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Interpreting Vineyard Landscape Heritage Through Historical Military Maps and LiDAR Data: The Little Carpathians Case Study (Slovakia)

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Abstract:

The aim of this research is to assess how historical military maps, LiDAR-derived terrain data, and present land-cover information can be integrated to improve the interpretation of former vineyard extent and to identify patterns of vineyard abandonment in the Little Carpathians. The study focuses on one of Slovakia's most important historical wine-growing regions, where vineyards formed a characteristic component of the cultural landscape for centuries but have undergone substantial spatial reduction and transformation over time.

Historical vineyard distribution in the study area is documented by the First Military Survey (1764–1787), which represents one of the earliest region-wide cartographic sources depicting vineyards in the Habsburg Monarchy. The Second Military Survey provides an additional reference for the nineteenth century and makes it possible to assess continuity or change in mapped vineyard extent. However, direct interpretation of these sources is limited by positional inaccuracies, varying cartographic detail, and later land-use changes. In many places, former vineyards are no longer visible in current land-use records, while their physical traces may still be preserved in terrain morphology.

To address this problem, the paper combines historical military mapping with a high-resolution LiDAR-derived digital elevation model and present land-cover information interpreted from recent orthophotos. Particular attention is paid to relict vineyard terraces preserved on slopes that are currently cultivated, abandoned, overgrown, or already incorporated into forest cover. These terrace forms are treated as terrain-based indicators of former viticultural land use. Their spatial distribution is analysed in relation to historical vineyard patterns and to present categories of land cover in order to distinguish areas of persistence, abandonment, and overgrowth.

The methodological workflow consists of four main steps. First, vineyard areas mapped on the First and Second Military Surveys are identified and compared. Second, relict terraces are interpreted from LiDAR-derived terrain data, with emphasis on their recognisability in both open land and forested areas. Third, present vineyard extent and current overgrown or forested surfaces are assessed from recent imagery and other contemporary spatial layers. Finally, these three lines of evidence are compared in order to interpret the long-term transformation of the vineyard landscape and to identify areas where historical map evidence and preserved terrain structures either correspond or diverge.

The comparison demonstrates that LiDAR-derived data substantially improve the interpretation of former vineyard extent by revealing abandoned terraces that are no longer visible from present land use alone. In some areas, terrace morphology confirms the vineyard pattern shown in historical military maps, whereas in others it indicates a more complex history of abandonment and transformation. This applies especially to slopes currently covered by forest.

The paper argues that historical military maps and LiDAR data should be understood as complementary sources rather than competing representations of past landscape structure. While historical maps preserve cartographic evidence of vineyard distribution in specific periods, LiDAR reveals the material remnants of former land use that persisted in the terrain despite later abandonment. Their joint interpretation contributes not only to the reconstruction of vineyard decline, but also to a broader understanding of how historical cartography can be enriched by current geospatial technologies. In this sense, abandoned vineyard terraces represent not only geomorphological traces of past agricultural activity, but also elements of viticultural landscape heritage whose interpretation can be strengthened through the combined use of historical maps and LiDAR data.

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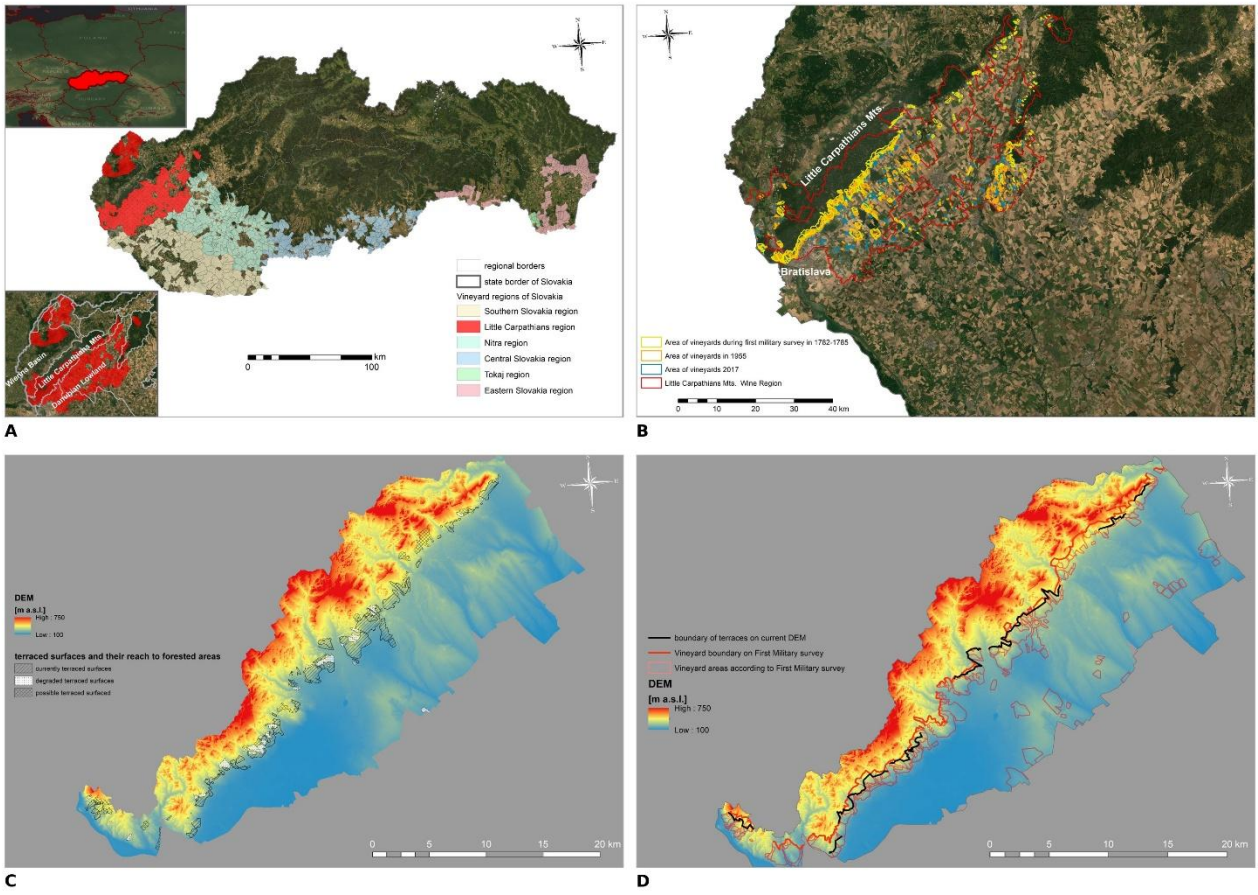

Figure 1. Historical maps and LiDAR-based evidence used to interpret vineyard landscape change in the Little Carpathians: (A) location of the study area, (B) comparison of vineyard extent in the First Military Survey, 1955, and 2017, (C) LiDAR-derived DEM with mapped terraced surfaces, and (D) comparison of terrace boundaries derived from the current DEM with vineyard boundaries from the First Military Survey.

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