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## Identification, GIS-based mapping and morphometric analysis of river terraces from airborne LiDAR data in the Augšdaugava spillway valley, South-eastern Latvia

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The Augšdaugava spillway valley located in SE Latvia has a system of river terraces formed by both glacio-fluvial and fluvial processes. The flight of terraces forms a staircase-like relief in the riverine landscape and represents the evidence of valley evolution during the transition from glacial to post-glacial conditions in this region. Hence terraces are substantial 'archives' of paleoenvironmental data and their geomorphometry could provide key information for untangling geomorphological history of the spillway valley. Hence the need for precise identification and mapping of terraces is obvious. However, these landforms, particularly upper terraces commonly are poorly preserved. It is a result of the interplay of many geological processes – channel incision, lateral erosion in the course of the river Daugava meandering, mass wasting etc., leaving discontinuous remnants of terraces along to the present-day long profile of the river. Previously, mapping of these features was performed via extensive field surveys and to some extent by interpretation of aerial images or topographic maps, because the presence of tree cover hinders the identification of terraces by conventional geomorphological techniques. Thereby due to the poor preservation of fluvial landforms and the abundant vegetation cover, the previously mapped terrace surfaces and inferred levels may be questionable.

Yet the now available high-resolution LiDAR data in Latvia and application of modern GIS-based techniques offer an opportunity to resolve these problems. Hence the main goal of the study was to apply a methodology based on using LiDAR-derived DEM and combining different semi-automated GIS analysis tools for the identification, mapping and morphometric analysis of fluvial terraces in the valley. In this study, LiDAR data coverage (courtesy of the Latvian Geospatial Information Agency) was used to generate a DEM. LiDAR coverage consists of 317 data folders in \*.LAS format, each one of 1 km<sup>2</sup> extent. DEM with 0.5 x 0.5 m pixel resolution and <15 cm vertical accuracy was created by ArcGIS PRO tool 'LAS Dataset to Raster' following the standard procedure of the IDW interpolation. After the construction of DEM, the TerEx toolbox integrated into the ArcGIS environment was used for the extraction and delineation of terrace surfaces. After the completion of GIS works, the ground-truthing of the obtained data on the location of fluvial terraces was performed during field geomorphological reconnaissance.

DEM analysis allowed to identify the terrace sequence in the Augšdaugava spillway valley

consisting of eight different terrace levels – T1 to T8. From the applied methodology, authors were able to delineate surfaces of river terraces in those parts of the valley, where in the course of previous research terraces were interpreted incorrectly or even not identified at all. However, only terraces T1 and T2 can only be unambiguously identified by GIS-based extraction. Upper terraces with smoothed edges due to mass wasting and surfaces dissected by gullies are not easily recognizable. Hence, the presence of minor landforms which increase the topographical roughness of the surface directly influences the quality of extracted data, thus leading to the necessity of an extensive amount of manual editing.