Geophysical Research Abstracts
Vol. 14, EGU2012-6324-1, 2012
EGU General Assembly 2012

Fusion of terrestrial LiDAR and tomographic mapping data for 3D karst landform investigation

B. Höfle, M. Forbriger, C. Siart, and E. Nowaczinski
University of Heidelberg, Institute of Geography, Heidelberg, Germany (hoefle@uni-heidelberg.de)

Highly detailed topographic information has gained in importance for studying Earth surface landforms and processes. LiDAR has evolved into the state-of-the-art technology for 3D data acquisition on various scales. This multi-sensor system can be operated on several platforms such as airborne LS (ALS), mobile LS (MLS) from moving vehicles or stationary on ground (terrestrial LS, TLS). In karst research the integral investigation of surface and subsurface components of solution depressions (e.g. sediment-filled dolines) is required to gather and quantify the linked geomorphic processes such as sediment flux and limestone dissolution. To acquire the depth of the different subsurface layers, a combination of seismic refraction tomography (SRT) and electrical resistivity tomography (ERT) is increasingly applied. This multi-method approach allows modeling the extension of different subsurface media (i.e. colluvial fill, epikarst zone and underlying basal bedrock). Subsequent fusion of the complementary techniques – LiDAR surface and tomographic subsurface data – first-time enables 3D prospection and visualization as well as quantification of geomorphometric parameters (e.g. depth, volume, slope and aspect).

This study introduces a novel GIS-based method for semi-automated fusion of TLS and geophysical data. The study area is located in the Dikti Mountains of East Crete and covers two adjacent dolines. The TLS data was acquired with a Riegl VZ-400 scanner from 12 scan positions located mainly at the doline divide. The scan positions were co-registered using the iterative closest point (ICP) algorithm of RiSCAN PRO. For the digital elevation rasters a resolution of 0.5 m was defined. The digital surface model (DSM) of the study was derived by moving plane interpolation of all laser points (including objects) using the OPALS software. The digital terrain model (DTM) was generated by iteratively "eroding" objects in the DSM by minimum filter, which additionally accounts for thresholds on slope and object size in order to avoid erosion of the doline slopes. Three SRT cross-sections (Geometrics, 48 channels) and three ERT profiles (Geotom, 100 electrodes) were measured. After post processing with RAYFRACT and RES2DINV software packages, subsurface media were identified taking advantage of different sensitivities of each geophysical technique by cross-checking and matching all outcomes.

To join the LiDAR DTM and the subsurface profiles, symmetry of the subsurface bedrock zone is assumed. This allows extrapolation from seismic and resistivity data to the entire doline bottom. The extrapolated point cloud data is then joined with the surface LiDAR data by spline interpolation of the transition zone between surface and subsurface bedrock. The entire fusion procedure of the DTM and the tomographic cross-sections is implemented in the GRASS GIS environment. Finally, the derived digital terrain and subsurface model (DTSM) is used to extract the geomorphological parameters of the landforms (e.g. total volume, sediment volume). Tests using different input datasets (e.g. DSM, DTM, DTSM) for parameter derivation at varying cell resolutions clearly indicate the need for high-resolution terrain and subsurface data for obtaining the geometry and function of karst landforms.