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Heatwave social vulnerability index validated on mortality data in Europe

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Climate change projections underscore an imminent temperature escalation of 1.1°C to 6.4°C above the 1990 baseline by 2100, leading to heatwaves of higher frequency, intensity, and duration. In the last decades, Europe has experienced severe heatwave events, such as the catastrophic one in summer 2003 that claimed over 70,000 lives. Thus, it is of pivotal importance to better understand the drivers of heatwave impacts to promote effective adaptation and mitigation strategies. While many studies have been carried out to explore the social vulnerability to heat-related impacts at local and regional scales, a large-scale continental analysis is still missing. This study aims at exploring the temporal and spatial dynamics of social vulnerability to heatwaves in Europe. This will be achieved by developing a dynamic spatial and temporal social vulnerability index for heatwaves in Europe. The index is validated against impact metrics such as mortality, which remains underexplored in large-scale assessments. In particular, a regression analysis between heatwave mortality and socio-economic and demographic factors, including population changes, income variations, and alterations in social infrastructure is carried out to assess the degree to which these factors are associated with heatwave mortality. The regression coefficients serve as the weights in the composite social vulnerability index. Such validation enhances the credibility, accuracy, and applicability of social vulnerability indices, bridging the divide between theoretical assessments and real-world consequences. Our empirical results indicate that diverse socio-economic and demographic variables exhibit distinct correlations with heatwave mortality. Consequently, an index incorporating ad hoc weighting of its constituent terms more effectively captures the social vulnerability component to heatwaves. This research provided new insights to better understand social vulnerability to heatwaves and allow better-informed decision-making to enable the development of resilient communities. Moreover, our findings advanced the understanding of heat risks in the broader context of escalating climate change challenges across Europe.