

Mapping Local Climate Risk: A High-Resolution Climate Classification for Spain

Jose M. Pavía¹Priscila Espinosa²

Abstract

Climate conditions play a central role in economic activity, influencing sectors such as agriculture, tourism, energy demand, infrastructure planning, and regional development. However, most existing climate classifications operate at coarse spatial scales, limiting their usefulness for local economic analysis and policy design. In a country such as Spain, characterised by pronounced climatic, geographical, and topographical heterogeneity, this limitation is particularly relevant. This study investigates whether a high-resolution climate classification can be constructed at the census-tract level in order to support geographically detailed economic and territorial analyses. In particular, the paper pursues three objectives. First, it delineates climatically homogeneous areas for the whole of Spain using census tracts as the smallest spatial unit. Second, it evaluates the spatiotemporal stability of these areas over the period 2000–2024. Third, it examines whether spatial stability reflects genuine climatic persistence or conceals internal dynamics associated with ongoing climate change. The empirical strategy relies on daily meteorological observations collected from weather stations across Spain. Since these observations do not spatially coincide with census tracts, climatic variables are interpolated to tract centroids using Ordinary Kriging. Annual climate indicators are then constructed, summarised through Principal Component Analysis, and used to identify climatically homogeneous areas by means of k-means clustering. The temporal robustness of the classification is assessed through rolling five-year windows, transition matrices, and dissimilarity indices, while the internal evolution of each climate group is examined using linear trend models. The results identify six well-defined and territorially coherent climate areas across Spain. These areas display remarkable spatial stability throughout the study period, as the proportion of census tracts changing cluster across time windows remains low. However, this spatial persistence does not imply the absence of internal climatic change: a substantial share of the indicators exhibits significant temporal trends, particularly in variables related to temperature, precipitation, and solar radiation. These findings suggest that Spain's climate geography is simultaneously stable in its spatial structure and dynamic in its internal evolution. The proposed classification therefore provides a useful framework for analysing local climate exposure and informing economic planning, territorial policy, and climate adaptation strategies.

Keywords: climate classification, spatial clustering, spatiotemporal stability, climate change

Doi: <https://doi.org/10.66414/mlabs.9724>

¹ Universitat de València, Valencia, Spain. ORCID: 0000-0002-0129-726X

² Universitat de València, Valencia, Spain. ORCID: 0000-0002-3870-6194