

Supplementary Information

Greening mitigates heat-related mortality in Paris

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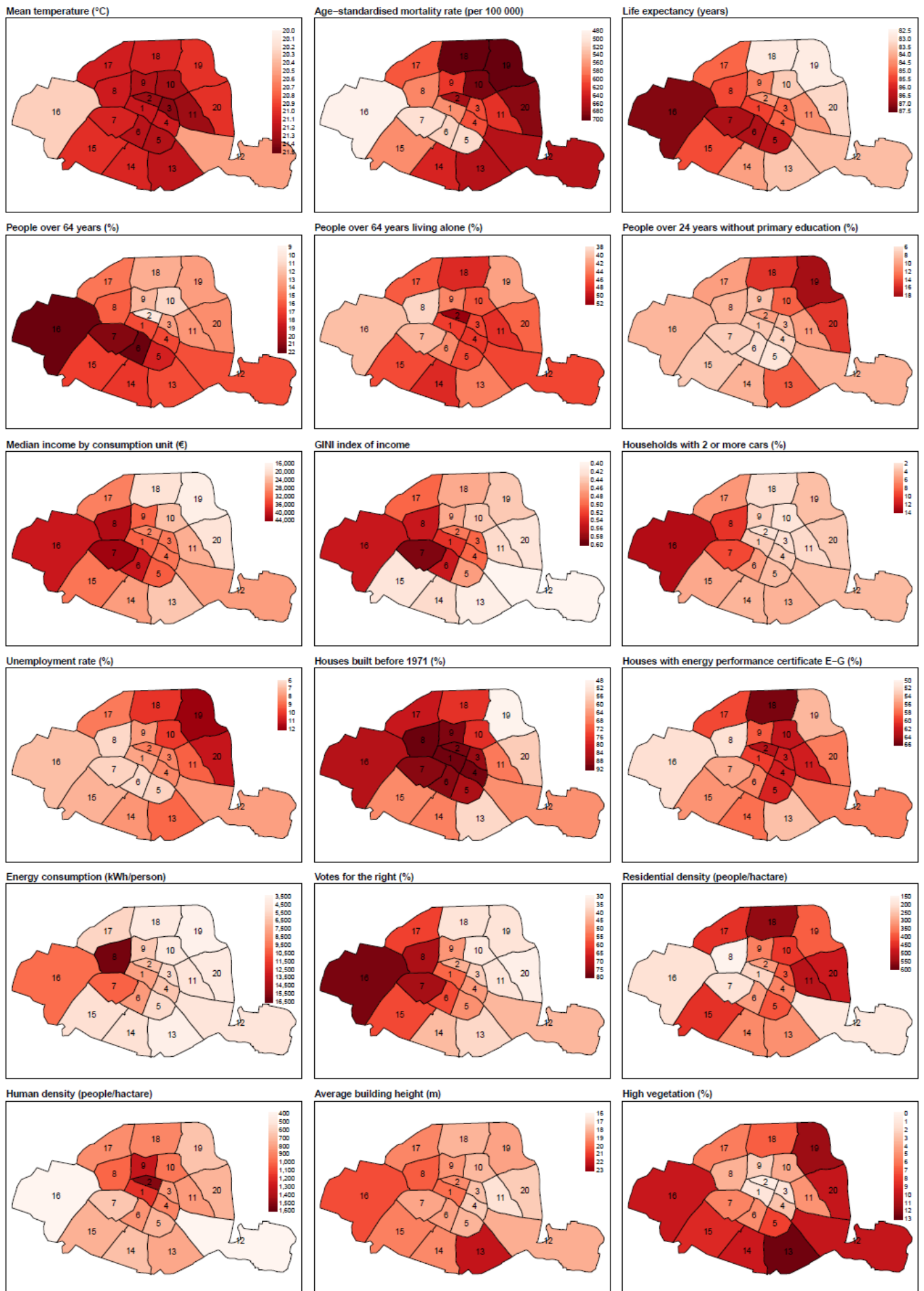
Supplementary Table 1. Description of contextual indicators

(*) Indicators weighted by the number of residents in urban islands (UI).

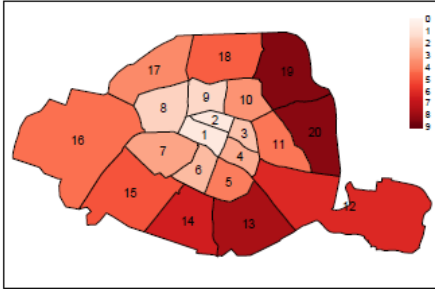
Indicator	Description	Geo.	Time	Source	
Temperature*	Gridded hourly air temperature estimations (°C)	100m × 100m	2008-2017	Urban climate model UrbClim	
Mortality rate	Age-standardised mortality rate	District (N=20)	2013-2017	Institut Paris Region (IPR): Données de mortalité pour la période 2013-17	
Life expectancy	Life expectancy at birth		2009, 2014 2020	Insee. Recensement de la population	
People over 64 years	Proportion (%) of population aged 65 and more		2007-2020	Insee. Recensement de la population	
People over 64 years living alone	Proportion (%) of people aged 65 and more living alone		2009, 2020	Insee. Recensement de la population	
People over 24 years without primary education	Proportion (%) of people aged 25 and more without primary school diploma		2004-2019	Insee. Dispositif Fichier localisé social et fiscal (Filosofi)	
Income	Median income by consumption unit (€)		2009, 2014	Insee. Comparateur de territoires	
GINI index	GINI index of income		2006-2020	Insee. Recensement de la population	
Unemployment	Unemployment rate (%) among people aged 15-64		2013-2020		
Households with 2 or more cars	Proportion (%) of households with 2 or more cars		2018	Insee. Analyses Ile-de-France #154	
Houses built before 1971	Proportion (%) of houses built before 1971		2020		
Energy performance	Proportion (%) of houses (private sector) with energy performance certificate (EPC) E-G		2007, 2012, 2017	J Cagé et T Piketty : Une histoire du conflit politique. Le Seuil, 2023	
Energy consumption	Residential consumption of gas, electricity and district heating (kWh/person)		Urban island (N=9 600)	2016 (residents)	Institut Paris Region (IPR): Îlots morphologiques urbains d'Île-de-France
Voting behaviour	Proportion (%) of votes for the right			2019 (workers)	
Residential density	Number of people living in the urban island (UI) in 2016 (per hectare)			2022	
Human density	Sum of the number of people living in the UI (2016) and the number of people working in the UI (2019) (per hectare)	2019, 2021			
Average building height*	Ratio between the volume of the buildings and the ground surface area they occupy (m)				
High vegetation*	Proportion (%) of high vegetation planimetric surface: trees (shrub/trees layer)				

Low vegetation*	Proportion (%) of low vegetation surface: lawn & mixture (herbaceous/shrub layer)		2021	
Vegetation*	Sum of the proportions (%) of low and high vegetation		2019, 2021	
Impervious surface*	Proportion (%) of the ground surface of buildings and paved roads.		2022	
Potential for a daytime/nighttime urban heat island (UHI)	A set of physical parameters contributing to the UHI (surface admittance, albedo, local heat production, etc) were estimated for each UI and combined into a score (from 1 [low] to 9 [high]) grading the “potential to develop a high day/night UHI” under specific atmospheric conditions (Cordeau & Dore, 2024).		2022	Institut Paris Region (IPR): Îlots de chaleur urbains (ICU) d’île-de-France

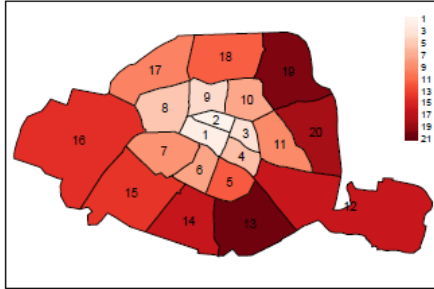
Supplementary Figure 1. Geographical distribution of the contextual indicators across Paris districts



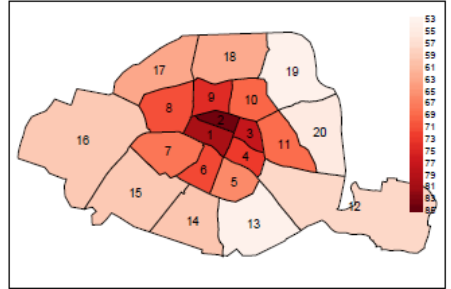
Low vegetation (%)



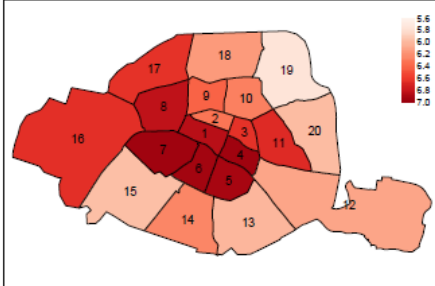
Vegetation (%)



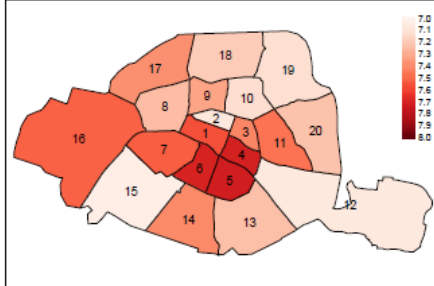
Impervious surface (%)



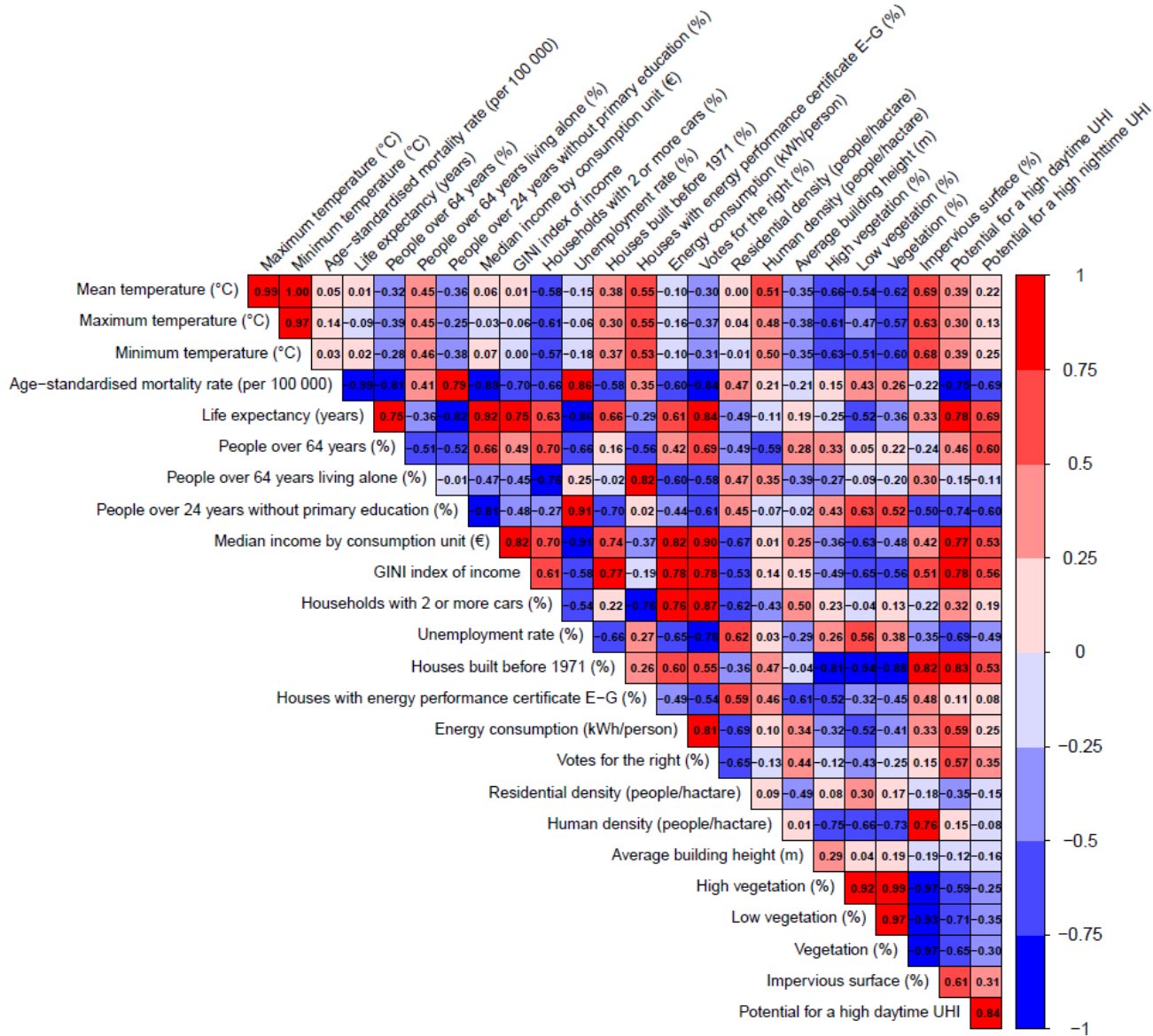
Potential for a high daytime UHI



Potential for a high nighttime UHI

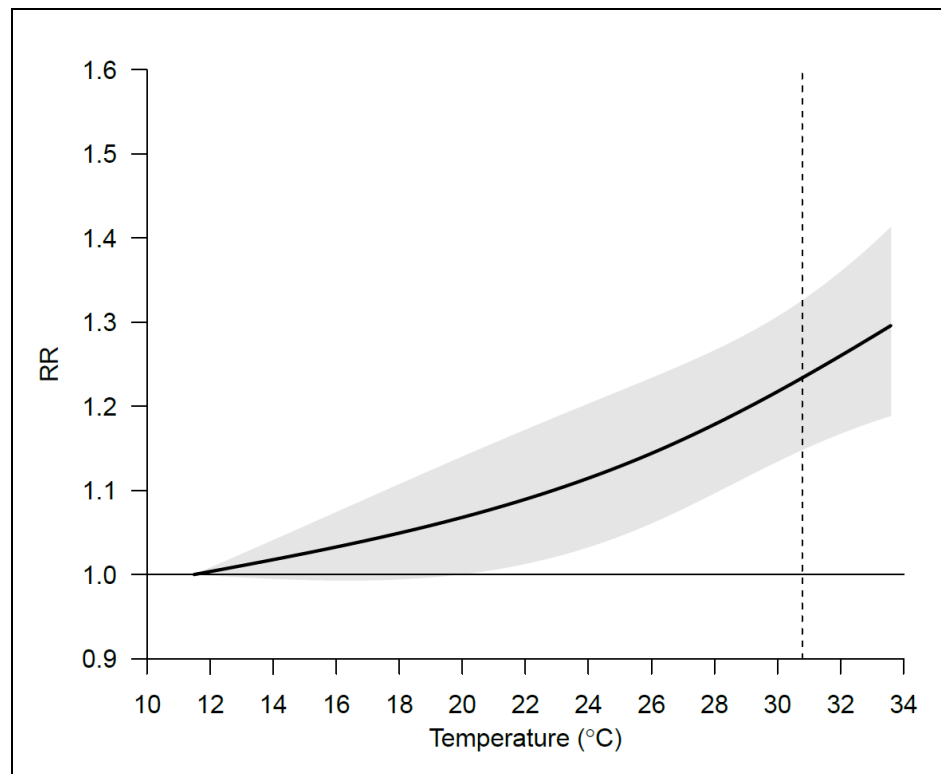


Supplementary Figure 2. Correlation matrix for contextual indicators



Supplementary Figure 3. Temperature-mortality relationship for Paris city during the summer season

The figure represents the relative risk of mortality (RR) associated with the average daily mean temperature cumulated within lag 0–1. Vertical dashed line represents the 99th percentile of the summer-season (June–September) daily temperature.



Supplementary Table 2. Change in heat-related mortality risk by contextual factors

The table reports the %CR of mortality (with 95% CI) at the 99th percentile of daily mean temperature (cumulated within lag 0–1) between the minimum and maximum observation for each contextual indicator.

	Temperature		
	Minimum	Mean	Maximum
Mean temperature	4.1 (-16.3 to 29.5)	-4.1 (-22.4 to 18.5)	-8.9 (-26 to 12.2)
Maximum temperature	6.2 (-15.6 to 33.5)	-2.7 (-22.3 to 21.8)	-7.4 (-25.9 to 15.6)
Minimum temperature	2.3 (-17.3 to 26.4)	-5.3 (-22.8 to 16.3)	-9.6 (-26.1 to 10.4)
Age-standardised mortality rate	-7.6 (-23 to 10.8)	-9.4 (-24.3 to 8.4)	-10.1 (-24.7 to 7.5)
Life expectancy	9.4 (-9 to 31.4)	12.1 (-6.6 to 34.4)	12.9 (-5.7 to 35.2)
People over 64 years	-5.3 (-23.8 to 17.6)	2.8 (-17 to 27.5)	6.5 (-13.9 to 31.7)
People over 64 years living alone	8.3 (-15.1 to 38)	0.5 (-20.9 to 27.8)	0.6 (-20.7 to 27.6)
People over 24 years without primary education	-4.1 (-21.1 to 16.4)	-6.4 (-22.7 to 13.3)	-8.7 (-24.3 to 10.2)
Median income by consumption unit	5.9 (-13 to 29)	13 (-7 to 37.3)	15.9 (-4.4 to 40.6)
GINI index of income	13.5 (-7.9 to 39.8)	23.9 (0.8 to 52.3)	25.4 (2.2 to 54)
Households with 2 or more cars	-0.5 (-19.5 to 23.1)	6.4 (-13.8 to 31.3)	8.8 (-11.8 to 34.2)
Unemployment rate	-1 (-18.4 to 20.1)	-5.3 (-21.7 to 14.6)	-8 (-23.7 to 10.8)
Houses built before 1971	22.8 (1.7 to 48.4)	30.9 (8.7 to 57.8)	32.2 (10.1 to 58.8)
Houses with EPC E-G	28.8 (5.3 to 57.5)	25.4 (2.9 to 52.9)	23.3 (1.4 to 49.8)
Energy consumption	-0.3 (-27.1 to 36.5)	16.2 (-15 to 58.9)	23.1 (-9.9 to 68.2)
Votes for the right	1.5 (-15.4 to 21.8)	5.1 (-12.2 to 26)	6.4 (-11.1 to 27.3)
Residential density	19.9 (-1.2 to 45.4)	6.5 (-11.9 to 28.7)	-0.3 (-17.3 to 20.1)
Human density	10 (-18.8 to 48.9)	-2.8 (-27.8 to 30.7)	-8.7 (-31.9 to 22.3)
Average building height	-24.3 (-39 to -6)	-24.1 (-38.7 to -6.1)	-23.7 (-38.1 to -5.8)
High vegetation	-22.9 (-38.7 to -3)	-23.5 (-38.9 to -4.3)	-23.4 (-38.6 to -4.6)
Low vegetation	-18 (-33.6 to 1.4)	-20.4 (-35.3 to -2)	-21.3 (-35.8 to -3.4)
Vegetation	-21.2 (-36.9 to -1.7)	-22.6 (-37.8 to -3.8)	-23 (-37.8 to -4.6)
Impervious surface	29.2 (-1.9 to 70)	31.7 (0.6 to 72.4)	33.9 (2.8 to 74.4)
Potential for a high daytime UHI	15.4 (-4.3 to 39.2)	26 (4.7 to 51.5)	28.9 (7.5 to 54.7)
Potential for a high nighttime UHI	15.2 (-5.8 to 40.9)	24.1 (1.7 to 51.4)	25.2 (2.9 to 52.4)

Supplementary Figure 4. Variation in heat-related mortality risk by contextual factors derived from daily mean temperatures from UrbClim and the Paris-Montsouris meteorological station

The figure represents the %CR of mortality at the 99th percentile of daily mean temperature (cumulated within lag 0–1) between the minimum and maximum observation for each contextual indicator. Error bars represent the 95% confidence interval. Note that UrbClim temperatures vary spatially across urban districts, while temperatures from the Paris-Montsouris meteorological station are applied uniformly to all districts.

