Geophysical Research Abstracts
Vol. 20, EGU2018-9698-1, 2018
EGU General Assembly 2018

Multi-aspect analysis of automatic landslide mapping using LiDAR data

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Landslide susceptibility mapping, hazard and risk assessment are basic means to rational management of natural resources and land use in landslide affected areas. Fundamental sources for any landslide related purposes are landslide inventories. The conventional landside mapping, based on field inspections, requires expert knowledge, is highly subjective with limited reproducibility and first of all associated with a lot of effort. These disadvantages and limitations can be reduced by applying automatic landslide mapping (ALM). Recently, ALM is the subject of great interest in the research because the increasing availability of remote sensing data, especially airborne laser scanning (ALS) data increases also the effectiveness of this technique. ALM is based mostly on a pixel approach. It means that the available data is converted into a defined grid and then a set of grid-related information is the subject of analysis and clustering using a classification algorithm. Several issues have to be considered in order to achieve high-quality results of ALM and the following questions have to be answered: What is the proper (optimal) resolution (grid cell size) of the digital terrain model (DTM) used? Which terrain morphology descriptors (landslide descriptor) should be taken into account? What should be the kernel size for the calculation of DTM derivatives (terrain morphology descriptors)? And finally, which classification method should be utilized? All of these issues have been widely investigated and discussed in the literature.
In contrary to many previous studies we investigate all of the abovementioned aspects in an integrated and combined way. Our broad analysis is based on almost 500 experimental numerical tests. In a systematic way, we tested six DTM resolutions, 17 landslide derivatives, 7 kernel sizes, and we implement for that maximum likelihood (ML), feed-forward neural network (FFNN) and support vector machine (SVM) as the classification method.
Empirical tests were carried out on a study area located in the central part of the Carpathians in Poland, that covers an area of ca 27 square kilometers. The study area has been affected by more than 250 landslides. The DTM was generated based on ALS point cloud with the average point density of 4-6 points per square meter and a vertical accuracy of 0.15 m.
Based on achieved results, feature sensitivity in the case of kernel size increase with coarser DTM resolution. Nevertheless, the peak of the best performance for selected study area was demonstrated for a resolution of 20 m. Moreover, 30 m resolution provide the best performance when the combination of many topographic variables is applied. SVM classification presented the best performance in almost all cases of the classification.