IMPROVEMENT OF LANDSLIDE DETECTION TECHNIQUE "HORIZONTAL DISPLACEMENT FROM MULTI TEMPORAL IMAGERY" BY INTEGRATING VEGETATION, DRAINAGE AND TOPOGRAPHIC INFORMATION

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Abstract

Landslide is one of the major geologic hazards in mountainous areas. Detection and monitoring of which, is an important task for decision support systems and policy makers. However, accessibility to high mountainous regions is challenging for preparing landslide inventories. These problems have been addressed by modern methodological advance technique, assembled in the form of software package called Co-Registration of Optically Sensed Images and Correlation (COSI-Corr) Although this technique for the automatic detection of landslide on sub-pixel level proves to be one of the best techniques even then it suffers from some minor problems of having high number of false positive values. The noise is produced by numerous factors like platform changing attitude during the scanning operation of the images, digital elevation model (DEM) errors, natural features (vegetation change, shadowing effects, erosion and sedimentation) and man-made structures (urbanization). These false positive values degrade the interpretability of the data and decrease the accuracy of the results. Hence, landslide automatic identification based on displacement measurement technique from the bi-temporal imagery alone may not be adequate to detect landslides effectively. Therefore, a detection approach that incorporates data from other sources may thus be more effective than the one based solely upon the displacement measurement from bi-temporal remote sensing images. In this paper, the influence of factors (*i.e.*, vegetation, sedimentation, erosion and builtup areas) contributing to false positives values has been investigated and addressed. In this study we used pre- and post-event ASTER level 1A imagery with a time span of 4 year, obtained for November 14th 2001 and October 27th 2005. Additional pre-and post-event (IKONOS and Quickbird) images were used for GCPs collection and validation dataset preparation. Satellite images were ortho-rectified, resampled and then projected onto the ground according to their viewing geometry. Then phase correlation method has followed for the calculation of relative offset between the two imageries. Results shows that the main reason for noise or false positive values in and along the drainage lines (streams, river banks and meanders) were inundation and sedimentation by the streams and rivers. This was predominantly visible along the meandering sides of the river Neelum and some narrow stream valleys of Khata Shawai. Various false positives were also identified in the correlation images due to several natural and man-made changes in urban areas (*i.e.*, new built-up areas, roads pavements, erosion, terracing ground deformation, subsidence, etc.) either located on very gentle slopes or flat terrain. These were eliminated by masking the plane areas from the results. After the application of the plane area mask to the correlation results the true positive rate (sensitivity) remained the same but false positive rate decreased from 0.87 to 0.74, a total of 0.13 decreases. Spatial and temporal changes in vegetation over time create significant variation, therefore those areas where vegetation changes had occurred were detected as changed patches and ultimately as landslides. In the past NDVI has been effectively adopted to differentiate landslides from other changes. An effort was made to solve the problem of false positives caused by vegetation changes by masking the areas with vegetation or eliminating areas having NDVI value greater than 0.1. After the application of NDVI

mask false positive rate (1-specificity) greatly decreased from 0.74 to 0.14 (figure 3). But at the same time sensitivity also decreased from 0.96 to 0.84 (84%). Now for threshold 0.1 the sensitivity was 0.84, corresponding to only 16% probability of an omission error. This study presents a systematic approach by using a stepwise binary masking idea to enable a significant reduction of false positive from the correlation images, caused by many spatial and temporal changes. The false positives are sequentially eliminated from the landslide class by removing the noises resulting from drainage, urban sprawl and vegetation phonology. The results showed a great improvement in term of increase in true positive rate and decrease of false positive rate. The best threshold found was this for which error of omission and error of commission was less than 20%. The results also showed that medium scale imagery like ASTER could be used in a rough topographic area like Himalayas to automatically detect above 80% of landslides. The application of this method with some well-developed masks will further improve the automatic detection of landslides on regional scale in an economical way. This approach will also eliminate the need for extensive data analysis with huge rule-sets.