Monitoring ground surface displacement in the Three Gorges Area, Dangxiong-Lhasa and Jiangsu Province Areas

Mulller, Jan Peter[1]; Zeng, Qiming[2]; Zhang, Jingfa[3]; Li, Zhenhong[4]*

[1]UNITED KINGDOM; [2](1) Institute of Remote Sensing and GIS, Peking University, CHINA; [3](3) Institute of Crustal Dynamics, China Earthquake Administration, CHINA; [4]School of Geographical and Earth Sciences, University of Glasgow, UNITED KINGDOM

Research within the project has addressed the objectives set to improve SAR processing for landslide and earthquake hazards, using both differential interferometry and subpixel correlation with improved DEMs generated from new sources of spaceborne data. For Differential Interferometry (DInSAR), the Peking University (PKU) Institute of Remote Sensing and GIS group led by Prof. Zeng has developed and distributed worldwide the Peking University Multi-mode SAR Interferometric Processing Kit (PUMSIP) based on the open source software package ROI_PAC (developed by JPL/Caltech) for processing ENVISAT Wide Swath mode ASAR data (Liang et al., 2012a,b). More than ten research groups worldwide have been using this software. Research has also been carried out on water vapour correction for DInSAR processing using combined numerical weather prediction NWP model output fused with WV derived from MERIS (Xiai et al., 2012). For subpixel correlation, Dr XiaoFan Li working with the UCL group led by Prof. Jan-Peter Muller and Prof. Yong-Hong Zhao of PKU Dept of Geophysics has assessed the potential of subpixel correlation using the open source Cosi_Corr (ENVI plugin) with the DLR-Infoterra TerraSAR-X SLC data. (Li et al., 2011) discuss the exciting results, which show deformation at the level of a few mms/11 day before, during and after a landslide took place. Hayley Larkin at the UCL group also investigated the potential of ICESat-GLAS lidar altimetry heights for assessing the accuracy of the ASTER GDEM & SRTM product along with generating and assessing an ALOS-PALSAR L-band interferometric DEM. UCL showed that ASTER had an accuracy of 0.98}12.77m, SRTM-C of -0.57}6.31m, SRTM-X of -0.02}7.16m whereas the ALOS-PALSAR was 21.91}42.44m. ASTER and SRTM showed best agreement with the centroid of the ICESat waveform echo whereas PALSAR showed the best results for the lowest echo waveform. The Glasgow Space Geodesy Research Group led by Dr Zhenhong Li has been active in employing Small Baseline InSAR time-series and SAR Pixel Offset techniques to monitor landslides in the TG region. Peng Liu has demonstrated the use of Small Baseline InSAR for the time period from 2003-2011 to be able to monitor deformation rates of 10-15mm/yr in Badong county (Liu et al., 2011). Early indications are that the re-activation of landslides is due to water level changes associated with the Three Gorges dam reservoir emplacement and seasonal rainfall patterns. Andrew Singleton has used three different sensors with different wavelengths (Envisat, TerraSAR-X and COSMO SkyMed) to identify active landslides along a 60 km stretch of the Yangtze River. The Remote Sensing and Numerical Simulation Group at the Institute of Crustal Dynamics, China Earthquake Administration (ICD, CEA), led by Prof. Jingfa Zhang, has been monitoring the slow deformation of the Dangxiong-Yangbajing fault (Li et al., 2012 a, b) in Tibet and ground subsidence of Suzhou area (Liu et al., 2012). The group is mainly concerned with the design and building of a monitoring network covering the fault zone through a combination of 15 corner reflectors with stronger natural-reflected points, and analyzes error contributions to InSAR process of earthquakes in Tibet related to Dangxiong earthquakes. Different InSAR algorithms for time series analysis have also been applied to monitoring subsidence in the Suzhou areas due to over-pumping of groundwater. They evaluate the reliability of InSAR in monitoring ground subsidence by comparing the results of different methods based on other measurements and hydrogeology data. 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三峡库区、当雄、拉萨和江苏省的地表形变监测

曾琪明（1），Jan-Peter Muller（2），张景发（3），李振洪（4）
（1）遥感与地理信息系统研究所，北京大学，北京100871，中国;
（2）Mullard Space Science Laboratory, Department of Space and Climate Physics, University College London, Holmbury St Mary, Surrey RH5 6NT, UK
（3）中国地震局地壳应力研究所，北京100085，中国
（4）School of Geographical and Earth Sciences, University of Glasgow, Glasgow G12 8QQ, UK

该项目的研究旨在利用差分干涉SAR技术和亚像元相关技术改善SAR处理在滑坡和地震灾害中的应用，同时提高从新的星载数据源生成DEM的精度。

在差分干涉技术方面（DInSAR技术），北京大学遥感与地理信息系统研究所的曾琪明教授带领的团队基于开源的软件包ROI_PAC（由JPL和加州理工学院开发）开发并向全世界发布了北京大学多模式SAR干涉处理工具包（PUMSIP）用于处理ENVISAT宽幅模式的ASAR数据（Liang et al., 2012a,b）。在全世界，已经有超过十个研究小组一直在使用该软件。同时，研究组将从数值天气预报中数值预报模式得到的输出结果与MERIS水汽产品融合对DInSAR进行了水汽矫正。

在亚像素相关性计算研究方面，李小凡博士和与她合作的由Jan-Peter Muller教授带领的伦敦学院大学（UCL）小组以及北京大学地球物理系的赵永红教授利用DLR-Infoterra Terra SAR-X 的SLC数据，通过开源的Cosi_Corr软件（Envi 插件）计算评估了亚像素相关性的应用潜力。结果表明滑坡辐射、发展的不同阶段存在每个观测周期（）11天）几个毫米的形变，这令人振奋，UCL的Hayley Larkin研究了利用ICESat卫星星载地学激光测高系统（GLAS）得到的结果来评估ASTER GDEM、SRTM产品和ALOS-PALSAR（L波段）生成DEM精确性的可能性。结果表明ASTER产品精度为0.98±12.77m，SRTM-C为-0.57±6.31m，SRTM-X为0.02±7.16m，ALOS-PALSAR为21.91±42.44m。ASTER 和SRTM的结果表现出和ICESat回波波形重心的一致性，而PALSAR与ICESat的最低回波最接近。

由李振洪博士领导的格拉斯哥空间大地测量小组一直致力于采用小基线InSAR时间序列和像素错位技术监测三峡库区山体滑坡的研究。刘鹏已经证明在2003到2011年期间，使用小基线InSAR技术可以监测巴东县的形变，形变率为10-15毫米/年。早期迹象表明山体滑坡的重新活跃是由于水位的变化，后者和三峡大坝水库的建设和季节性降水相关。 Andrew Singleton曾经使用具有不同波长的三个传感器（Envisat, TerraSAR-X 和 COSMO SkyMed）来识别沿长江60km路段中活跃的山地滑坡。

由张景发教授带领的中国地震局地壳应力研究所的遥感和数值模拟研究小组一直在监测西藏的当雄-羊八井地区的地表缓慢变形（Li et al., 2012 a, b），以及苏州地区的地面沉降（Liu et al., 2012）。该小组主要致力于设计和建立一个覆盖断裂段的监测网络，此网络通过将15个角反射器和较强的自然反射目标相结合，并且分析西藏当雄地震对InSAR处理的误差影响。研究小组利用不同的时间序列分析算法来监测苏州地区由于地下水过度抽取造成的地表沉降。他们通过与其他测量方法和水文数据进行比较来评估InSAR监测地表沉降的可靠性。

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