LANDSLIDE IDENTIFICATION, MOVEMENT MONITORING AND RISK ASSESSMENT USING ADVANCED EARTH OBSERVATION TECHNIQUES

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List of Principal Investigators (PIs)

Topic Nr.	PIs	Title
32365_1	*Dr. J. Sousa Joaquim,* *Prof. Fan Jinghui*	***Landslide and ice movement identification, monitoring near typical glacier lakes in Tibet using advanced earth observation techniques***
32365_2	*Dr. Perski Zbigniew,* *Dr. Liu Guang*	***Monitoring landslides movement over rugged mountain area integrated with multiband SAR and LIDAR***
32365_3	*Dr. Benni Thiebes,* *Dr. Bai Shibiao*	***Spatio-temporal landslide identification and activity assessment for hazard and risk investigations in Longnan region, Northwest China***
32365_4	*Dr. Stefano Salvi,* *Prof. Lixin Wu*	***Collaborative Monitoring of Multiple Geohazards over Traditional Heavy Industrial Region in Northeast China with Multi-source Remote Sensing Data***

EXECUTIVE SUMMARY

China has been affected by some of the world's most serious geological disasters and experiences high economic damage every year. Geohazards occur on remote and highly populated areas. Therefore, the greatest benefits of modern remote sensing data are their wide spatial and temporal coverage which allow a detailed reconstruction of past events and allow to monitor currently occurring phenomena. The proposed project aims to carry out an extensive exploitation of available remote sensing data and methods to evaluate their importance for various geohazards, with emphasis to landslide hazard, risk management and disaster prevention. This includes the detailed documentation of landslides occurrences for the past decades and the analysis of current movement trends which are required to predict future conditions. For the mapping of landslides and other geohazards and the evaluation of their activity, SAR data and multi temporal SAR interferometry and SAR tomography and high-resolution image matching, data modelling and assimilation technology will be extensively used. The proposed research is going to explore various areas and various geohazard problems including:

- Surface deformation of the mountain slopes and glaciers of the Tibet plateau;
- the geohazards in the Longnan area, one of the four most serious landslide and debris flow prone regions in China;
- Various areas in China and Poland to study landslide movement evidence of landslide using multiband SAR and LIDAR techniques;
- Subsidence, landslides, ground fissure and building inclination studies in the Benxi-Anshan-Shenyang-Fushun (BASF) region of China.

ABSTRACT 32365_1: "Landslide and ice movement identification, monitoring near typical glacier lakes in Tibet using advanced earth observation techniques"

European Principal Investigator	***Chinese Principal Investigator***
Dr. J. Sousa Joaquim (Universidade de Trás-os-Montes e Alto Douro,Portugal)	Prof. Jinghui Fan (China Aero Geophysical Survey & Remote Sensing Center for Land and resources,CHINA)

Climate change in the Tibet plateau and its surrounding mountains manifests itself in very tangible ways, all of which affect water cycle variability from this region (sometimes referred to as the 'water tower' of Asia), and through the water cycle also affects large human populations downstream.Landslides, ice slides, and glacial lakes outburst floods (GLOF) are all remarkable geohazards affected by the climate change in the Tibet plateau. In the area near glacier lakes, landslides, ice slides, and GLOF are usually interrelated. Monitoring the surface deformation of the mountain slopes and glaciers will give us basic information to understand these geohazards and make risk mitigation. Furthermore, the valuable information will improve the research level on climate change in Tibet plateau.

The aim of the project is to establish a technique system based on advanced earth observation techniques and to evaluate the ability of the system for geohazards management focusing on landslide, ice slide, and glacial lakes outburst floods (GLOF) in Tibet under the cooperation between the team members.

There are three objectives to achieve the goal of this research work. Firstly, a technique system will be established mainly based on multisource satellite SAR and optical sensors images. Advanced methods should be researched and improved for the rugged and cold areas where glacial lakes exist. For example, time series InSAR, pixel tracking and stereo measurement are all important parts for the technique system. Secondly, the methods would be applied for glacier movement, ice slide, and landslide monitoring in different types of glacier areas, such as oceanic, subcontinental and continental glacier areas. Finally, the ability evaluation of the technique system should be carried out focusing on landslide, ice slide, and GLOF risk management in Tibet.

The research work has been funded by China Geological Survey. The period of the fund is from Jan. 2016 to Dec. 2018, and the project name is "Comprehensive remote sensing survey on glaciers change and geohazards about glacial lakes outburst floods (GLOF) in Tibet". China's study of the region now includes remote sensing programs using land-resource, environmental, and meteorological satellites, and various international satellites as well.

ABSTRACT 32365_2: "Monitoring landslides movement over rugged mountain area integrated with multiband SAR and LIDAR"

European Principal Investigator	***Chinese Principal Investigator***
Dr. Perski Zbigniew (Polish Geological Institute - National Research Institute,POLAND)	Dr. Guang Liu (Institute of Remote Sensing and Digital Earth,CAS,CHINA)

This project will focus on study the movement evidence of landslide using multiband SAR and LIDAR technique. Landslides are catastrophic phenomena for those who live in landslide-prone areas. In general landslides occur on steep, unstable slopes. The triggering of catastrophic landslide movement is usually asociated with intense and extreme rainfalls. However, before catastrophy there is always an evidence that particular landslide remains or became active. This kind of movement may help the local authorities to make decision and assess the hazard degree of the area.

SAR interferometry is an effective remote sensing technique for surface movement monitoring, and it has been successfully used in many areas especially for subsidence monitoring, for SAR could penetrate the cloud and fog, it is very useful for landslides movement during raining season. LIDAR is an optical remote sensing technology that can measure the distance of the target to the sensor by illuminating the target with laser; it is common used for high resolution and high accuracy topography mapping, by a repeat-visit of the landslide, the movement could be obtained as well, but the terrestrial lidar monitoring is always depends on the weather situation. So the integration of these two methods is considered in this study for a better performance in landslides monitoring.

Since landslides commonly happened on rugged mountain area, these areas are often difficult to monitor with InSAR technique due to layover, foreshortening and shadow, in addition, rugged topography cause a big challenge in compensating residual topographic phase even with accurate DEM. The common method used here is polynomial based coregistration method. However, it doesn't not work well in mountain area. For the project purposes a new attempt including external DEM assisted and local optimum criteria based SAR image coregistration methods will be developed. Moreover, in order to improve the time series analysis technique and make it applicable to the mountain area many additional improvements of SAR interferometric technique will be tested: a multi criteria stable point targets selection method, and DEM-based network construction method, offset track method, orbit reestimation method, precise CR positing method and CR peak extracting method. The ground GPS data will be used for validation. And for LIDAR, it will be used to obtain the high resolution and high accuracy DEM for selected areas and used to measure surface displacements for validation.

In this study we will use sensors of SENTINEL, ENVISAT ASAR, ALOS PALSAR and TerraSAR-X for comparison in the test site. They will be used for independent and possible combined validation for the derived landslides movement as well.

This research work is funded by the 3 years International S&T Cooperation Program and a 5 years National Natural Science Foundation of China project. It has also support of Polish Ministry of Science and High Education within Poland-China bilateral cooperation.

ABSTRACT 32365_3: "Spatio-temporal landslide identification and activity assessment for hazard and risk investigations in Longnan region, Northwest China"

European Principal Investigator	*Chinese Principal Investigator*
Dr. Benni Thiebes (Institute for Applied Remote Sensing EURAC research,Italy)	Dr. Shibiao Bai (School of Geography Science, Nanjing Normal University,CHINA)

China has been affected by some of the world's most serious geological disasters and experiences high economic damage every year. Especially given the vastness of the Chines country and remoteness of some areas, the greatest benefits of remote sensing data are the wide spatial and temporal availability which allow a detailed description of landslide histories even of remote regions. Existing landslide inventories are rarely complete because in most cases data sources (e.g. aerial photographs, spatial images, ground-based observations) are not available to the scientists, which hinders an effective use within landslide risk management. In particular, synthetic aperture radar interferometry (InSAR) has become increasingly popular over the last years because of the availability of high resolution data of slope movements for large areas. The benefits of satellite-based InSAR to detect and monitor deep-seated and slow-moving landslides have already been analysed within the frame of several research projects. However, it was not always possible to validate these to extensive ground-based observations. In addition, we propose to use optical satellite images for mapping shallow debris flows in order to overcome drawbacks of SAR acquisitions such as radar shadows or offsets and to make use of the high amount of newly available Copernicus data.

We selected a study area located in the South-East of Gansu Province in Northwest China, one of the four most serious landslide and debris flow-prone region in China.

The proposed project pursues four main objectives:

(1) The creation and updating of multi-temporal landslide inventory maps which also describe the landslides' state of activity;

(2) The acquisition of ground-based landslide monitoring data for a validation of remote sensing-based maps;

(3) The application of local and regional landslide simulation models to predict future landslide scenarios;

(4) The qualitative and quantitative assessment of landslide hazards and risks.

The data from ESA and the Chinese Space mission represent an ideal data source for the described objectives. The creation and updating of landslide inventories from remote-sensing data will utilise a wide range of methods. Historic activity of landslides will be assessed by multi-temporal analyses of data also utilising satellite-based InSAR data. Additionally, current land uses and land use changes will be derived from high spatial resolution optical data. Field surveys will be used to carry out local scale monitoring campaigns (e.g. including geomorphological mapping and GPS measurements) at landslide "hot spots" and to validate the results of remote-sensing data analyses. The application of regional landslide susceptibility and local landslide simulation models will enhance the understanding of landslide occurrence and allow predictions of future behaviour. Moreover, the evaluation of the applicability of progressive failure analysis will be tested as a potential monitoring and forecasting system. Qualitative and quantitative hazard and risk analyses will be carried out to enable local and regional authorities to manage landslides more appropriately. Herein, land use change detection forms an important source information due to the substantial influence of management techniques.

The expected deliverables provided by the project will be GIS-based landslide inventory and landslide activity maps (after 18 months). The validation of satellite-based maps using ground-based landslide monitoring data is expected to be deliverable after 24 months. After 36 months, the investigations of landslide pre-disposing factors (inlcuding land use changes) and the subsequent modelling of landslide susceptibility, as well as the application of local landslide simulation models will be finished. Finally, after 48 months the proposed project will provide thematic maps on landslide hazards, vulnerability and risks and respective management strategies. In addition, the final report will aim to sum up all methods and results of the research project, what constitutes a milestone for the scientific community and local and regional authorities.

The proposed project includes researchers from Nanjing Normal University, and the Institute for Applied Remote Sensing, EURAC research (Italy) who form a well balanced team with ample experience in related research projects. In this study, we will use SAR sensors (SENTINEL, ENVISAT ASAR, ALOS PALSAR and COSMO-Skymed) and optical images (e.g. Sentinel-2 and RapidEye) for deriving
complementary information at the test site. They will be processed independently, possibly combined to ground-based measurements and compare to the existing landslide inventories.

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ABSTRACT 32365_4: "Collaborative Monitoring of Multiple Geohazards over Traditional Heavy Industrial Region in Northeast China with Multi-source Remote Sensing Data"	
European Principal Investigator Dr. Stefano Salvi (National Institute of Geophysics and Volcanology,ITALY)	***Chinese Principal Investigator*** Prof. Lixin Wui (Northeastern University,CHINA)
The traditional heavy industrial base of Northeast China, especially in Benxi-Anshan-Shenyang-Fushun (BASF) region, has played an important role in the economic development, however with severe consequences on local environment due to continuous mining ac	