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Combined use of aerial photographs and LIDAR elevation data to obtain large scale landslide inventory maps

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Landslide inventory maps (LIMs) are prepared to study the evolution of landscapes, and are mandatory to ascertain landslide susceptibility, hazard and risk. LIMs can be prepared using different techniques, depending on the extent of the study area, the scale of the base maps, and the resources available. Most commonly, medium- to large-scale LIMs are prepared through the interpretation of aerial photographs (API), aided by more or less extensive field checks. In places, the production of LIMs is hampered by the presence of forest. Under forest, landslides are difficult to detect through API or field mapping, limiting the completeness of an inventory map. The ability of LIDAR to penetrate the forest canopy and to provide detailed and accurate representations of the topographic surface even under forest coverage may represent an advantage for the preparation of LIMs. Preliminary results of an experiment aimed at exploiting LIDAR technology combined with API and field survey to prepare large-scale LIMs are presented. The area selected for the experiment extends for 26 square kilometres in the Swabian Alb (SW Germany), near the village of Moessingen. In the area landslides are abundant, and cover about 22.4 percentage of the territory. Mass movements are chiefly deep-seated block slides, deep-seated and shallow slides and slide-earth flows, and shallow soil slides. In the study area, landslides - and particularly deep-seated landslides - have a distinct morphological (topographical) signature, which allows for their recognition and mapping. A large proportion of the study area (about 51.8 percentage) is covered by deciduous forest. and numerous landslides are present in the forested area. The following information was available for the study

area: (i) five sets of aerial photographs taken in the period from 1941 to 2002 at scales ranging between 1:12,000 and 1:29,000; (ii) a high-resolution (HR, 1 m Œ 1 m ground resolution) representation of terrain obtained through airborne LIDAR in the period from 2001 to 2003; and (iii) medium- to large-scale lithological and land use maps in digital format. For the study area, a landslide inventory map was prepared through the interpretation of the five sets of stereoscopic aerial photographs, and very limited field surveys. Landslides were recognized on the aerial photographs based on their morphological appearance, were mapped on 1:10,000 scale topographic maps, and were digitized to obtain a digital landslide database. During the production of the LIM through API, the LIDAR information was not used to detect or map landslides. Next, the HR DEM was used to obtain digital representations of the topographic surface of the study area, including elevation, shaded relief, and slope maps. The digital maps were exploited to identify the landslides visually, based on their morphological (topographical) appearance. Landslides identified using the digital terrain information were mapped on the shaded relief image, digitized, and stored in a separate layer of the digital landslide database. The landslide information obtained through API and the limited field checks was compared with the landslide information obtained by visually analysing the digital representations of topography. Preliminary results of this exercise indicate that: (i) in cultivated areas and grasslands, old and recent (fresh) landslides clearly recognizable using API where also clearly visible in the derivatives maps of the HR DEM; (ii) in forested terrain, some of the old and recent (fresh) landslides not clearly (or univocally) recognizable on the aerial photographs were identifiable in the shaded relief image obtained from the HR DEM; (iii) not all landslides mapped through API and field surveys were clearly visible in the shaded relief image obtained from the HR DEM; (iv) topographic features typical of - but not unique to - landslides visible on the aerial photographs and the HR DEM could be attributed to landslide features only through specific field surveys.