FIERA INTERNAZIONALE
DELL'INNOVAZIONE IMPIANTISTICA
DEL MEDITERRANEO

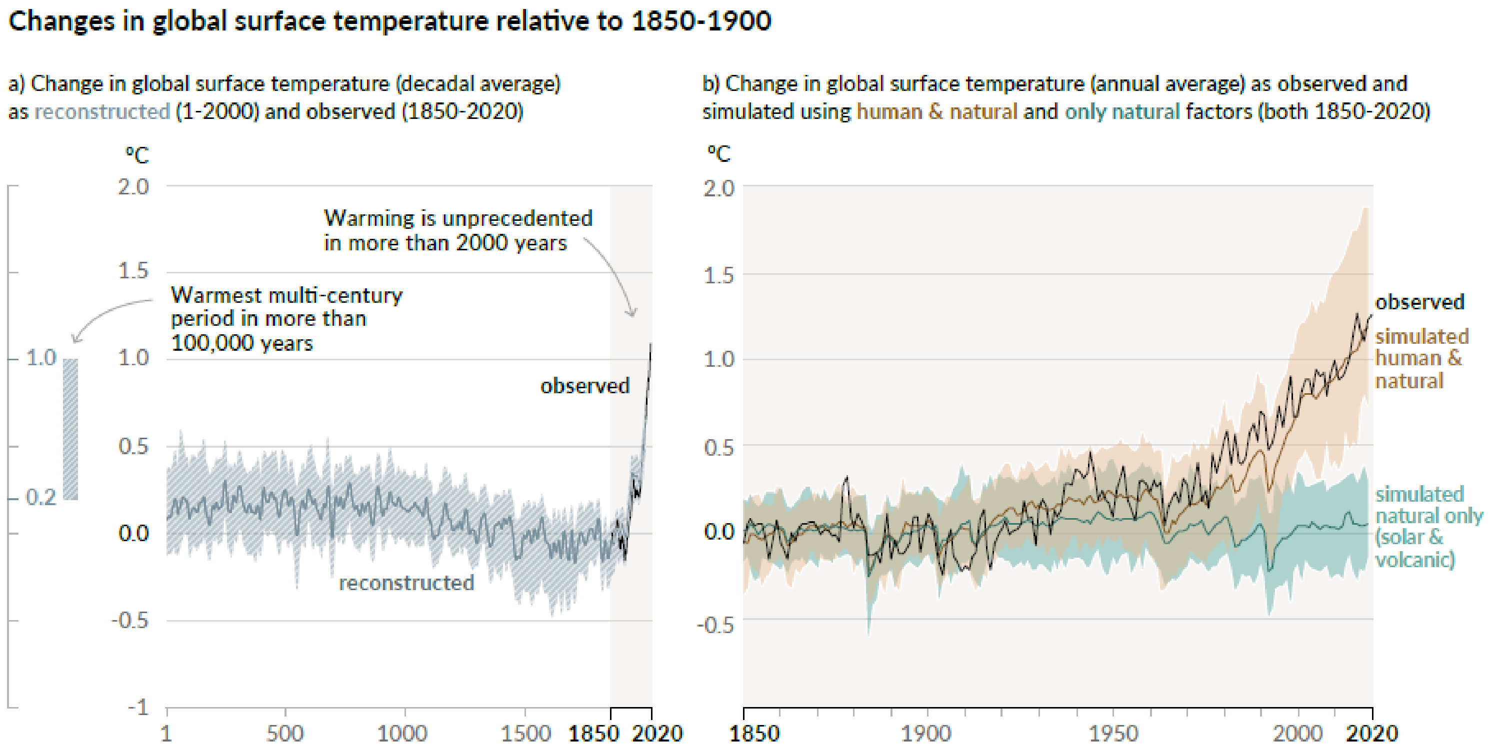
12-13-14 Maggio 2022 Fiera del Levante, Bari

BARI
SMART CITY
CONFERENCE

TECNICHE DI MITIGAZIONE DEI CAMBIAMENTI CLIMATICI GLOBALI E LOCALI

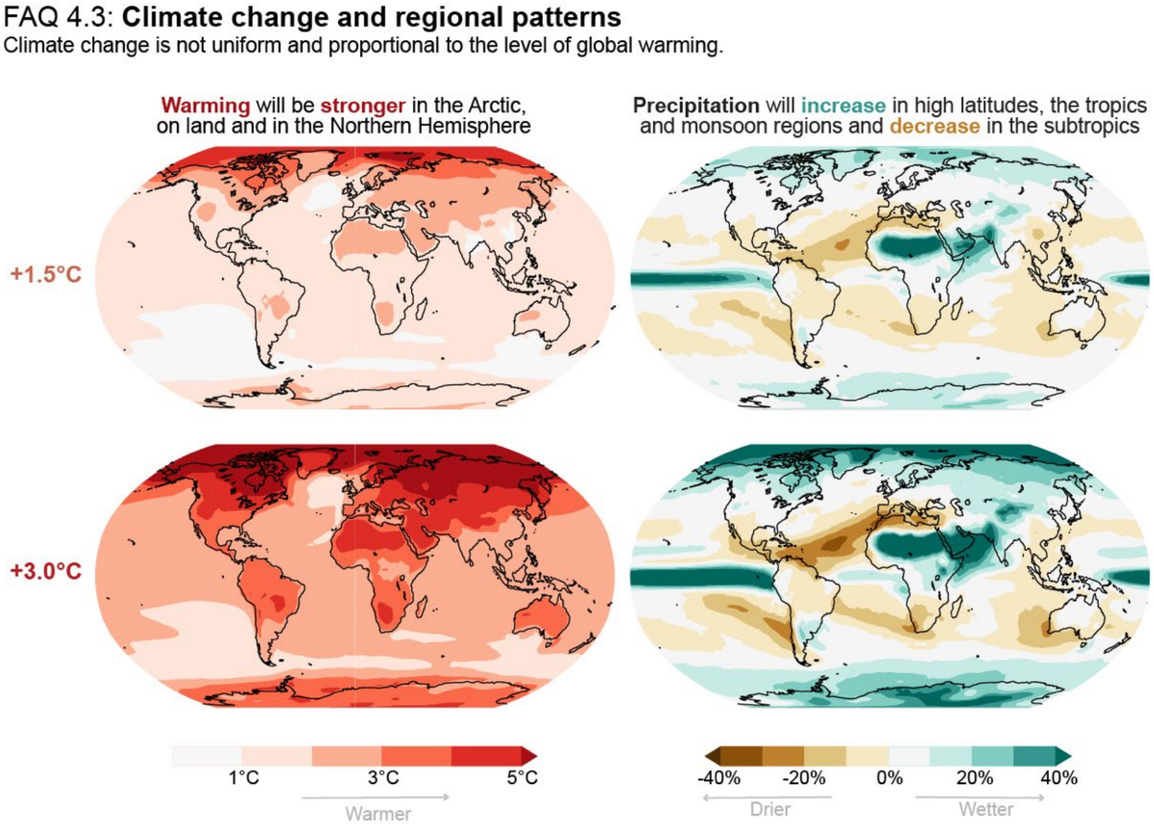
prof. ing. Francesco Fiorito – Professore Associato di Architettura Tecnica presso il Politecnico di Bari

Adattamento e mitigazione dei cambiamenti climatici: una delle sfide maggiori dell'ingegneria del XXI secolo



Fonte: IPCC, Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, in: V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, B. Zhou (Eds.), 2021.

Adattamento e mitigazione dei cambiamenti climatici: una delle sfide maggiori dell'ingegneria del XXI secolo



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Cambiamenti climatici e salute umana

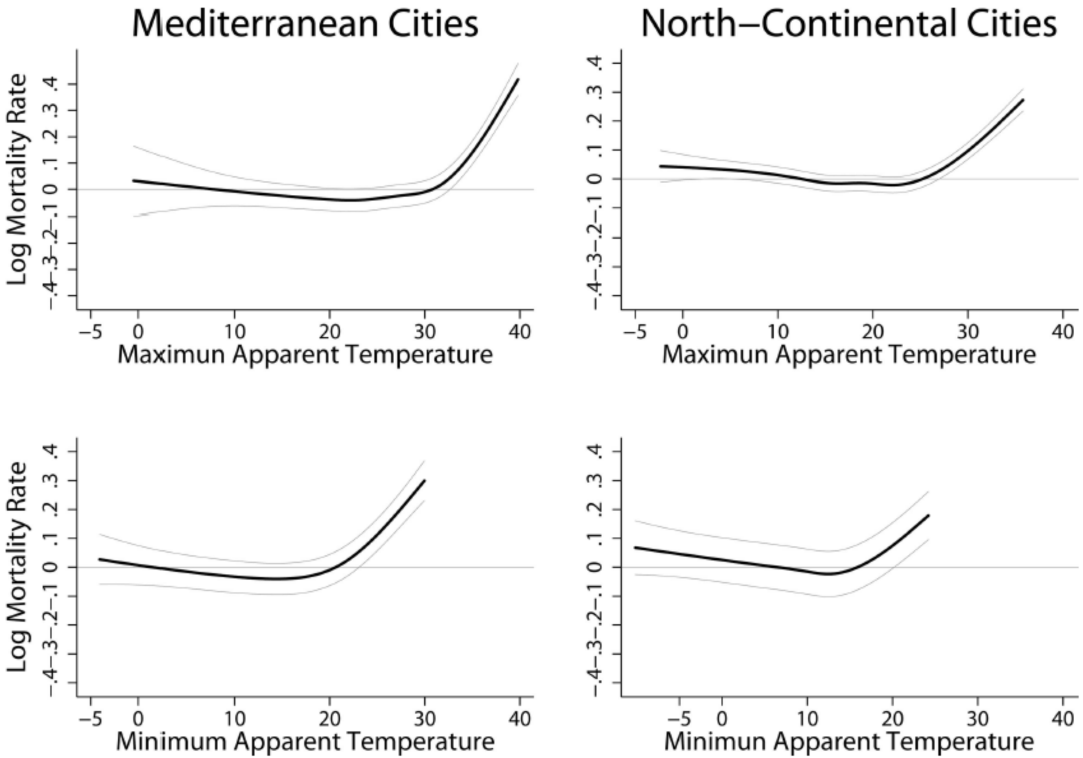
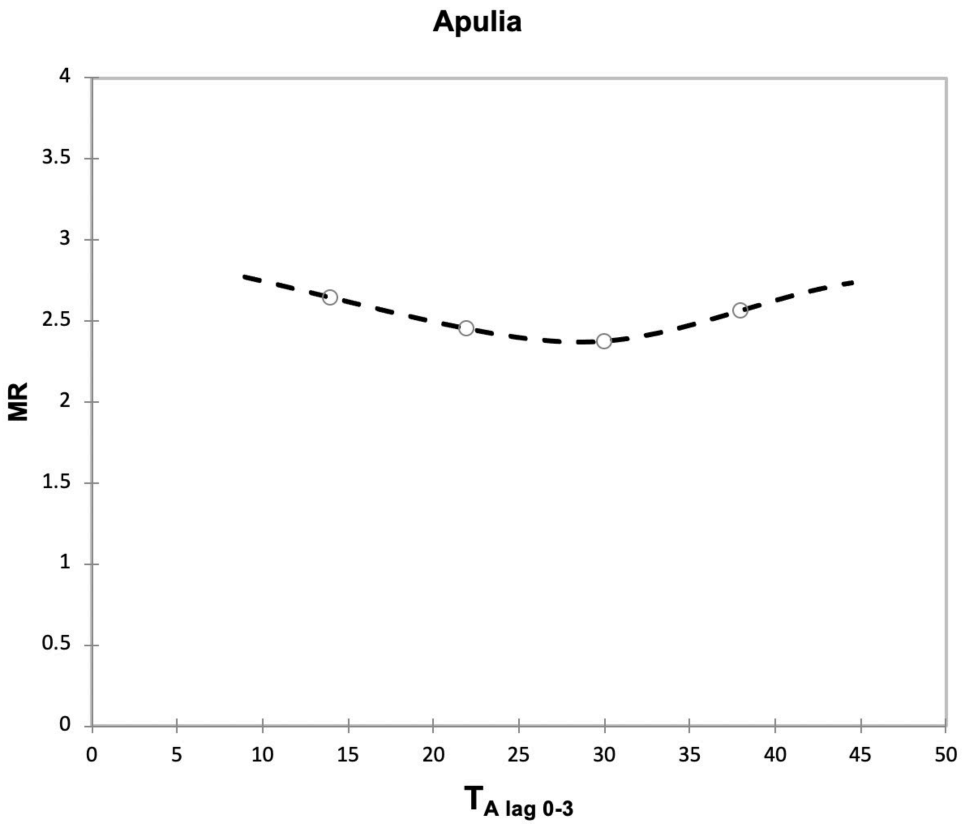


FIGURE 2. Fixed effects meta-analytic curves (pointwise 95% confidence bands) describing, on log scale, the adjusted effect of daily maximum (top) and daily minimum (bottom) apparent temperature at lag 0–3 on natural mortality. The left panel illustrates meta-analytic curves for Mediterranean cities (excluding Barcelona). The right panel shows the same curves for north-continental cities.

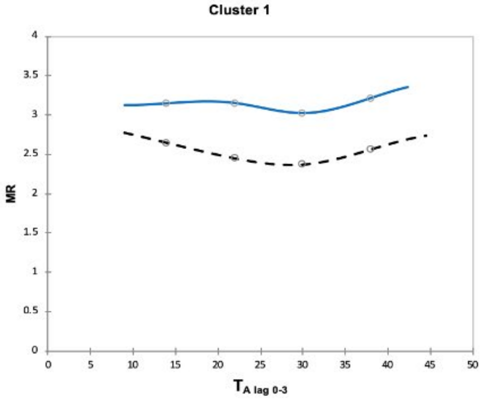
Fonte: Baccini M, Biggeri A, Accetta G, Kosatsky T, Katsouyanni K, Analitis A, et al. Heat effects on mortality in 15 European cities. Epidemiology. 2008;19(5):711-9. doi: 10.1097/EDE.0b013e318176bfcd.

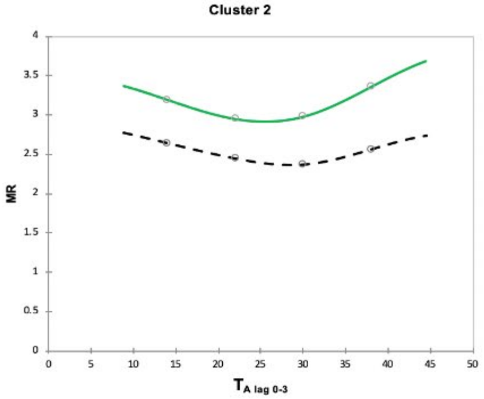
Cambiamenti climatici e salute umana

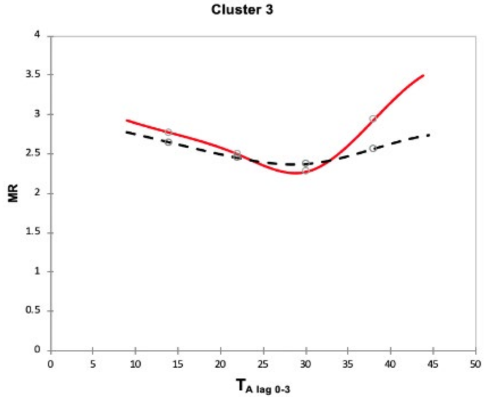


Fonte: P. Pierucci, V. Sangiorgio, F. Lucanie, F. Fiorito, M. Santamouris. On the impact of Regional Overheating, Socio-Demographic Indicators and Quality of Buildings on Mortality Rate in the Apulia Region. Submission under review

Cambiamenti climatici e salute umana





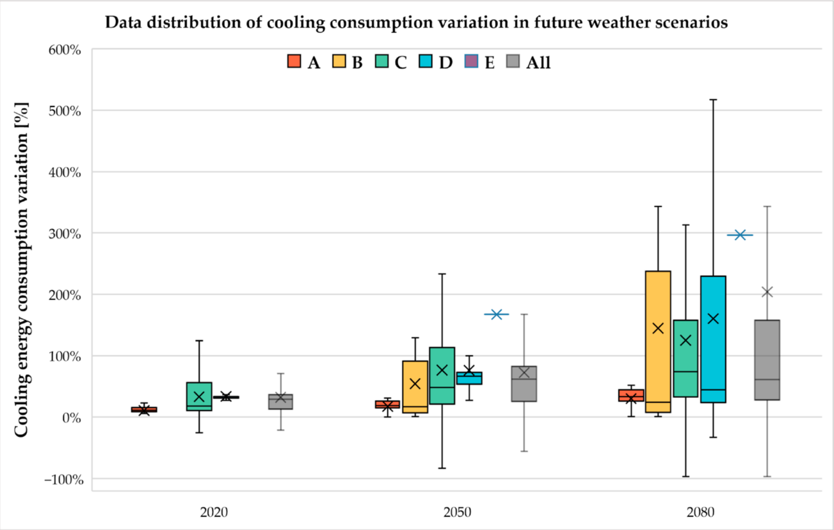


Livello di istruzione | Tipologia edilizia | Età edifici | Stato di conservazione

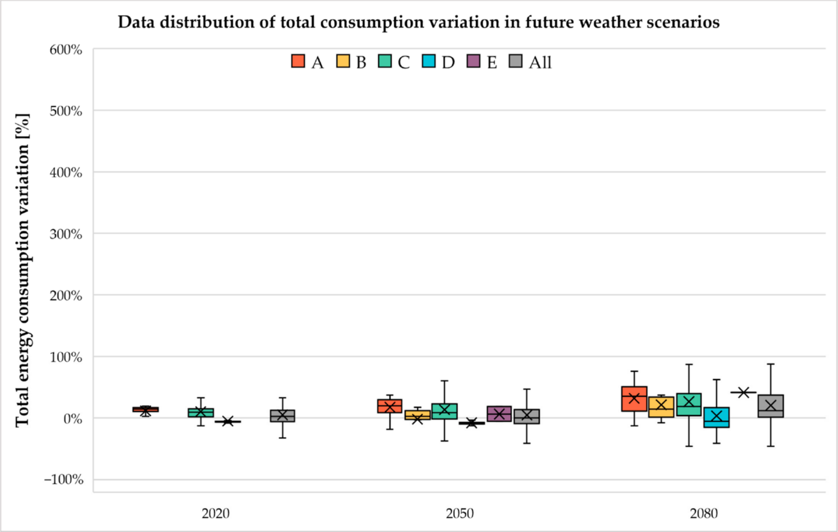
	P1 [%]	P2 [%]	P3 [%]	P4 [%]	P5 [n/1000p]	P6 [km²/1000p]	P7 [y]	P8 [k€/p]
Overall Region	36.27	30.25	27.52	83.31	6.19	4.81	44.27	9.60
Cluster 1	36.89	40.91	24.61	83.70	5.54	6.47	44.26	9.68
Cluster 2	38.51	35.37	22.80	81.50	9.07	4.13	44.68	10.35
Cluster 3	32.65	24.77	31.84	85.38	3.09	5.08	43.96	8.28
Cluster 4	34.57	35.30	30.58	82.52	3.45	4.92	43.17	9.15
Cluster 5	35.44	22.17	28.60	84.17	6.03	4.44	44.65	9.36

Fonte: P. Pierucci, V. Sangiorgio, F. Lucanie, F. Fiorito, M. Santamouris. On the impact of Regional Overheating, Socio-Demographic Indicators and Quality of Buildings on Mortality Rate in the Apulia Region. Submission under review

Cambiamenti climatici e consumi energetici degli edifici



(b)



(c)

Source: L.M. Campagna, F. Fiorito, On the Impact of Climate Change on Building Energy Consumptions: A Meta-Analysis, Energies, 15:134 (2022)

Cambiamenti climatici e povertà energetica

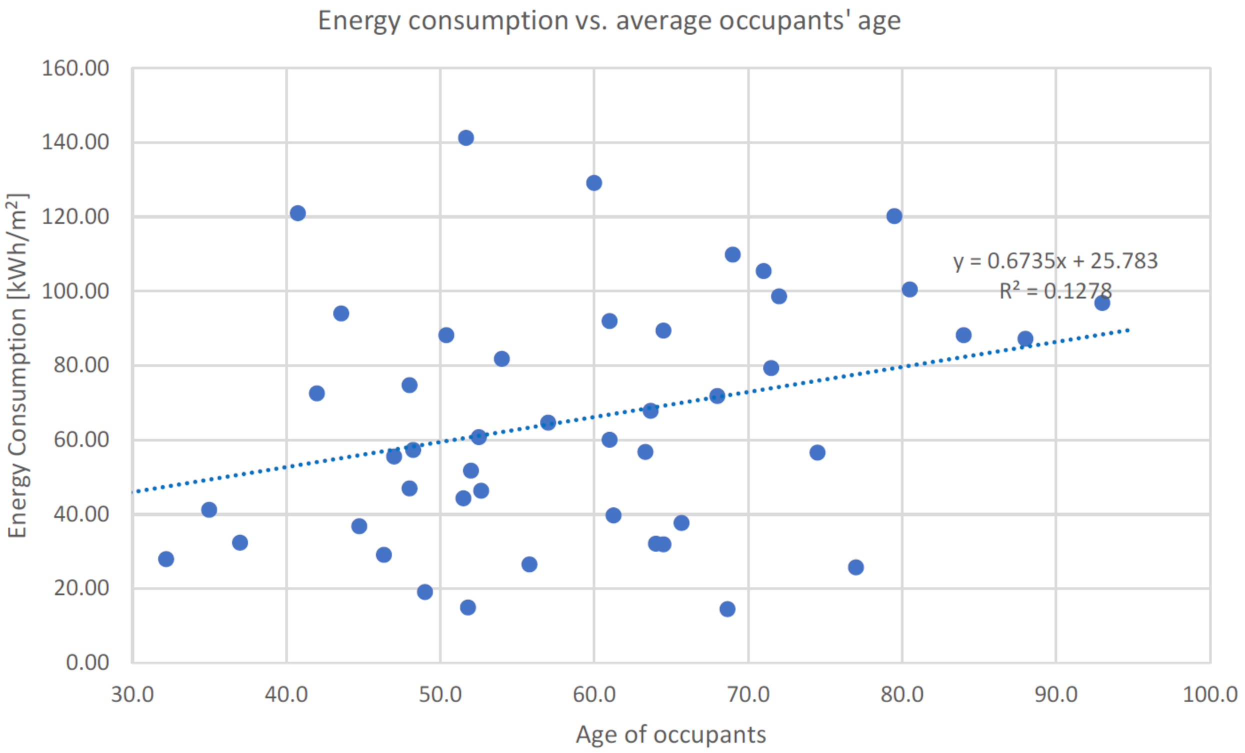


Figure 6. Relationship between energy consumption for heating and age of occupants of the building.

Fonte: G. Vurro, V. Santamaria, C. Chiarantoni, F. Fiorito, Climate Change Impact on Energy Poverty and Energy Efficiency in the Public Housing Building Stock of Bari, Italy. Climate 10:55 (2022)

Cambiamenti climatici e povertà energetica

Table 2. Heating, cooling and total energy consumptions of the building in 2020, 2050 and 2080.

	Energy Consumption [kWh/m²]			Variation [%]		
	2020	**2050**	**2080**	**2020–2050**	**2050–2080**	**2020–2080**
Heating	34.13	26.63	19.35	−22.0	−27.3	−43.3
Cooling	37.50	51.35	70.89	37.0	38.0	89.1
Total	71.63	77.99	90.24	8.9	15.7	26.0

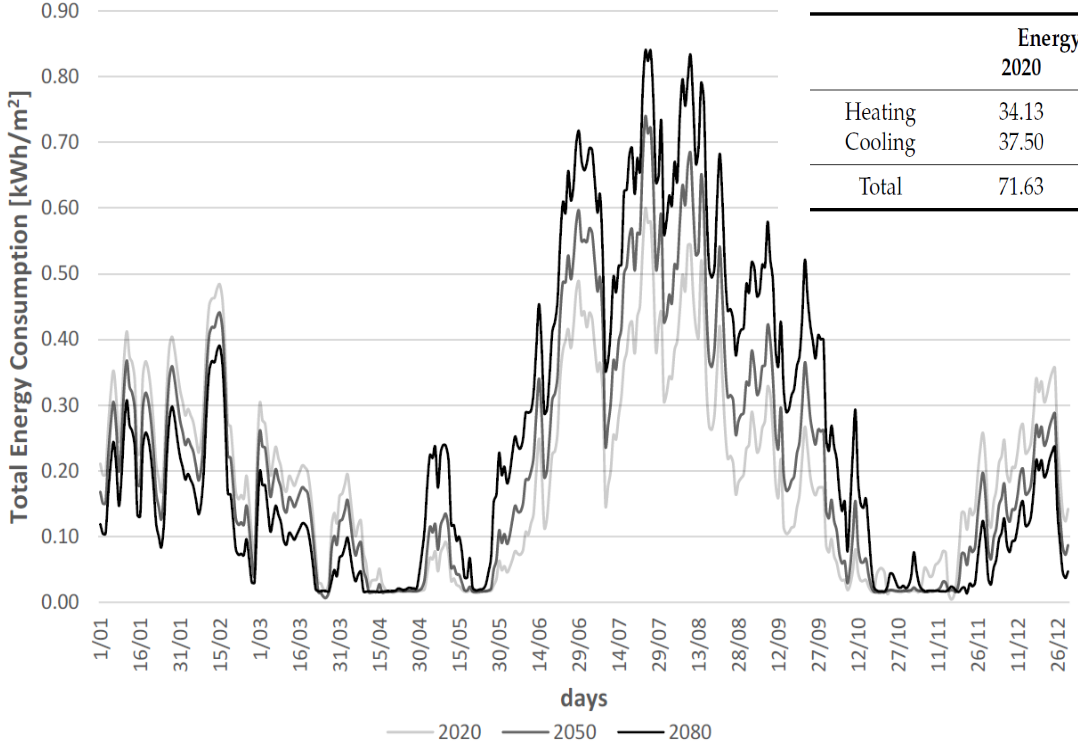
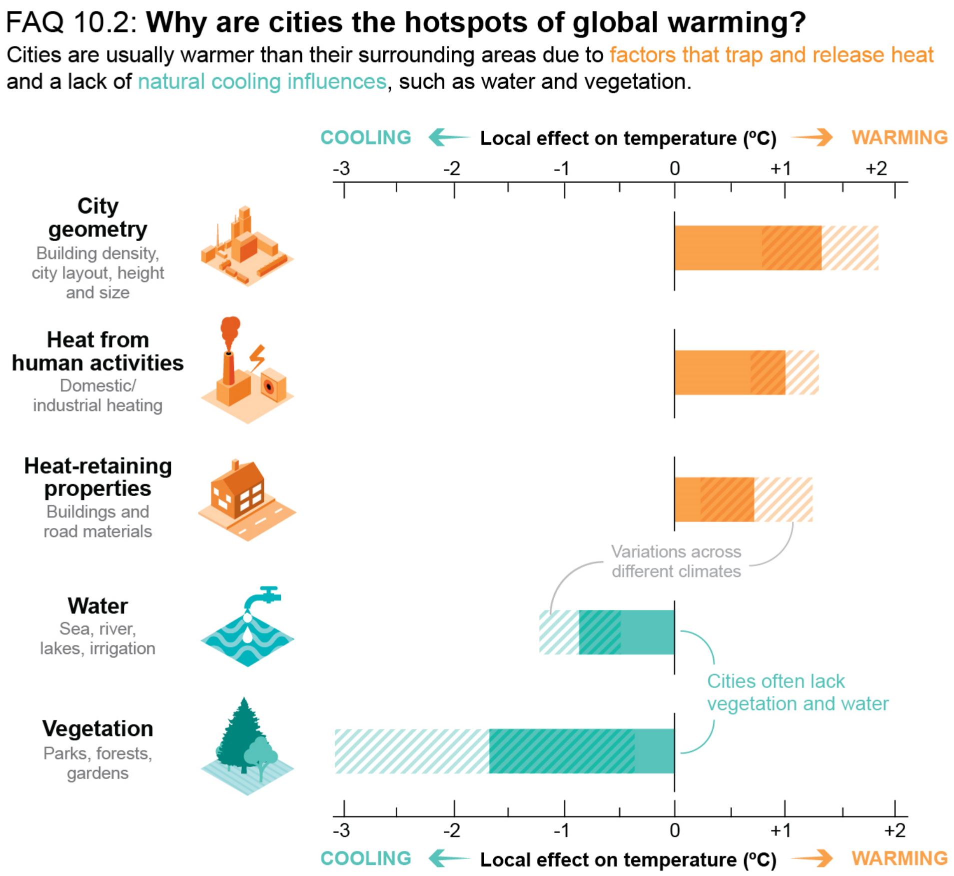


Figure 7. Comparison of total energy consumption of the building for the future scenarios.

Fonte: G. Vurro, V. Santamaria, C. Chiarantoni, F. Fiorito, Climate Change Impact on Energy Poverty and Energy Efficiency in the Public Housing Building Stock of Bari, Italy. Climate 10:55 (2022)

Clima urbano e cambiamenti climatici



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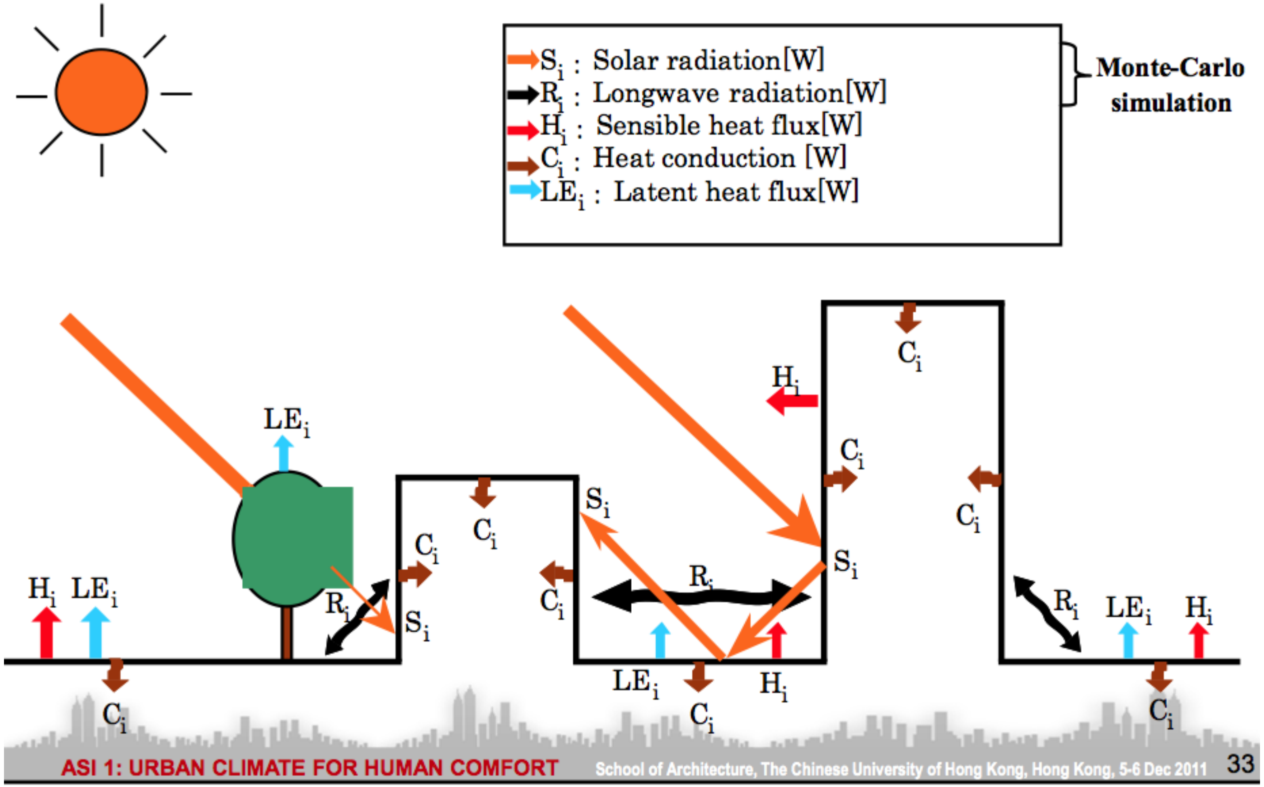
Clima urbano e cambiamenti climatici

Heat balance components considered in the coupled analysis



http://www.arch.cuhk.edu.hk/asi2011/en/Sources/ASI_PPT_Final/ASI%20PDF/ASI%201/6%20Dec%202011/ASI1_Lecture_5_Akashi%20Mochida.pdf

Intensità del fenomeno dell'ICU

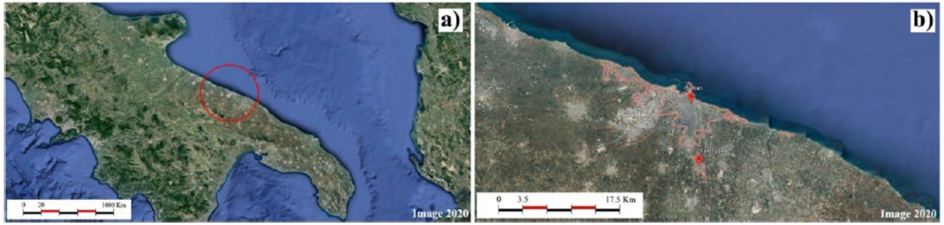


Figure 1. Google Earth image of (**a**) geographic location of Bari and (**b**) Bari and Valenzano areas.

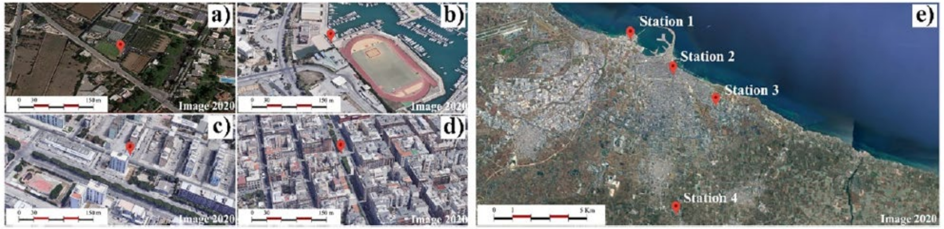


Figure 2. (**a**) Station 4 area, (**b**) station 1 area; (**c**) station 3 area; (**d**) station 2 area; (**e**) locations of the weather stations.

Figure 3. View from the ground of the four weather stations: (**a**) weather station 1 positioned near the University Sport Centre, (**b**) weather station 2 at corso Cavour, (**c**) weather station 3 at via Caldarola, (**d**) weather station 4 at the Mediterranean Agronomic Institute in Valenzano.

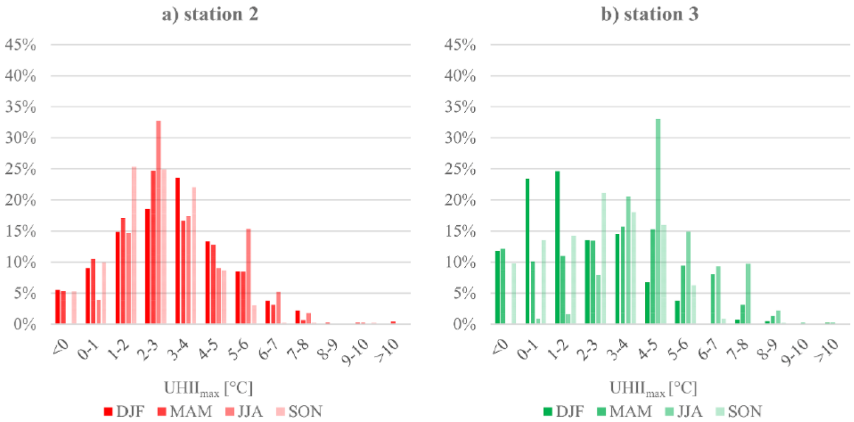


Figure 7. Seasonal distribution of daily values of maximum hourly difference of temperature recorded during each day (UHII$_{max}$) at (**a**) stations 2 and (**b**) 3.

Fonte: Martinelli, A.; Kolokotsa, D.D.; Fiorito, F. Urban heat island in mediterranean coastal cities: The case of bari (italy). Climate 2020, 8.

Il ruolo dell’involucro edilizio nella mitigazione degli effetti dei cambiamenti climatici

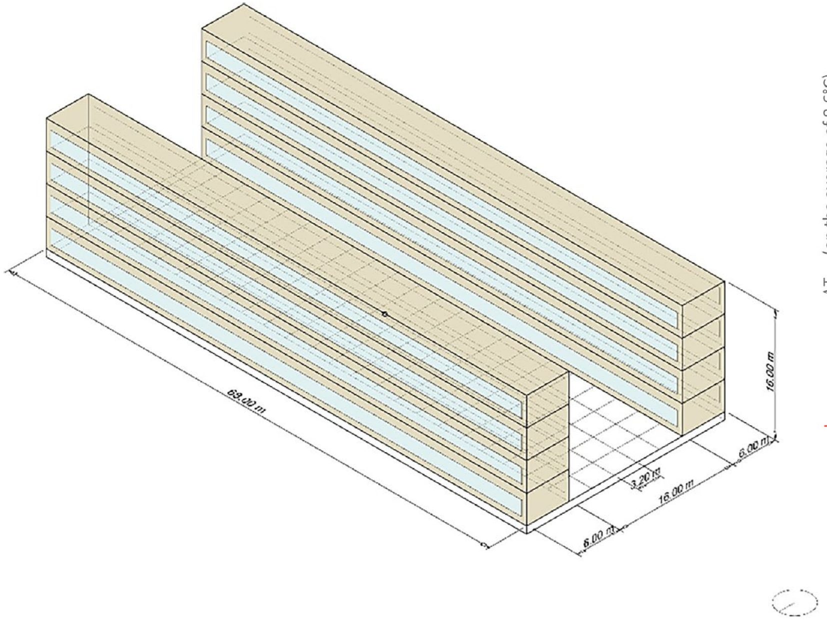
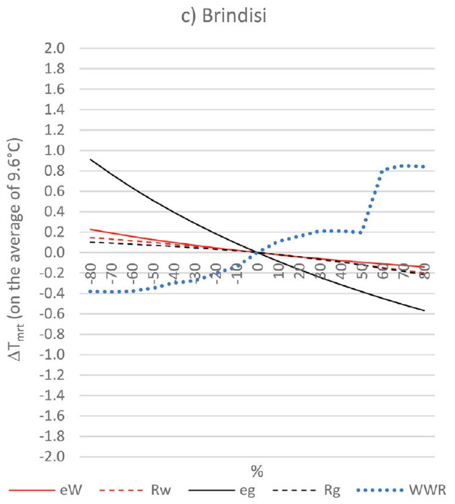


Fig. 6. Winter design week: parametric analysis of T_{mrt} as a variation of WWR, façade and ground, emissivity and solar reflectance.



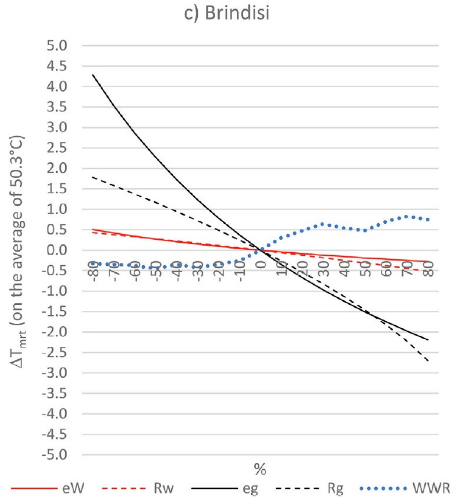
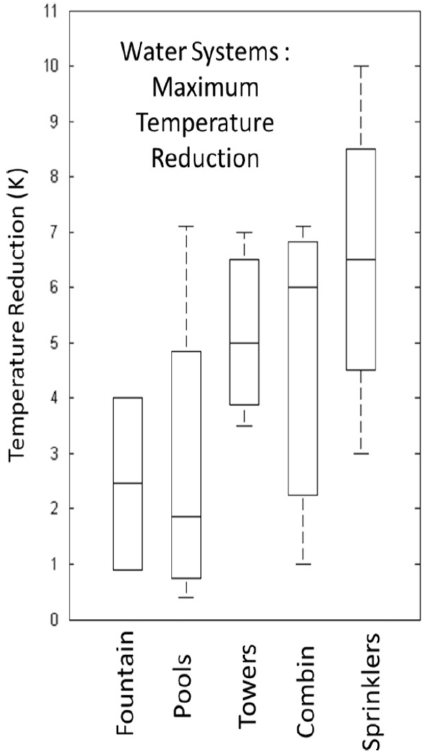
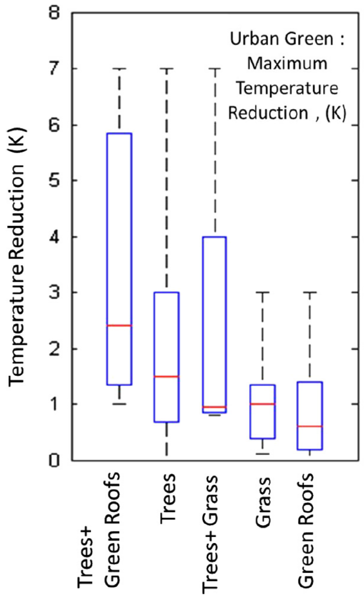


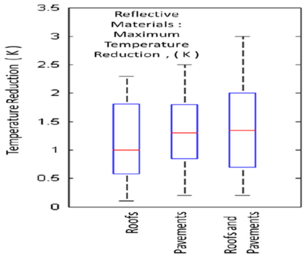
Fig. 7. Parametric analysis of T_{mrt} as a variation of WWR, emissivity and solar reflectance during typical summer design weeks.

Fonte: E. Naboni, A. Milella, R. Vadalà, F. Fiorito, On the localised climate change mitigation potential of building facades. Energy and Buildings (2020).

Tecnologie convenzionali di mitigazione degli effetti dei cambiamenti climatici locali e globali







Fonte: M. Santamouris, L. Ding, F. Fiorito, P. Oldfield, P. Osmond, R. Paolini, D. Prasad, A. Synnefa, Passive and active cooling for the outdoor built environment – Analysis and assessment of the cooling potential of mitigation technologies using performance data from 220 large scale projects, Solar Energy (2016).

Applicazione delle tecnologie di mitigazione ad un distretto esistente e Analisi degli effetti sul consumo energetico degli edifici

Fonte: M. Santamouris, S. Haddad, M. Saliari, K. Vasilakopoulou, A. Synnefa, R. Paolini, G. Ulpiani, S. Garshasbi, F. Fiorito, On the energy impact of urban heat island in Sydney: Climate and energy potential of mitigation technologies, Energy and Buildings, 166 (2018) 154-164.

Applicazione delle tecnologie di mitigazione ad un distretto esistente e Analisi degli effetti sul consumo energetico degli edifici

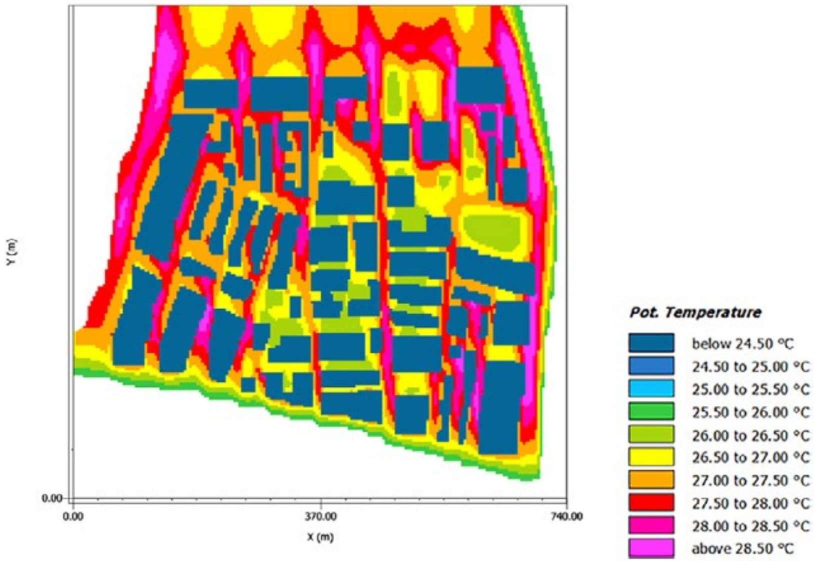


Fig. 2. Temperature distribution at the ground level of base case scenario (ID 1).

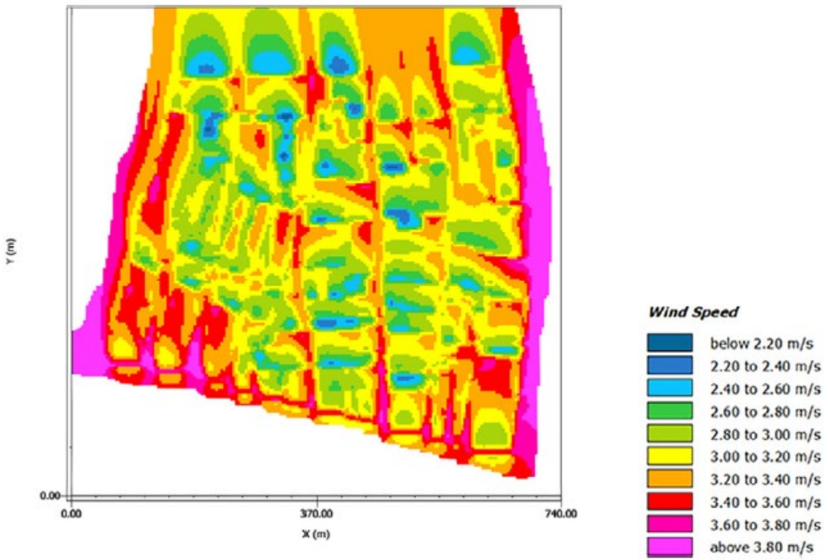


Fig. 3. Wind speed distribution at the ground level of base case scenario (ID 1).

Fonte: M. Santamouris, S. Haddad, M. Saliari, K. Vasilakopoulou, A. Synnefa, R. Paolini, G. Ulpiani, S. Garshasbi, F. Fiorito, On the energy impact of urban heat island in Sydney: Climate and energy potential of mitigation technologies, Energy and Buildings, 166 (2018) 154-164.

Applicazione delle tecnologie di mitigazione ad un distretto esistente e Analisi degli effetti sul consumo energetico degli edifici

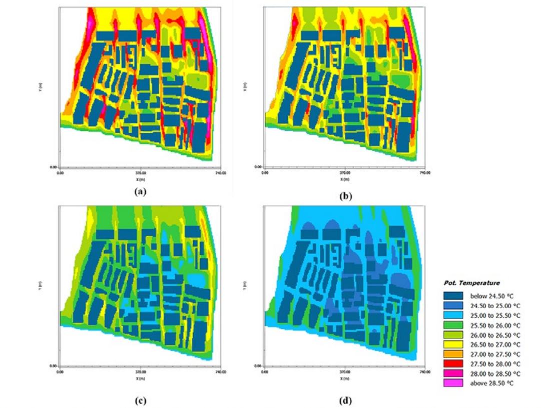


Fig. 4. Temperature distribution at the ground level of scenarios involving the increase of the global albedo. (a) Scenario ID 2; (b) Scenario ID 3; (c) Scenario ID 4; (d) Scenario ID 5.

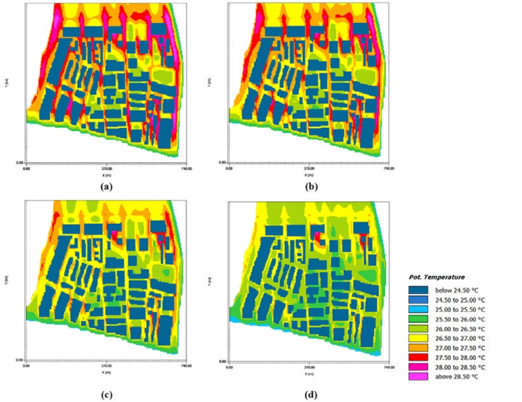


Fig. 5. Temperature distribution at the ground level of scenarios involving the increase of the albedo of streets. (a) Scenario ID 6; (b) Scenario ID 7; (c) Scenario ID 8; (d) Scenario ID 9.

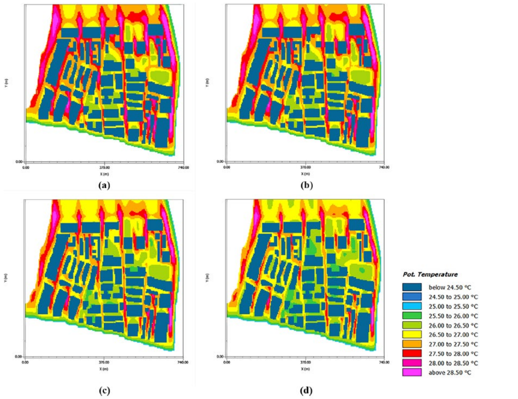


Fig. 6. Temperature distribution at the ground level of scenarios involving the increase of the albedo of pavements. (a) Scenario ID 10; (b) Scenario ID 11; (c) Scenario ID 12; (d) Scenario ID 13.

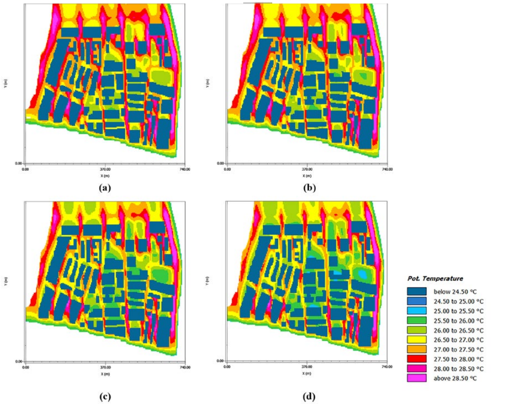


Fig. 7. Temperature distribution at the ground level of scenarios involving the increase of the albedo of roofs. (a) Scenario ID 14; (b) Scenario ID 15; (c) Scenario ID 16; (d) Scenario ID 17.

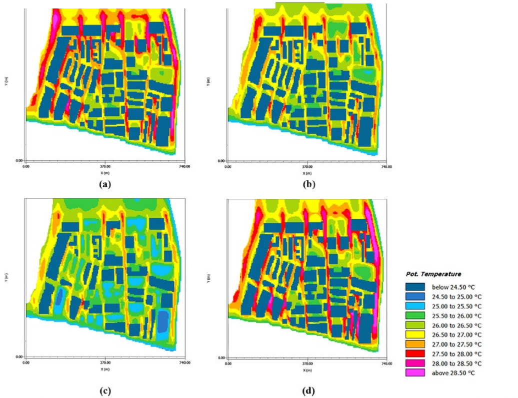


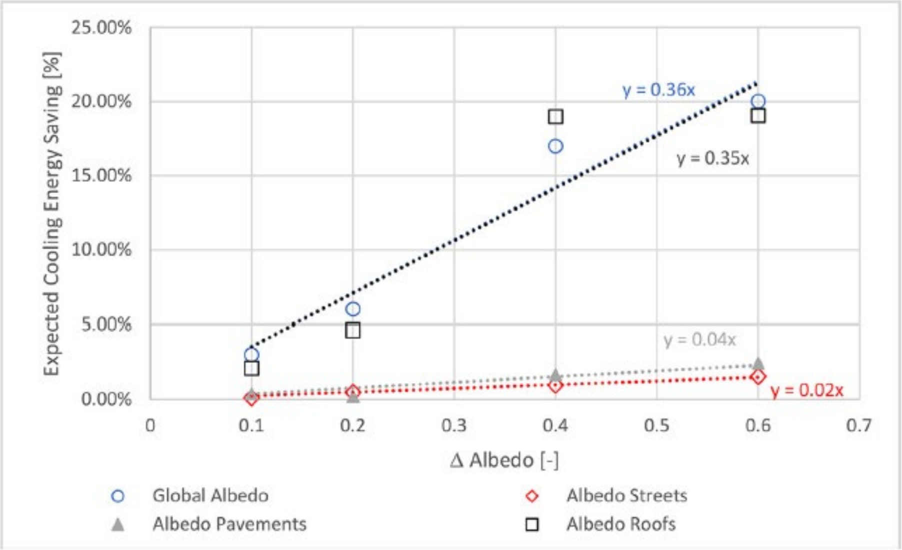
Fig. 8. Temperature distribution at the ground level of scenarios involving the increase of the greenery. (a) Increase of the greenery at ground level to 20% (ID 18); (b) Increase of the greenery at ground level to 40% (ID 19); (c) Increase of the greenery at ground level to 60% (ID 20); (d) Implementation of green roofs on the 100% of the area (ID 21).

Fonte: M. Santamouris, S. Haddad, M. Saliari, K. Vasilakopoulou, A. Synnefa, R. Paolini, G. Ulpiani, S. Garshasbi, F. Fiorito, On the energy impact of urban heat island in Sydney: Climate and energy potential of mitigation technologies, Energy and Buildings, 166 (2018) 154-164.

Applicazione delle tecnologie di mitigazione ad un distretto esistente e Analisi degli effetti sul consumo energetico degli edifici

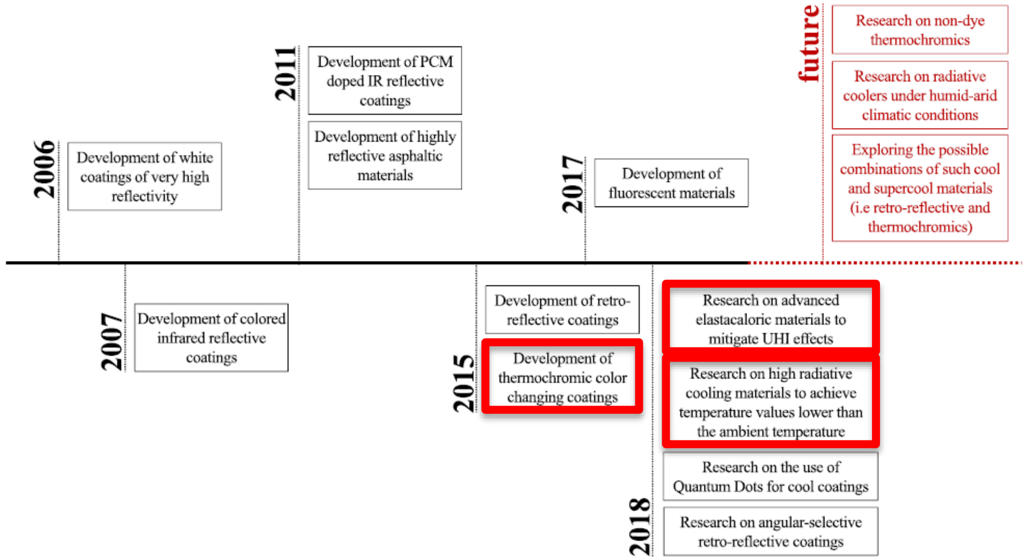
Table 3
Calculated cooling loads for the typical building under the 21 scenarios.

Category	Scenario ID	Cooling load [kWh/m²]	Energy conservation [%]
Base case	1	2.35	
Global Albedo	2	2.28	−3.00%
	3	2.21	−6.00%
	4	1.94	−17.00%
	5	1.89	−20.00%
Albedo Streets	6	2.34	−0.11%
	7	2.34	−0.46%
	8	2.32	−0.97%
	9	2.31	−1.54%
Albedo Pavements	10	2.34	−0.36%
	11	2.34	−0.20%
	12	2.31	−1.65%
	13	2.29	−2.42%
Albedo Roofs	14	2.30	−2.10%
	15	2.24	−4.62%
	16	1.90	−18.98%
	17	1.90	−19.06%
Greenery	18	2.34	−0.48%
	19	2.32	−1.23%
	20	2.29	−2.31%
Green roofs	21	2.35	+0.2%



Fonte: M. Santamouris, S. Haddad, M. Saliari, K. Vasilakopoulou, A. Synnefa, R. Paolini, G. Ulpiani, S. Garshasbi, F. Fiorito, On the energy impact of urban heat island in Sydney: Climate and energy potential of mitigation technologies, Energy and Buildings, 166 (2018) 154-164.

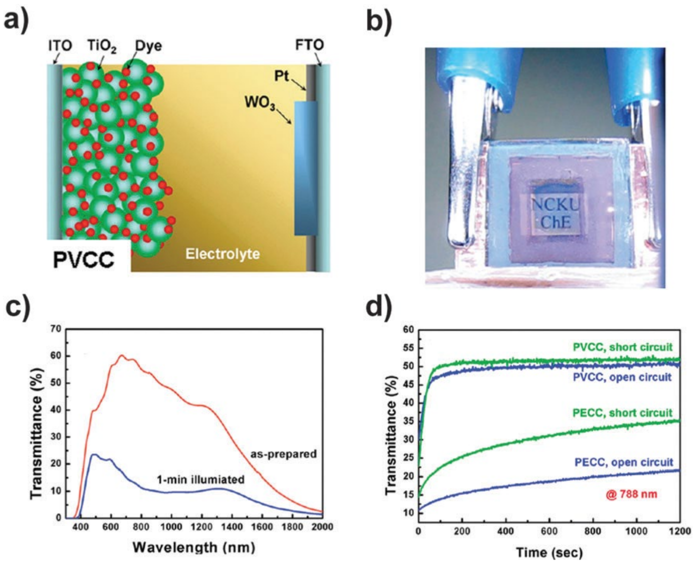
Tecnologie innovative di mitigazione degli effetti dei cambiamenti climatici locali e globali



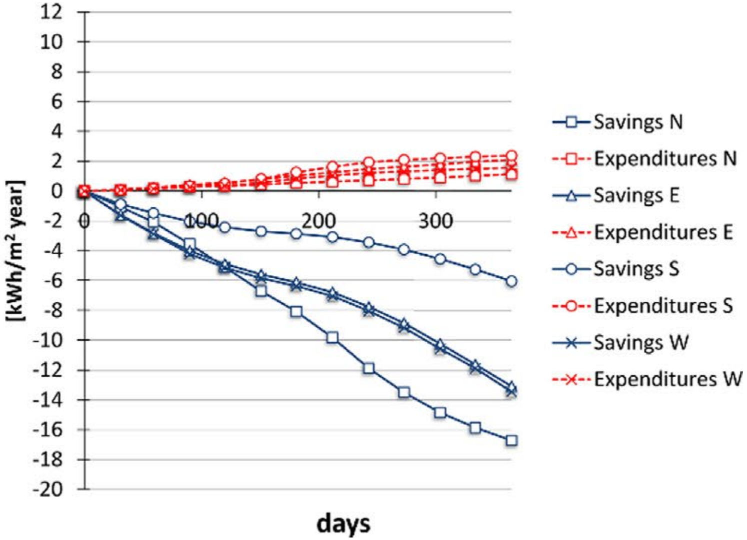
Fonte: M. Manni, I. Kousis, G. Lobaccaro, F. Fiorito, A. Cannavale, M. Santamouris. Urban overheating mitigation through facades: the role of new and innovative cool coatings. Rethinking Building Skins, Elsevier (2022)

Tecnologie innovative di mitigazione degli effetti dei cambiamenti climatici locali e globali

Tecnologie fotovoltacromiche



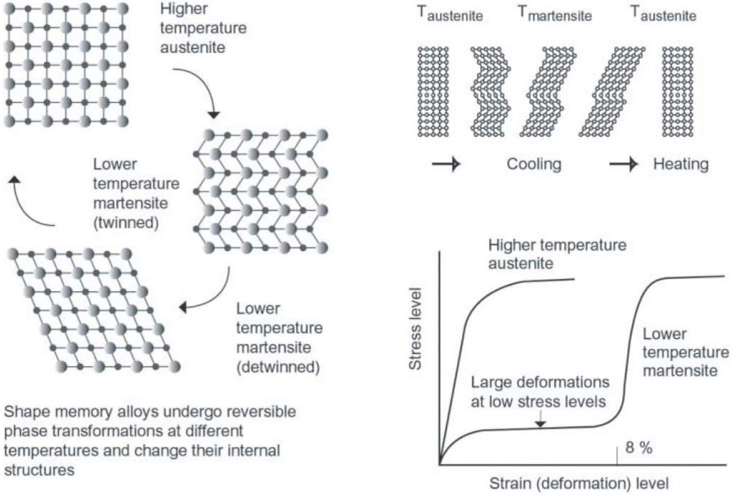
Fonte: Cannavale, A.; Cossari, P.; Eperon, G.E.; Colella, S.; Fiorito, F.; Gigli, G.; Snaith, H.J.; Listorti, A. Forthcoming perspectives of photoelectrochromic devices: A critical review. Energy and Environmental Science (2016)

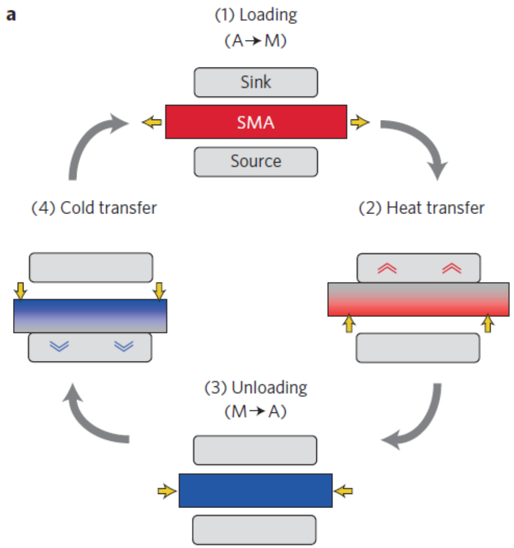


Fonte: F. Fiorito, A. Cannavale, M. Santamouris. Development, testing and evaluation of energy savings potentials of photovoltachromic windows in office buildings. A perspective study for Australian climates. Solar Energy (2020).

Tecnologie innovative di mitigazione degli effetti dei cambiamenti climatici locali e globali

Tecnologie elastocaloriche





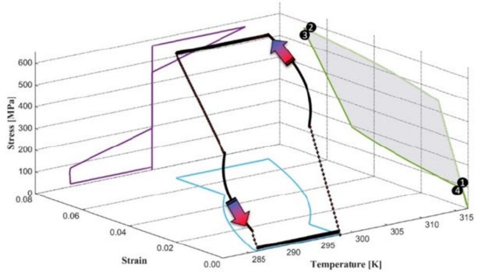
Fonte: Ossmer, H.; Kohl, M. Elastocaloric cooling: Stretch to actively cool. Nature Energy (2016)

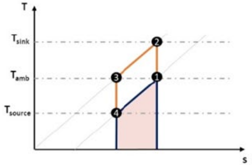
Tecnologie innovative di mitigazione degli effetti dei cambiamenti climatici locali e globali

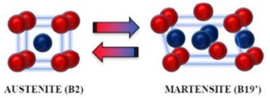
Tecnologie elastocaloriche

Australian Government
Australian Research Council

Discovery Project 180101589
(UNSW, USYD, KIT, POLIBA)



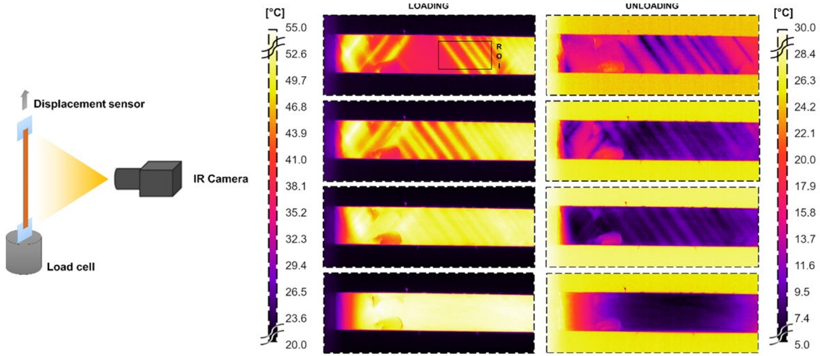


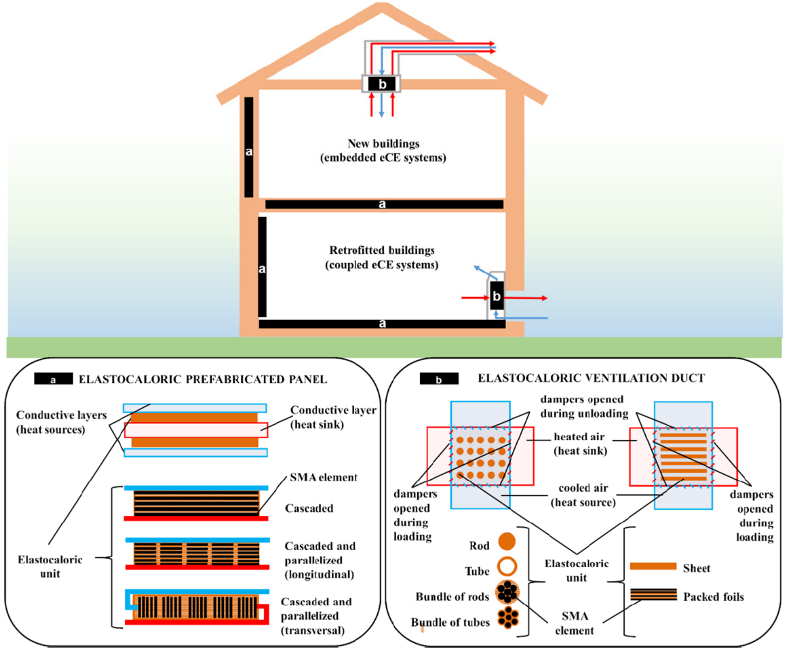


$$Q_c = \int_{41} T ds$$

$$COP = \frac{Q_c}{W}$$

$$W = \frac{1}{\rho} \int_{1234} \sigma d\varepsilon = \int_{1234} T ds$$





Fonte: G. Ulpiani, G. Ranzi, F. Bruederlin, R. Paolini, F. Fiorito, S. Haddad, M. Kohl, M. Santamouris. Elastocaloric cooling: roadmap towards successful implementation in the built environment. AIMS Materials Science (2019)

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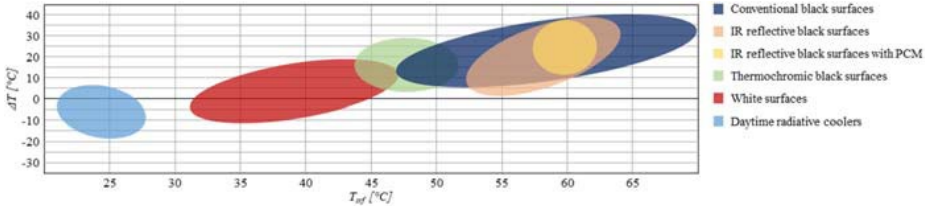

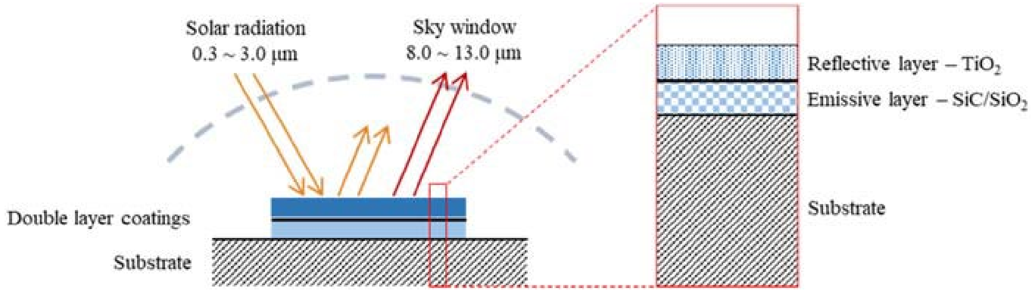

Fonte: M. Manni, I. Kousis, G. Lobaccaro, F. Fiorito, A. Cannavale, M. Santamouris. Urban overheating mitigation through facades: the role of new and innovative cool coatings. Rethinking Building Skins, Elsevier (2022)

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