natureresearch
https://doi.org/10.1038/s43017-020-00129-5

Supplementary information

Greenery as a mitigation and adaptation strategy to urban heat

In the format provided by the authors and unedited

Supplementary Information

Greenery as a mitigation and adaptation strategy to urban heat

Nyuk Hien Wong, Chun Liang Tan, Dionysia Denia Kolokotsa & Hideki Takebayashi

Supplementary Table 1. Studies used in the analyses of Figure 3.

	No.	Temperature reduction	Location	Year of Publication	Remarks	Citation
Greenery on the ground - air temperature	1	1	London, England	2016	8 green spaces in London	Vaz Monteiro, et al. [1]
	2	1.5	Washington, USA	1992	Spot measurements at 3 sites with tree plantings	Kjelgren and Clark [2]
	3	1.7	Singapore	2020	88 measurement points across city-state	Richards, et al. [3]
	4	1.85	Taipei city, Taiwan	2003	60 parks in Taipei city	Chang and Li [4]
	5	1.9	Nagoya, Japan	2010	24 measurement points within Heiwa Park	Hamada and Ohta [5]
	6	2	Tokyo, Japan	1998	Multiple measurements around Tama Central Park	Ca, et al. [6]
	7	2	Gaborone, Botswana	2004	Records from 1 urban and 1 rural climatological station	Jonsson [7]
	8	2	Stockholm, Sweden	2006	Mobile measurements in and around a 15 ha park	Jansson, et al. [8]
	9	2	Seoul, South Korea	2017	Street level mobile measurements of air temperature across small green spaces	Park, et al. [9]
	10	2	Aracaju, Brazil	2017	7 measurement points in Aracaju	Anjos and Lopes [10]
	11	2.2	Tel Aviv, Israel	2014	4 sites in Tel Aviv, including a 2.8 ha urban park	Cohen, et al. [11]
	12	2.26	Various	2010	Various sites	Bowler, et al. [12]
	13	2.5	Southern Israel	2009	2 courtyards	Shashua-Bar, et al. [13]
	14	2.8	Beijing, China	2018	680 ha park	Yan, et al. [14]
	15	3	Chiba, Japan	2007	2.1 ha park	Thorsson, et al. [15]
	16	3	Melbourne, Australia	2020	Small urban park	Motazedian, et al. [16]
	17	3.36	Seoul, South Korea	2009	5 measurement sites in Seoul, including Seolleung Royal Tomb Park	Lee, et al. [17]
	18	3.4	Queensland, Australia	2019	18 urban parks in Gold Coast	Zhang, et al. [18]
	19	3.5	Tel Aviv, Israel	2006	3 different types of urban parks	Potchter, et al. [19]
	20	3.8	Tel Aviv, Israel	2012	10 measurement points, including 3 urban parks	Cohen, et al. [20]
	21	3.8	Athens, Greece	2014	16 measurement points in Athens, including a medium sized park	Skoulika, et al. [21]
	22	4	London, England	2014	111 ha park	Doick, et al. [22]
	23	4.01	Singapore	2005	Mobile measurements across city-state	Wong and Yu [23]
	24	4.1	Hong Kong	2019	Woodlands and Urban-forest	Fung and Jim [24]
	25	4.5	Ghardaia, Algeria	2012	4 measurement points in Ghardaia	bencheikh and Rchid [25]
	26	5.2	Switzerland	2009	14 locations, from the Jura Mountains to the southern side of the Alps	Renaud and Rebetez [26]
	27	5.8	Florence, Italy	2003	7 measurement sites, comprising of 6 gardens and 1 urban area	Bacci, et al. [27]
	28	5.9	Adelaide, Australia	2017	Mobile measurements within Adelaide	Soltani and Sharifi [28]
	29	6.3	Athens, Greece	2008	5 measurement routes, including a 15.5 ha garden	Zoulia, et al. [29]
	30	6.9	Lisbon, Portugal	2011	8 measurement points, including a 0.58 ha park	Oliveira, et al. [30]
Greenery on the ground - surface temperature	31	1.11	Beijing, China	2017	QuickBird and IKONOS images of Beijing	Sun and Chen [31]
	32	1.4	Pune, India	2020	Landsat images of Pune	Gohain, et al. [32]
	33	1.71	Beijing, China	2020	Landsat images of Beijing	Qiu and Jia [33]
	34	1.74	Guangzhou, China	2012	Landsat images of Guangzhou	Chen, et al. [34]
	35	1.78	Fuzhou, China	2017	Landsat images of Fuzhou	Yu, et al. [35]

	36	1.87	China	2014	32 cities in China	Zhou, et al. [36]
	37	2	Arizona, USA	2017	ASTER_08 images of Phoenix, Arizona	Zhang, et al. [37]
	38	2.04	Abuja City, Nigeria	2018	Landsat images of Abuja City	Chibuike, et al. [38]
	39	2.5	Barcelona, Spain	2020	Landsat images of Barcelona	Lemus-Canovas, et al. [39]
	40	3.2	Indianapolis, USA	2004	Landsat images of Indianapolis	Weng, et al. [40]
	41	4	Shenzhen, China	2019	Landsat images of Shenzhen	Wang, et al. [41]
	42	4.8	Beijing, China	2015	Landsat images of Beijing	Lin, et al. [42]
	43	4.9	Nanjing, China	2014	Landsat images of Nanjing	Kong, et al. [43]
	44	5.2	Shanghai, China	2017	Landsat images of Shanghai	Du, et al. [44]
	45	6.65	Taipei, Taiwan	2016	40 green spaces	Shih [45]
	46	6.72	Addis Ababa, Ethiopia	2014	21 parks	Feyisa, et al. [46]
	47	6.82	Nagoya, Japan	2010	92 parks	Cao, et al. [47]
	48	7	Vancouver, Canada	1998	Several parks in Vancouver	Spronken-Smith and Oke [48]
	49	7	Tehran, Iran	2014	Landsat images of Tehran	Sodoudi, et al. [49]
	50	8	US	2010	38 cities in the US	Imhoff, et al. [50]
	51	8	South Tyrol, Italy	2015	124 Landsat images of South Tyrol over 40 years	Heinl, et al. [51]
	52	8.5	Hong Kong	2019	Woodlands and urban-forest	Fung and Jim [24]
	53	8.96	Changchun, China	2013	33 parks	Ren, et al. [52]
	54	9.18	Beijing, China	2007	Landsat images of Beijing	Xiao, et al. [53]
	55	10	Melbourne, Australia	2019	27 parks	Algretawee, et al. [54]
	56	12	Akure City, Nigeria	2019	Landsat images of 16 urban sites	Daramola and Balogun [55]
	57	15	4 cities in USA	2020	Landsat images of Baltimore, Detroit, Phoenix and Portland	Logan, et al. [56]
	58	19	Tokyo, Japan	1998	Multiple locations in and around Tama New Town	Ca, et al. [6]
	59	19	Bolzano, Italy	2020	Surface temperature under 332 trees	Speak, et al. [57]
	60	25	Chicago, USA	1997	2 parking lots and turf area	Kjelgren and Montague [58]
Green roofs - air temperature	61	0.5	Osaka, Japan	2001	4m x 9m roof lawn garden	Onmura, et al. [59]
	62	0.7	Hong Kong	2012	484m^2 extensive green roof	Jim and Peng [60]
	63	1	Reading, England	2013	1.2m x 0.4m x 0.4m custom-made containers with plants	Blanusa, et al. [61]
	64	1.3	Singapore	2012	Two 2m x 2m green roofs and one concrete roof	Qin, et al. [62]
	65	1.6	Taiwan	2012	1 green roof and 1 concrete roof	Sun, et al. [63]
	66	1.9	Morelos, Mexico	2020	Two test boxes of 1.2m x 1.2m	Ávila-Hernández, et al. [64]
	67	2	Athens, Greece	2001	1 green roof	Niachou, et al. [65]
	68	2.3	Cosenza, Italy	2016	200 m^2 extensive green roof	Bevilacqua, et al. [66]
	69	3.7	Tehran, Iran	2017	Two buildings, one with green roof	Moghbel and Erfanian Salim [67]
	70	4	Queensland, Australia	2020	Extensive green roof on a 6m shipping container	Anwar, et al. [68]
	71	4.02	Nanjing, China	2019	509m^2 extensive green roof	Yin, et al. [69]
	72	4.2	Singapore	2003	Intensive green roof	Wong, et al. [70]
	73	5	Shanghai, China	2016	3m x 3m lightweight extensive green roof	He, et al. [71]
	74	6.21	Hong Kong	2018	451 m^2 native-woodland intensive green roof	Lee and Jim [72]
	75	8	Hangzhou, China	2020	Three 0.5m x 0.5m x 0.2m green roof plots	Zhang, et al. [73]
Green walls – air temperature	76	0.2	Berlin, Germany	2015	3 building facades with climber plants	Hoelscher, et al. [74]
	77	1	Ouargla, Algeria	2013	Plants on a test cell	Nadia, et al. [75]
	78	2	Thessaloniki, Greece	2009	Climber green wall on a five storey building	Eumorfopoulou and Kontoleon [76]
	79	2	Lleida, Spain	2011	Support system green walls around a building on 3 sides	Pérez, et al. [77]
	80	2.1	Chicago, USA	2014	Climber green wall on a four storey building	Susorova, et al. [78]
	81	2.1	Indoor (Laboratory)	2017	1m x 1m green wall	Ottelé and Perini [79]
	82	2.7	Guangzhou, China	2019	2.1m x 2.1m wire mesh planting rack on a concrete wall	Zhang, et al. [80]

	83	3	Reading, England	2014	Combinations of green walls and brick walls (Total = 10 walls)	Cameron, et al. [81]
	84	3	Suzhou, China	2019	Climber green wall on a two storey building	Li, et al. [82]
	85	3.33	Singapore	2010	Eight 4m x 8m green walls and one control wall	Wong, et al. [83]
	86	4	Kyushu, Japan	1988	Ivy sunscreen	Hoyano [84]
	87	4	Johor, Malaysia	2014	Three 0.6m x 0.6m x 0.6m boxes with plants	Tabassom, et al. [85]
	88	4.1	Madrid, Spain	2014	1.8m x 2.4m green wall	Olivieri, et al. [86]
	89	5	Abu Dhabi, United Arab Emirates	2014	Carrier system green wall on two storey building	Haggag, et al. [87]
	90	8.7	Shiraz, Iran	2020	3m x 2m green wall on test cell	Shafiee, et al. [88]
Green roofs – surface temperature	91	5.2	Hong Kong	2012	484m^2 extensive green roof	Jim and Peng [60]
	92	8	Morelos, Mexico	2020	Two test boxes of 1.2m x 1.2m	Ávila-Hernández, et al. [64]
	93	9	Mauritius	2020	Nine 1.56m x 1.41m x 1.22m green roof cells	Mungur, et al. [89]
	94	10	Reading, England	2017	Fourteen 1.5m x 1.5m x 0.1m plots on a rooftop	Vaz Monteiro, et al. [90]
	95	12	Reading, England	2013	1.2m x 0.4m x 0.4m custom-made containers with plants	Blanusa, et al. [61]
	96	12	Cosenza, Italy	2016	200 m^2 extensive green roof	Bevilacqua, et al. [66]
	97	15.3	Singapore	2012	Two 2m x 2m green roofs and one concrete roof	Qin, et al. [62]
	98	19.8	Hong Kong	2018	451 m^2 native-woodland intensive green roof	Lee and Jim [72]
	99	20	Tartu, Estonia	2009	120m^2 Extensive green roof	Teemusk and Mander [91]
	100	20	Michigan, USA	2011	325.2m^2 extensive green roof	Getter, et al. [92]
	101	21.7	Shanghai, China	2020	One 1.5m x 1.5m x 1.5m cool roof and five 1.5m x 1.5m x 1.5m green roofs	He, et al. [93]
	102	23	Singapore	2017	Nine 1m x 1m plots on a rooftop	Tan, et al. [94]
	103	25	Unspecified	2005	Unspecified	Meng and Hu [95]
	104	30	Osaka, Japan	2001	4m x 9m roof lawn garden	Onmura, et al. [59]
	105	30	La Rochelle, France	2011	2 extensive green roofs	Ouldboukhitine, et al. [96]
Green walls - surface temperature	106	8.4	Indoor (Laboratory)	2017	1m x 1m green wall	Ottelé and Perini [79]
	107	9	Bari, Italy	2018	3 green walls	Vox, et al. [97]
	108	9.15	5 sites in England	2011	Ivy (Hedera helix) on building facades	Sternberg, et al. [98]
	109	9.9	Reading, England	2014	Combinations of green walls and brick walls (Total = 10 walls)	Cameron, et al. [81]
	110	11.58	Singapore	2010	Eight 4m x 8m green walls and one control wall	Wong, et al. [83]
	111	12.6	Chicago, USA	2014	Climber green wall on a four storey building	Susorova, et al. [78]
	112	14.2	Guangzhou, China	2019	2.1m x 2.1m wire mesh planting rack on a concrete wall	Zhang, et al. [80]
	113	15.5	Berlin, Germany	2015	3 building facades with climber plants	Hoelscher, et al. [74]
	114	16	Hong Kong	2010	2.5m x 1m green wall	Cheng, et al. [99]
	115	16	Singapore	2014	2 carrier system green walls	Tan, et al. [100]
	116	17.62	Lleida, Spain	2011	Support system green walls around a building on 3 sides	Pérez, et al. [77]
	117	20	3 sites in Italy	2013	Two 3m x 3m green walls, one 10.8m x 2.8m green wall	Mazzali, et al. [101]
	118	20.8	Wuhan, China	2013	Green walls on two thermal labs	Chen, et al. [102]
	119	30	Santiago, Chile	2015	Two 4m^2 green walls	Victorero, et al. [103]
	120	31.9	Madrid, Spain	2014	1.8m x 2.4m green wall	Olivieri, et al. [86]

References

1. Vaz Monteiro, M., Doick, K. J., Handley, P. & Peace, A. The impact of greenspace size on the extent of local nocturnal air temperature cooling in London. *Urban Forestry & Urban Greening* **16**, 160-169, doi:https://doi.org/10.1016/j.ufug.2016.02.008 (2016).
2. Kjelgren, R. K. & Clark, J. R. Microclimates and tree growth in three urban spaces. *Journal of Environmental Horticulture* **10**, 139-145 (1992).
3. Richards, D. R., Fung, T. K., Belcher, R. N. & Edwards, P. J. Differential air temperature cooling performance of urban vegetation types in the tropics. *Urban Forestry & Urban Greening* **50**, 126651, doi:https://doi.org/10.1016/j.ufug.2020.126651 (2020).
4. Chang, C.-R. & Li, M.-H. Effects of urban parks on the local urban thermal environment. *Urban Forestry & Urban Greening* **13**, 672-681, doi:https://doi.org/10.1016/j.ufug.2014.08.001 (2014).
5. Hamada, S. & Ohta, T. Seasonal variations in the cooling effect of urban green areas on surrounding urban areas. *Urban Forestry & Urban Greening* **9**, 15-24, doi:https://doi.org/10.1016/j.ufug.2009.10.002 (2010).
6. Ca, V. T., Asaeda, T. & Abu, E. M. Reductions in air conditioning energy caused by a nearby park. *Energy and Buildings* **29**, 83-92, doi:https://doi.org/10.1016/S0378-7788(98)00032-2 (1998).
7. Jonsson, P. Vegetation as an urban climate control in the subtropical city of Gaborone, Botswana. *International Journal of Climatology* **24**, 1307-1322, doi:10.1002/joc.1064 (2004).
8. Jansson, C., Jansson, P. E. & Gustafsson, D. Near surface climate in an urban vegetated park and its surroundings. *Theoretical and Applied Climatology* **89**, 185-193, doi:10.1007/s00704-006-0259-z (2007).
9. Park, J., Kim, J.-H., Lee, D. K., Park, C. Y. & Jeong, S. G. The influence of small green space type and structure at the street level on urban heat island mitigation. *Urban Forestry & Urban Greening* **21**, 203-212, doi:https://doi.org/10.1016/j.ufug.2016.12.005 (2017).
10. Anjos, M. & Lopes, A. Urban heat island and park Cool island intensities in the coastal city of Aracaju, north-eastern Brazil. *Sustainability* **9**, 1379 (2017).
11. Cohen, P., Potchter, O. & Schnell, I. A methodological approach to the environmental quantitative assessment of urban parks. *Applied Geography* **48**, 87-101, doi:https://doi.org/10.1016/j.apgeog.2014.01.006 (2014).
12. Bowler, D. E., Buyung-Ali, L., Knight, T. M. & Pullin, A. S. Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and Urban Planning* **97**, 147-155, doi:https://doi.org/10.1016/j.landurbplan.2010.05.006 (2010).
13. Shashua-Bar, L., Pearlmutter, D. & Erell, E. The cooling efficiency of urban landscape strategies in a hot dry climate. *Landscape and Urban Planning* **92**, 179-186, doi:https://doi.org/10.1016/j.landurbplan.2009.04.005 (2009).
14. Yan, H., Wu, F. & Dong, L. Influence of a large urban park on the local urban thermal environment. *Science of The Total Environment* **622-623**, 882-891, doi:https://doi.org/10.1016/j.scitotenv.2017.11.327 (2018).

15 Thorsson, S., Honjo, T., Lindberg, F., Eliasson, I. & Lim, E.-M. Thermal Comfort and Outdoor Activity in Japanese Urban Public Places. *Environment and Behavior* **39**, 660-684, doi:10.1177/0013916506294937 (2007).
16 Motazedian, A., Coutts, A. M. & Tapper, N. J. The microclimatic interaction of a small urban park in central Melbourne with its surrounding urban environment during heat events. *Urban Forestry & Urban Greening* **52**, 126688, doi:https://doi.org/10.1016/j.ufug.2020.126688 (2020).
17 Lee, S.-H., Lee, K.-S., Jin, W.-C. & Song, H.-K. Effect of an urban park on air temperature differences in a central business district area. *Landscape and Ecological Engineering* **5**, 183-191, doi:10.1007/s11355-009-0067-6 (2009).
18 Zhang, J., Gou, Z., Lu, Y. & Lin, P. The impact of sky view factor on thermal environments in urban parks in a subtropical coastal city of Australia. *Urban Forestry & Urban Greening* **44**, 126422, doi:https://doi.org/10.1016/j.ufug.2019.126422 (2019).
19 Potchter, O., Cohen, P. & Bitan, A. Climatic behavior of various urban parks during hot and humid summer in the mediterranean city of Tel Aviv, Israel. *International Journal of Climatology* **26**, 1695-1711, doi:10.1002/joc.1330 (2006).
20 Cohen, P., Potchter, O. & Matzarakis, A. Daily and seasonal climatic conditions of green urban open spaces in the Mediterranean climate and their impact on human comfort. *Building and Environment* **51**, 285-295, doi:https://doi.org/10.1016/j.buildenv.2011.11.020 (2012).
21 Skoulika, F., Santamouris, M., Kolokotsa, D. & Boemi, N. On the thermal characteristics and the mitigation potential of a medium size urban park in Athens, Greece. *Landscape and Urban Planning* **123**, 73-86, doi:https://doi.org/10.1016/j.landurbplan.2013.11.002 (2014).
22 Doick, K. J., Peace, A. & Hutchings, T. R. The role of one large greenspace in mitigating London's nocturnal urban heat island. *Science of The Total Environment* **493**, 662-671, doi:https://doi.org/10.1016/j.scitotenv.2014.06.048 (2014).
23 Wong, N. H. & Yu, C. Study of green areas and urban heat island in a tropical city. *Habitat International* **29**, 547-558, doi:https://doi.org/10.1016/j.habitatint.2004.04.008 (2005).
24 Fung, C. K. W. & Jim, C. Y. Microclimatic resilience of subtropical woodlands and urban-forest benefits. *Urban Forestry & Urban Greening* **42**, 100-112, doi:https://doi.org/10.1016/j.ufug.2019.05.014 (2019).
25 bencheikh, H. & Rchid, A. The Effects of Green Spaces (Palme Trees) on the Microclimate in Arides Zones, Case Study: Ghardaia, Algeria. *Energy Procedia* **18**, 10-20, doi:https://doi.org/10.1016/j.egypro.2012.05.013 (2012).
26 Renaud, V. & Rebetez, M. Comparison between open-site and below-canopy climatic conditions in Switzerland during the exceptionally hot summer of 2003. *Agricultural and Forest Meteorology* **149**, 873-880, doi:https://doi.org/10.1016/j.agrformet.2008.11.006 (2009).
27 Bacci, L., Morabito, M., Raschi, A. & Ugolini, F. Thermohygrometric conditions of some urban parks of Florence (Italy) and their effects on human well-being. *trees* **6**, 49 (2003).
28 Soltani, A. & Sharifi, E. Daily variation of urban heat island effect and its correlations to urban greenery: A case study of Adelaide. *Frontiers of Architectural Research* **6**, 529-538, doi:https://doi.org/10.1016/j.foar.2017.08.001 (2017).
29 Zoulia, I., Santamouris, M. & Dimoudi, A. Monitoring the effect of urban green areas on the heat island in Athens. *Environmental Monitoring and Assessment* **156**, 275, doi:10.1007/s10661-008-0483-3 (2008).
30 Oliveira, S., Andrade, H. & Vaz, T. The cooling effect of green spaces as a contribution to the mitigation of urban heat: A case study in Lisbon. *Building and Environment* **46**, 2186-2194, doi:https://doi.org/10.1016/j.buildenv.2011.04.034 (2011).
31 Sun, R. & Chen, L. Effects of green space dynamics on urban heat islands: Mitigation and diversification. *Ecosystem Services* **23**, 38-46, doi:https://doi.org/10.1016/j.ecoser.2016.11.011 (2017).

32 Gohain, K. J., Mohammad, P. & Goswami, A. Assessing the impact of land use land cover changes on land surface temperature over Pune city, India. *Quaternary International*, doi:https://doi.org/10.1016/j.quaint.2020.04.052 (2020).
33 Qiu, K. & Jia, B. The roles of landscape both inside the park and the surroundings in park cooling effect. *Sustainable Cities and Society* **52**, 101864, doi:https://doi.org/10.1016/j.scs.2019.101864 (2020).
34 Chen, X. *et al.* Study on the cooling effects of urban parks on surrounding environments using Landsat TM data: a case study in Guangzhou, southern China. *International Journal of Remote Sensing* **33**, 5889-5914, doi:10.1080/01431161.2012.676743 (2012).
35 Yu, Z., Guo, X., Jørgensen, G. & Vejre, H. How can urban green spaces be planned for climate adaptation in subtropical cities? *Ecological Indicators* **82**, 152-162, doi:https://doi.org/10.1016/j.ecolind.2017.07.002 (2017).
36 Zhou, D., Zhao, S., Liu, S., Zhang, L. & Zhu, C. Surface urban heat island in China's 32 major cities: Spatial patterns and drivers. *Remote Sensing of Environment* **152**, 51-61, doi:https://doi.org/10.1016/j.rse.2014.05.017 (2014).
37 Zhang, Y., Murray, A. T. & Turner, B. L. Optimizing green space locations to reduce daytime and nighttime urban heat island effects in Phoenix, Arizona. *Landscape and Urban Planning* **165**, 162-171, doi:https://doi.org/10.1016/j.landurbplan.2017.04.009 (2017).
38 Chibuike, E. M., Ibukun, A. O., Abbas, A. & Kunda, J. J. Assessment of green parks cooling effect on Abuja urban microclimate using geospatial techniques. *Remote Sensing Applications: Society and Environment* **11**, 11-21, doi:https://doi.org/10.1016/j.rsase.2018.04.006 (2018).
39 Lemus-Canovas, M., Martin-Vide, J., Moreno-Garcia, M. C. & Lopez-Bustins, J. A. Estimating Barcelona's metropolitan daytime hot and cold poles using Landsat-8 Land Surface Temperature. *Science of The Total Environment* **699**, 134307, doi:https://doi.org/10.1016/j.scitotenv.2019.134307 (2020).
40 Weng, Q., Lu, D. & Schubring, J. Estimation of land surface temperature–vegetation abundance relationship for urban heat island studies. *Remote Sensing of Environment* **89**, 467-483, doi:https://doi.org/10.1016/j.rse.2003.11.005 (2004).
41 Wang, W., Liu, K., Tang, R. & Wang, S. Remote sensing image-based analysis of the urban heat island effect in Shenzhen, China. *Physics and Chemistry of the Earth, Parts A/B/C* **110**, 168-175, doi:https://doi.org/10.1016/j.pce.2019.01.002 (2019).
42 Lin, W., Yu, T., Chang, X., Wu, W. & Zhang, Y. Calculating cooling extents of green parks using remote sensing: Method and test. *Landscape and Urban Planning* **134**, 66-75, doi:https://doi.org/10.1016/j.landurbplan.2014.10.012 (2015).
43 Kong, F., Yin, H., James, P., Hutyra, L. R. & He, H. S. Effects of spatial pattern of greenspace on urban cooling in a large metropolitan area of eastern China. *Landscape and Urban Planning* **128**, 35-47, doi:https://doi.org/10.1016/j.landurbplan.2014.04.018 (2014).
44 Du, H. *et al.* Quantifying the cool island effects of urban green spaces using remote sensing Data. *Urban Forestry & Urban Greening* **27**, 24-31, doi:https://doi.org/10.1016/j.ufug.2017.06.008 (2017).
45 Shih, W.-y. The cooling effect of green infrastructure on surrounding built environments in a sub-tropical climate: a case study in Taipei metropolis. *Landscape Research* **42**, 558-573, doi:10.1080/01426397.2016.1235684 (2017).
46 Feyisa, G. L., Dons, K. & Meilby, H. Efficiency of parks in mitigating urban heat island effect: An example from Addis Ababa. *Landscape and Urban Planning* **123**, 87-95, doi:https://doi.org/10.1016/j.landurbplan.2013.12.008 (2014).
47 Cao, X., Onishi, A., Chen, J. & Imura, H. Quantifying the cool island intensity of urban parks using ASTER and IKONOS data. *Landscape and Urban Planning* **96**, 224-231, doi:https://doi.org/10.1016/j.landurbplan.2010.03.008 (2010).

48 Spronken-Smith, R. A. & Oke, T. R. The thermal regime of urban parks in two cities with different summer climates. *International Journal of Remote Sensing* **19**, 2085-2104, doi:10.1080/014311698214884 (1998).
49 Sodoudi, S., Shahmohamadi, P., Vollack, K., Cubasch, U. & Che-Ani, A. I. Mitigating the Urban Heat Island Effect in Megacity Tehran. *Advances in Meteorology* **2014**, 547974, doi:10.1155/2014/547974 (2014).
50 Imhoff, M. L., Zhang, P., Wolfe, R. E. & Bounoua, L. Remote sensing of the urban heat island effect across biomes in the continental USA. *Remote Sensing of Environment* **114**, 504-513, doi:https://doi.org/10.1016/j.rse.2009.10.008 (2010).
51 Heinl, M., Hammerle, A., Tappeiner, U. & Leitinger, G. Determinants of urban–rural land surface temperature differences – A landscape scale perspective. *Landscape and Urban Planning* **134**, 33-42, doi:https://doi.org/10.1016/j.landurbplan.2014.10.003 (2015).
52 Ren, Z. *et al.* Estimation of the relationship between urban park characteristics and park cool island intensity by remote sensing data and field measurement. *Forests* **4**, 868-886 (2013).
53 Xiao, R.-b. *et al.* Spatial pattern of impervious surfaces and their impacts on land surface temperature in Beijing, China. *Journal of Environmental Sciences* **19**, 250-256, doi:https://doi.org/10.1016/S1001-0742(07)60041-2 (2007).
54 Algretawee, H., Rayburg, S. & Neave, M. Estimating the effect of park proximity to the central of Melbourne city on Urban Heat Island (UHI) relative to Land Surface Temperature (LST). *Ecological Engineering* **138**, 374-390, doi:https://doi.org/10.1016/j.ecoleng.2019.07.034 (2019).
55 Daramola, M. T. & Balogun, I. A. Analysis of the urban surface thermal condition based on sky-view factor and vegetation cover. *Remote Sensing Applications: Society and Environment* **15**, 100253, doi:https://doi.org/10.1016/j.rsase.2019.100253 (2019).
56 Logan, T. M., Zaitchik, B., Guikema, S. & Nisbet, A. Night and day: The influence and relative importance of urban characteristics on remotely sensed land surface temperature. *Remote Sensing of Environment* **247**, 111861, doi:https://doi.org/10.1016/j.rse.2020.111861 (2020).
57 Speak, A., Montagnani, L., Wellstein, C. & Zerbe, S. The influence of tree traits on urban ground surface shade cooling. *Landscape and Urban Planning* **197**, 103748, doi:https://doi.org/10.1016/j.landurbplan.2020.103748 (2020).
58 Kjelgren, R. & Montague, T. Urban tree transpiration over turf and asphalt surfaces. *Atmospheric Environment* **32**, 35-41, doi:https://doi.org/10.1016/S1352-2310(97)00177-5 (1998).
59 Onmura, S., Matsumoto, M. & Hokoi, S. Study on evaporative cooling effect of roof lawn gardens. *Energy and Buildings* **33**, 653-666, doi:https://doi.org/10.1016/S0378-7788(00)00134-1 (2001).
60 Jim, C. Y. & Peng, L. L. H. Weather effect on thermal and energy performance of an extensive tropical green roof. *Urban Forestry & Urban Greening* **11**, 73-85, doi:https://doi.org/10.1016/j.ufug.2011.10.001 (2012).
61 Blanusa, T. *et al.* Alternatives to Sedum on green roofs: Can broad leaf perennial plants offer better 'cooling service'? *Building and Environment* **59**, 99-106, doi:https://doi.org/10.1016/j.buildenv.2012.08.011 (2013).
62 Qin, X., Wu, X., Chiew, Y. & Li, Y. A green roof test bed for stormwater management and reduction of urban heat island effect in Singapore. *British Journal of Environment and Climate Change* **2**, 410-420 (2012).
63 Sun, C. Y., Lee, K. P., Lin, T. P. & Lee, S. H. in *Advanced Materials Research.* 552-556 (Trans Tech Publ).
64 Ávila-Hernández, A. *et al.* Test box experiment and simulations of a green-roof: Thermal and energy performance of a residential building standard for Mexico. *Energy and Buildings* **209**, 109709, doi:https://doi.org/10.1016/j.enbuild.2019.109709 (2020).

65 Niachou, A., Papakonstantinou, K., Santamouris, M., Tsangrassoulis, A. & Mihalakakou, G. Analysis of the green roof thermal properties and investigation of its energy performance. *Energy and Buildings* **33**, 719-729, doi:https://doi.org/10.1016/S0378-7788(01)00062-7 (2001).
66 Bevilacqua, P., Mazzeo, D., Bruno, R. & Arcuri, N. Experimental investigation of the thermal performances of an extensive green roof in the Mediterranean area. *Energy and Buildings* **122**, 63-79, doi:https://doi.org/10.1016/j.enbuild.2016.03.062 (2016).
67 Moghbel, M. & Erfanian Salim, R. Environmental benefits of green roofs on microclimate of Tehran with specific focus on air temperature, humidity and CO2 content. *Urban Climate* **20**, 46-58, doi:https://doi.org/10.1016/j.uclim.2017.02.012 (2017).
68 Anwar, M., Rasul, M. G. & Khan, M. M. K. Performance Analysis of rooftop greenery systems in Australian subtropical climate. *Energy Reports* **6**, 50-56, doi:https://doi.org/10.1016/j.egyr.2019.08.017 (2020).
69 Yin, H., Kong, F., Dronova, I., Middel, A. & James, P. Investigation of extensive green roof outdoor spatio-temporal thermal performance during summer in a subtropical monsoon climate. *Science of The Total Environment* **696**, 133976, doi:https://doi.org/10.1016/j.scitotenv.2019.133976 (2019).
70 Wong, N. H., Chen, Y., Ong, C. L. & Sia, A. Investigation of thermal benefits of rooftop garden in the tropical environment. *Building and Environment* **38**, 261-270, doi:https://doi.org/10.1016/S0360-1323(02)00066-5 (2003).
71 He, Y., Yu, H., Dong, N. & Ye, H. Thermal and energy performance assessment of extensive green roof in summer: A case study of a lightweight building in Shanghai. *Energy and Buildings* **127**, 762-773, doi:https://doi.org/10.1016/j.enbuild.2016.06.016 (2016).
72 Lee, L. S. H. & Jim, C. Y. Thermal-cooling performance of subtropical green roof with deep substrate and woodland vegetation. *Ecological Engineering* **119**, 8-18, doi:https://doi.org/10.1016/j.ecoleng.2018.05.014 (2018).
73 Zhang, G., He, B.-J. & Dewancker, B. J. The maintenance of prefabricated green roofs for preserving cooling performance: A field measurement in the subtropical city of Hangzhou, China. *Sustainable Cities and Society* **61**, 102314, doi:https://doi.org/10.1016/j.scs.2020.102314 (2020).
74 Hoelscher, M.-T., Nehls, T., Jänicke, B. & Wessolek, G. Quantifying cooling effects of facade greening: Shading, transpiration and insulation. *Energy and Buildings* **114**, 283-290, doi:https://doi.org/10.1016/j.enbuild.2015.06.047 (2016).
75 Nadia, S., Noureddine, S., Hichem, N. & Djamila, D. Experimental Study of Thermal Performance and the Contribution of Plant-Covered Walls to the Thermal Behavior of Building. *Energy Procedia* **36**, 995-1001, doi:https://doi.org/10.1016/j.egypro.2013.07.113 (2013).
76 Eumorfopoulou, E. A. & Kontoleon, K. J. Experimental approach to the contribution of plant-covered walls to the thermal behaviour of building envelopes. *Building and Environment* **44**, 1024-1038, doi:https://doi.org/10.1016/j.buildenv.2008.07.004 (2009).
77 Pérez, G., Rincón, L., Vila, A., González, J. M. & Cabeza, L. F. Green vertical systems for buildings as passive systems for energy savings. *Applied Energy* **88**, 4854-4859, doi:https://doi.org/10.1016/j.apenergy.2011.06.032 (2011).
78 Susorova, I., Azimi, P. & Stephens, B. The effects of climbing vegetation on the local microclimate, thermal performance, and air infiltration of four building facade orientations. *Building and Environment* **76**, 113-124, doi:https://doi.org/10.1016/j.buildenv.2014.03.011 (2014).
79 Ottelé, M. & Perini, K. Comparative experimental approach to investigate the thermal behaviour of vertical greened façades of buildings. *Ecological Engineering* **108**, 152-161, doi:https://doi.org/10.1016/j.ecoleng.2017.08.016 (2017).

80 Zhang, L. *et al.* Thermal behavior of a vertical green facade and its impact on the indoor and outdoor thermal environment. *Energy and Buildings* **204**, 109502, doi:https://doi.org/10.1016/j.enbuild.2019.109502 (2019).
81 Cameron, R. W. F., Taylor, J. E. & Emmett, M. R. What's 'cool' in the world of green façades? How plant choice influences the cooling properties of green walls. *Building and Environment* **73**, 198-207, doi:https://doi.org/10.1016/j.buildenv.2013.12.005 (2014).
82 Li, C., Wei, J. & Li, C. Influence of foliage thickness on thermal performance of green façades in hot and humid climate. *Energy and Buildings* **199**, 72-87, doi:https://doi.org/10.1016/j.enbuild.2019.06.045 (2019).
83 Wong, N. H. *et al.* Thermal evaluation of vertical greenery systems for building walls. *Building and Environment* **45**, 663-672, doi:https://doi.org/10.1016/j.buildenv.2009.08.005 (2010).
84 Hoyano, A. Climatological uses of plants for solar control and the effects on the thermal environment of a building. *Energy and Buildings* **11**, 181-199, doi:https://doi.org/10.1016/0378-7788(88)90035-7 (1988).
85 Tabassom, S., Aminatuzuhariah Megat, A., Dilshan Remaz, O. & Mohammad, B. Thermal Impacts of Vertical Greenery Systems. *Environmental and Climate Technologies* **14**, 5-11, doi:https://doi.org/10.1515/rtuect-2014-0007 (2014).
86 Olivieri, F., Olivieri, L. & Neila, J. Experimental study of the thermal-energy performance of an insulated vegetal façade under summer conditions in a continental mediterranean climate. *Building and Environment* **77**, 61-76, doi:https://doi.org/10.1016/j.buildenv.2014.03.019 (2014).
87 Haggag, M., Hassan, A. & Elmasry, S. Experimental study on reduced heat gain through green façades in a high heat load climate. *Energy and Buildings* **82**, 668-674, doi:https://doi.org/10.1016/j.enbuild.2014.07.087 (2014).
88 Shafiee, E., Faizi, M., Yazdanfar, S.-A. & Khanmohammadi, M.-A. Assessment of the effect of living wall systems on the improvement of the urban heat island phenomenon. *Building and Environment*, 106923, doi:https://doi.org/10.1016/j.buildenv.2020.106923 (2020).
89 Mungur, M. *et al.* A numerical and experimental investigation of the effectiveness of green roofs in tropical environments: The case study of Mauritius in mid and late winter. *Energy* **202**, 117608, doi:https://doi.org/10.1016/j.energy.2020.117608 (2020).
90 Vaz Monteiro, M. *et al.* Functional green roofs: Importance of plant choice in maximising summertime environmental cooling and substrate insulation potential. *Energy and Buildings* **141**, 56-68, doi:https://doi.org/10.1016/j.enbuild.2017.02.011 (2017).
91 Teemusk, A. & Mander, Ü. Greenroof potential to reduce temperature fluctuations of a roof membrane: A case study from Estonia. *Building and Environment* **44**, 643-650, doi:https://doi.org/10.1016/j.buildenv.2008.05.011 (2009).
92 Getter, K. L., Rowe, D. B., Andresen, J. A. & Wichman, I. S. Seasonal heat flux properties of an extensive green roof in a Midwestern U.S. climate. *Energy and Buildings* **43**, 3548-3557, doi:https://doi.org/10.1016/j.enbuild.2011.09.018 (2011).
93 He, Y., Yu, H., Ozaki, A. & Dong, N. Thermal and energy performance of green roof and cool roof: A comparison study in Shanghai area. *Journal of Cleaner Production* **267**, 122205, doi:https://doi.org/10.1016/j.jclepro.2020.122205 (2020).
94 Tan, C. L. *et al.* Impact of soil and water retention characteristics on green roof thermal performance. *Energy and Buildings* **152**, 830-842, doi:https://doi.org/10.1016/j.enbuild.2017.01.011 (2017).
95 Meng, Q. & Hu, W. Roof cooling effect with humid porous medium. *Energy and Buildings* **37**, 1-9, doi:https://doi.org/10.1016/j.enbuild.2003.11.004 (2005).
96 Ouldboukhitine, S.-E., Belarbi, R., Jaffal, I. & Trabelsi, A. Assessment of green roof thermal behavior: A coupled heat and mass transfer model. *Building and Environment* **46**, 2624-2631, doi:https://doi.org/10.1016/j.buildenv.2011.06.021 (2011).

97 Vox, G., Blanco, I. & Schettini, E. Green façades to control wall surface temperature in buildings. *Building and Environment* **129**, 154-166, doi:https://doi.org/10.1016/j.buildenv.2017.12.002 (2018).
98 Sternberg, T., Viles, H. & Cathersides, A. Evaluating the role of ivy (Hedera helix) in moderating wall surface microclimates and contributing to the bioprotection of historic buildings. *Building and Environment* **46**, 293-297, doi:https://doi.org/10.1016/j.buildenv.2010.07.017 (2011).
99 Cheng, C. Y., Cheung, K. K. S. & Chu, L. M. Thermal performance of a vegetated cladding system on facade walls. *Building and Environment* **45**, 1779-1787, doi:https://doi.org/10.1016/j.buildenv.2010.02.005 (2010).
100 Tan, C. L., Wong, N. H. & Jusuf, S. K. Effects of vertical greenery on mean radiant temperature in the tropical urban environment. *Landscape and Urban Planning* **127**, 52-64, doi:https://doi.org/10.1016/j.landurbplan.2014.04.005 (2014).
101 Mazzali, U., Peron, F., Romagnoni, P., Pulselli, R. M. & Bastianoni, S. Experimental investigation on the energy performance of Living Walls in a temperate climate. *Building and Environment* **64**, 57-66, doi:https://doi.org/10.1016/j.buildenv.2013.03.005 (2013).
102 Chen, Q., Li, B. & Liu, X. An experimental evaluation of the living wall system in hot and humid climate. *Energy and Buildings* **61**, 298-307, doi:https://doi.org/10.1016/j.enbuild.2013.02.030 (2013).
103 Victorero, F. *et al.* Experimental Study of the Thermal Performance of Living Walls Under Semiarid Climatic Conditions. *Energy Procedia* **78**, 3416-3421, doi:https://doi.org/10.1016/j.egypro.2015.12.160 (2015).