Demography and heat stress: the role of population dynamics in climate risk projections

Climate change affects human health by exacerbating disease (morbidity) and death (mortality) rates. With heat waves increasing in frequency and intensity due to global warming, the risk of heat stress is expected to become more prominent in the future. In particular, urban populations face amplified health risks to the elevated temperatures in the built environment.

Epidemiological studies find that population groups with certain socio-economic and demographic characteristics such as age, sex, education, and income are associated with increased risk of mortality and morbidity during heat events. Older adults (aged ≥ 65 years), children (aged < 5 years), infants (aged <1 year), women or those with low socio-economic status or pre-existing health conditions are more vulnerable to the health risks of climate change. It is also expected that health vulnerability decreases with higher degrees of education. Research on the impacts of heat on health however consists mostly of studies carried out at the regional, national or city level. Employing these coarse resolutions may mask differences in vulnerabilities of certain population subgroups.

To address the research gaps related to scale and demographically differentiated vulnerabilities, this research provides a framework for quantifying differential vulnerability based on demographic variables at very high resolution (approximately 2400 observations) for the case study of Madrid. Spatial and temporal projections using Bayesian model averaging are developed in line with three scenarios of the Shared Socioeconomic Pathways (SSPs): *SSP1* - sustainable development, *SSP2* - middle-of-the-road and *SSP4* - inequality. Here, educational attainment is used as a proxy for socio-economic status. This paper advances on research gaps with 1) an application of innovative, advanced methods to 2) for the first time, include demographically differentiated vulnerability to climate risk assessments by preserving the heterogeneity of relevant population groups by age, sex and education and 3) by providing novel evidence on downscaled population projections for Madrid.

The resulting spatial distributions of population groups (by age, sex, and level of education), and their projected changes are relevant for local decision-making regarding adaptation strategies to decrease the burden climate change might impose on future public health.