Assessing Cultural Ecosystem Services under Land-Use Change: a Geospatial Approach to Support Sustainable and Climate-Resilient Landscape Planning

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SUMMARY

Cultural Ecosystem Services (CES) play an essential role in sustaining the social and cultural fabric of landscapes, yet they remain insufficiently represented in land management and spatial planning. As planners contribute more directly to the implementation of the Sustainable Development Goals and prepare for the post-2030 development agenda, there is a growing need for geospatial approaches capable of integrating cultural values with ongoing land-use transformations. In this study, we present a spatially explicit assessment of how land-use and land-cover change is reshaping the provision of CES in the Alqueva region of southern Portugal, a territory undergoing rapid transformation driven by irrigation development, agricultural intensification, and increasing climate pressures. The analysis combines geospatial modelling, participatory GIS, stakeholder consultation, and a Business-as-Usual scenario projected to 2040. Between 2007 and 2023, the region experienced a marked expansion of intensive agriculture, particularly in olive groves, almond orchards, and vineyards. This trend is projected to intensify, with an expected increase of more than 700 hectares of intensive agriculture by 2040, representing a growth of over 50 percent relative to current values. Validation of the 2040 projections using an 11 by 11 window similarity index resulted in 76 percent agreement, strengthening confidence in the spatial outputs. Hotspot analysis further identified statistically significant clusters of intensification, especially in areas directly influenced by the Alqueva irrigation network. These changes raise major concerns regarding landscape quality, cultural identity, recreational opportunities, and broader social dynamics. The simplification of landscape mosaics and the progressive loss of the traditional montado system contribute to an overall decline in key CES. At the same time, multifunctional landscapes that persist in the region continue to support a diverse range of cultural values, indicating that sustainable land and water management strategies can mitigate some of the negative impacts. Local population feedback highlights strong emotional and cultural attachments to the montado landscape, alongside apprehension that continued agricultural expansion may erode

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cultural identity and reduce well-being. These perspectives emphasise the need for balanced land-use planning that recognises trade-offs between agricultural productivity and the preservation of ecosystem services. By integrating spatial analysis, participatory methods, and scenario tools, this study illustrates how planners can provide evidence-based insights to support climate adaptation, inclusive decision making, and sustainable landscape planning. In doing so, it contributes to ongoing discussions on the role of the planning profession in advancing resilience, supporting the SDGs, and guiding the transition toward more sustainable land-use futures.