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Detecting and characterising active landslides in the Three Gorges Region (China) using a SAR sub-pixel offset time-series technique.

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The Three Gorges region in China is well-known to have many active landslides, with some large landslides reactivated over the last decade by the fluctuating Three Gorges reservoir. InSAR techniques have often been employed to provide a regional assessment of surface movements (including landslides), although there are significant limitations in the Three Gorges region. The very dense orange-tree vegetation and steep slopes pose a challenge for applying InSAR techniques beyond the most populated (i.e. more urban) areas and when non-linear slope movements exceed the maximum displacement gradient of InSAR, the technique becomes incapable of providing accurate estimates of the displacement magnitude.

A significant amount of SAR data from three different image modes (TerraSAR-X Spotlight, TerraSAR-X Stripmap and ENVISAT Stripmap) have been analysed using both InSAR and pixel offset techniques. Since the InSAR displacement gradient and the quality of pixel offset measurements are dependent on the resolution and wavelength of the SAR sensor, it is interesting to compare the capabilities of various image modes/sensors for monitoring landslides in densely vegetation regions.

Corner reflectors located within some landslide boundaries provide a very consistent radar return allowing precise sub-pixel offset measurements to be obtained. Other natural point-like targets with high correlation coefficients can also be used in areas without corner reflectors, allowing us to extend measurements to a 35 km stretch of the Yangtze River and over a 4 year period for the longest series of SAR images. The range offsets for one particular landslide demonstrate how a period of fast (cm/day) movements could only be measured using sub-pixel offset measurements with high resolution SAR imagery since they exceed the spatial displacement gradient for reliable InSAR analysis.

With sub-pixel offset techniques also capable of measuring displacements for the 2-dimensions of the SAR imagery (in range and azimuth directions), it is possible to estimate vertical and horizontal movements to characterise the likely landslide failure mode. Displacement time-series curves from sub-pixel offset techniques can also be compared with potential triggering factors such as rainfall, reservoir drawdown and seismic activity to help interpret landslide failure mechanisms. Combining the regional detection of active landslides with site-specific characterisation of individual landslides should ultimately be used to determine appropriate remedial measures and protect the infrastructure/communities built within the boundaries of active landslides.