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Agricultural terraces in the Mediterranean: a multidisciplinary approach to understanding human-landscape interactions

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Agricultural terraces, which demonstrate an ingenious and sustainable way of transforming hilly slopes into arable land, are widespread in Mediterranean landscapes, stretching from southern Portugal to the Judean Highlands. Despite their ecological and heritage values, there remain significant temporal and spatial gaps in understanding their histories, how they were constructed and what their socio-economic implications were for early populations. This lack of knowledge further restricts understanding the effects of terracing on landscape in terms of mitigating the impacts of past climate change and informing sustainable strategies for the future of land-management.

To this end, we employed a multidisciplinary approach to a case study in Naxos, Greece. A GIS-based technique which uses a range of cartographic remote sensing data was employed to identify over 20 terrace sites, and trenches were hand-dug and placed in a relative chronological sequence using a portable optically stimulated luminescence (OSL) dating reader and gamma spectrometer. Samples were then collected for absolute OSL dating, micromorphology and x-ray fluorescence (XRF) analyses. Trench profiles were documented using high-resolution image-based modelling for accurate sample location and volumetric reconstruction of soil layers, and historic and modern aerial spaceborne data were used together with sample results to create models of terrace systems for spatiotemporal analyses.

The results of this multidisciplinary approach adopted here have produced evidence of large-scale land-use in periods for which no other evidence indicative of landscape exploitation survives. A chronological framework based on over 25 OSL ages suggests terrace construction in Naxos between ~400 BC and the 16th century AD with intensification during the Medieval Greek period. Applications of soil micromorphology and XRF analyses identify key evidence of natural soil development and past land use including irrigation, soil mixing, crop residues and anthropogenic fertilisers. Modelling of terrace system development indicate their value as long-term resilient, adaptable agricultural and environmental features: where terrace systems have been maintained, reused, or abandoned under vegetation landscapes appear to maintain greater stability, retaining valuable soils and habitats compared to areas where terrace systems have been affected by overgrazing or consolidated by mechanical means. We conclude that our multidisciplinary

approach has concomitant implications for the future sustainability and biodiversity of Mediterranean landscapes and beyond.