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Mass movements of lowland areas in long range TLS and ALS monitoring

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The development of geodynamic processes in lowland areas remains an interesting issue for geomorphology and geology as well as civil engineering. Landslides, slumps, slope washes, rills and gully erosion are considered both geomorphological processes and natural hazards. In order to know precisely their origin and development, it is crucial to determine the rate and direction of their change. Previously such studies used geodesy and photogrammetry but the recent progress in the LiDAR technology allows collecting the data in a wider range and comparable or higher precision than most of geodetic methods. Airborne Laser Scanning (ALS) is also a good tool, but high costs and low frequency of the surveys make it difficult to trace the dynamics of the studied phenomena and processes. Nevertheless, this method enables gathering information from large areas, which is useful for the preliminary identification of the research issues and nomination of the areas for subsequent case studies. It is, however, more common to use Terrestrial Laser Scanning (TLS) for the detailed studies of morphology and its change. This method provides mobility and high accuracy, and enables frequent measurements. The problem in the analysis of many geoprocesses lies in the limited range of this method. This study concerns the Lower Vistula Valley located in northern Poland. It presents the results of measurements of landslides located in the escarpment zone of a big river valley. The object of the studies is mass movements developing within the quaternary deposits on the valley slopes. These processes were monitored in previous years with the traditional survey methods, mainly based on the geodesy field observations (benchmark) as well as the analyses of historical maps and archives. The ALS method used during the study enabled gathering the data on the valley with the density of 8 points per sq m, which provided the background for the consecutive monitoring study. In the surveys a terrestrial scanner Riegl VZ-4000 was applied. This TLS scanner has a very long range of up to 4000 m. The TLS scan positions were located from 0.5 km to 2-3 km from the research objects (depending on the position), on the opposite river bank or valley side. A point cloud of three to four scan positions was made for each landslide. The scans were performed at a maximum resolution of 0.002°. During the merging of each point cloud the Riegl Multi Station Adjustment tool was used for the automatic fine adjustment and alignment. The scan positions and georeferences were registered using the global coordinates with an integrated RTK GPS receiver. After three campaigns based on the collected data from the ALS and TLS scanning and previous filtration a digital terrain model was created. The obtained model was compared in the GIS software in order to assess the changes in the terrain morphology resulting from the geodynamic processes. This study was supported by the Virtual Institute of Integrated Climate and Landscape Evolution (ICLEA) of the Helmholtz Association.