region during the period from 1992 to 2013. Validation with precise levelling and GPS data suggest: (1) the accuracy of the InSAR-derived mean velocity measurements is 1-3 mm/yr; (2) InSAR-derived displacements agreed with precise levelling with root mean square errors around 5 mm. It is evident that InSAR TS + AEM can be used to image the evolution of deformation patterns in the Suzhou-Wuxi-Changzhou region over time: the maximum mean velocity decreased from ∼12 cm/yr during the period of 1992-1993 to ∼2 cm/yr in 2003-2013. This is believed to be a result of the prohibition of groundwater use carried out by Jiangsu provincial government.

The combination of multi-frequency SAR datasets allows a long record (∼20 years) of historic deformation to be measured over a large region. Ultimately this should help inform land managers in assessing land subsidence and planning appropriate remedial measures.