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Exploring the spatial heterogeneity of terraced landscapes using LiDAR: the Slope Local Length of Auto-Correlation (SLLAC).

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Terraces represent an outstanding example that displays centuries of a ubiquitous human-Earth interaction, in a very specific and productive way, and they are a significant part of numerous local economies. They, in fact, optimise the local resources for agricultural purposes, but also exploit marginal landscapes, expanding local populations. The ubiquity, variety, and importance of terraces have motivated studies designed to understand them better both as cultural and ecological features, but also as elements that can deeply influence runoff generation and propagation, contributing to local instabilities, and triggering or aggravating land degradation processes. Their vulnerability in the face of fast-growing urban settlements and the changes in agricultural practices is also well known, prompting protection measures strongly supported by local communities, but also by national and international projects. This work explores the spatial heterogeneity of terraced landscapes, identifying a proper indicator able to discriminate a terraced landscape respect to a more natural one. Recognizing and characterizing terraced areas can offer important multi-temporal insights into issues such as agricultural sustainability, indigenous knowledge systems, human-induced impact on soil degradation or erosive and landslide processes, geomorphological and pedologic processes that influence soil development, and climatic and biodiversity changes. More in detail, the present work introduces a new morphological indicator from LiDAR, effectively implementable for the automatic characterization of terraced landscapes. For the study, we tested the algorithm for environments that differ in term of natural morphology and terracing system. Starting from a LiDAR Digital Terrain Models (DTM), we considered the local auto-correlation ($\sim$local self-similarity) of the slope, calculating the correlation between a slope patch and its surrounding areas. We define the resulting map as the "Slope Local Length of Auto-Correlation", or SLLAC map. The SLLAC map texture is characterized by the presence of peculiar elongated fibers that change depending on the landscape morphology, and on the type of terracing system. The differences in texture can be measured, and they can be used to discriminate terraced areas from more natural ones. Given the raising importance of these landscapes, the proposed procedure can offer an important and promising tool to explore the spatial heterogeneity of terraced sites.