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Climatic Zones Classification and Building Energy Efficiency in Spain.

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In Spain, the adaptation of the European Directive on energy performance of buildings (2010) has been implemented through the Technical Building Code (TBC), which divides the territory into climate zones and evaluates the energy performance of buildings based on them (2013). The TBC segments Spain according to seasons, differentiating winter months (from October to May), which correspond to those where heating is necessary, and summer months (from June to September), those where air conditioning is necessary. Resulting in a characterization according to the climate severity of summer (SCS) or winter (WCS) to evaluate their energy efficiency. However, this classification methodology could be improved if taking into account the warming process of recent decades.

Between 1971-2022 in Spain, the maximum temperatures increased on average, 3.54°C, as well as the minimum temperatures, 2.73°C; as well as an exponential increase in heat waves over the last decades (Roca et al., 2023). "Summer" has increased by almost two more months, with a corresponding reduction in the "winter months”. For this reason, the research proposes a modification of the SCS and WCS, considering that “summer” runs from May to October and “winter” from November to April. Therefore, the research aims to study the limitations of the BTC climate zones classification, and propose a new climatic classification that allows a more accurate energy performance certification of buildings.

The study uses the E-OBS dataset, with a spatial resolution of 0.1°x 0.1°. Its continuity over time helps to track and analyze long-term climate change trends. For this purpose, the paper obtained daily data of average (tg), maximum (tx) and minimum (tn) temperature, and solar radiation (qq) from 1991 to 2020. At the same time, the study incorporates a series of climatic indices into the analysis to differentiate more precisely the different climates. For warm season, we introduce thermal indices such as CD25 and CN20 through 'Summer Days' (tx≥25) and 'Tropical Nights' (tn≥20). These outdoor temperatures, tx>25 and tn>20, indicate the thresholds above which the indoor environment of homes should be cooled. On the other hand, for the cold season, were calculated the cold indices HD15 and HD0 through 'Winter Days' (tg≤15) and the 'Frost Days' (tn≤0).

Through Principal Component Analysis (PCA), the determining factors of the climatic severities of "summer" and "winter" are extracted. These factors allow, through K-means classification, the delimitation of the different climatic zones that, require cooling (SCS) or heating (WCS). To obtain higher resolution climate data, the climate classification obtained by E-OBS has been downscaled to 1000 meters using multiple regression analysis (OLS), considering longitude, latitude, altitude and sea distance as independent variables, and SCS and WCS as dependent variables.

Finally, the research proposes an improved climatic zones classification, and, therefore, establish a more accurate energy efficiency valuation of buildings. This improved methodology not only reflects regional climate variations more accurately, but can also serve as a key tool for urban planners and building designers, allowing them to implement more effective strategies based on local climate.