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Monitoring and characterising slow-moving landslides using multiple SAR techniques

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The Three Gorges region, China, has long suffered from frequent, widespread and varied landslide hazards. Over the last decade, the Three Gorges dam has also created a 600 km long reservoir with a bi-annual fluctuating water-level which has connected new slopes to the Yangtze River and reactivated ancient landslides. InSAR has been frequently used to detect actively deforming slopes, although the well-known issues of temporal decorrelation, geometrical distortion and atmospheric water-vapour can often make time-series analysis difficult without ground data verification. Particularly in the Three Gorges area, the dense orange-tree vegetation and steep slopes pose a challenge for applying InSAR techniques beyond the most populated (i.e. more urban) areas. This study therefore attempts to extend remote slope monitoring and characterisation to non-urban areas within the Three Gorges (along the 60 km stretch between Badong and Zigui).

A significant amount of SAR data from three different sensors (TerraSAR-X, Envisat and COSMO SkyMed, in various modes) have been analysed using multiple SAR techniques (InSAR, InSAR time-series and pixel-offset measurements). Despite the shorter wavelength, the faster repeat cycle and higher spatial resolution of the TerraSAR-X Spotlight images best highlight the landslide boundaries along with Line-of-Sight (LOS) measurements in the order of cm's over the 11-day period between acquisitions. Whilst significant difficulties have been found with InSAR time-series techniques, the use of high resolution SAR data with sub-pixel offset tracking techniques has proved successful, and can distinguish between horizontal and LOS displacements. The InSAR signals, combined with the time-series measurements from pixel-offset techniques can firstly help validate both datasets without ground data. Secondly, they have been used to provide a first-order characterisation of the landslide mechanism and can be compared with the results from simple limit-equilibrium landslide models run under different hydrological scenarios.

Following recent acknowledgement about the increased landslide hazard after reservoir inundation, continued widespread monitoring could be achieved using frequently acquired, high resolution SAR imagery in this challenging terrain, ultimately to help mitigate the negative effects on local populations.