AN ANNOTATED BIBBLIOGRAPHY ON URBAN HEAT ISLAND EFFECT

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Abstract
Cities, towns, and urban areas differ from rural areas largely in size, population density, and the extent of man-made surface modification which make them more prone to the high solar radiation reaching the earth surface. These high temperatures cause different climate challenges as the global challenge of climate change. One of such evidence of climate change is the creation of the urban heat island (UHI) and it effect. Urban Heat Island (UHI) is a phenomena known as "an island" in which hot surface air is concentrated in urban regions and surrounding temperatures gradually decline in suburban/rural areas. This paper identifies the causes, mitigation strategies and methodologies used in the study of UHI. A systematic literature review was employed in this study. Variations in albedo, man-made structures (roads, pavements, buildings etc.), evaporation from water bodies, solar radiation falling on built areas among others were found to cause UHI. Use of cools surfaces (cool pavements, roofs), greenery as a nature based solution, green roofs, change in albedo and creation/preservation of water bodies among others were identified as mitigation strategies against UHI effects.

Keywords; Albedo climate change, eco-friendly urban heat island (UHI), urban heat island effect, urban neighbourhood, mitigation strategies.

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Introduction

Extreme temperatures caused by climate change have widespread impacts on the earth's surface, including more frequent and intense heat waves, increased risk of wildfires, and alterations in precipitation patterns. Rising temperatures also contribute to sea level rise, threatening coastal areas and ecosystems, and exacerbate water shortages in already stressed regions. It endangers the health of city developers and their well-being, as well as their thermal comfort. Urban heat islands are one of the many risks posed by climate change (Deilami et al., 2018). The structure of the atmospheric boundary layer (ABL) changes so significantly over a city that it is given its name, the urban boundary layer (UBL). It can be separated into two layers: mixed and surface. The latter is further separated into three sub-layers: inertial, roughness, and urban canopy layer (Brozovsky, 2022).

Cities, towns, and urban areas primarily have pollution, heat island, less green space, rural areas have more single family homes, zoning laws might be different too, population density, and types of activities they support and the extent of man-made surface modification. Cities are generally larger, more densely populated, and have a higher concentration of activities. Towns and semi-dense areas are in between, while rural areas are characterized by lower population densities. However, the particular criteria used to delimit these regions vary from country to country, and are difficult to define as universally applicable(Brozovsky, 2022). According to Gago et al., (2013), a city is a "permanent and densely settled place with administratively defined boundaries whose members work primarily on non-agricultural tasks". The final portion of the term already suggests a habitat that is fundamentally different from a natural landscape, with large, open, and vegetated or forested places playing only a supporting role. In contrast to the natural landscape, the urban landscape, sometimes known as the cityscape, is characterized by emissions and pollution from motorized vehicles, building HVAC systems, industrial activities, and so on. Furthermore, huge wind and sun barriers, such as buildings, and generally dark, heavy materials that are impervious to water are prevalent (Peng et al., 2018). Urban Heat Island (UHI) is a phenomenon known as "an island" in which hot surface air is concentrated in urban regions and surrounding temperatures gradually decline in suburban/rural areas (Ningrum, 2018).

As the name implies, the surface layer is dominated by thermal and turbulence influences from the urban environment. Heat flux from the ground and reduced turbulent heat transport in cities typically result in the so-called urban heat island (UHI) effect, which is one of the most investigated areas of urban climatology. It reflects the different warmth of an urban settlement in comparison to its rural surroundings and has been observed across all climate zones and settlement sizes(Brozovsky, 2022). The UHI phenomena were explained in terms of an 'urban energy balance' based on an examination of incoming and outgoing energy flux from an urban surface system (Wang et al., 2023). The energy collected by this urban surface system from solar radiation and created by human activity is thus physically balanced by warming the air above the surface (convection and radiation), evaporation of moisture, and heat storage in surface materials. The partitioning of this energy balance determines the character of the urban environment, which influences how cities consume energy as well as residents' comfort and well-being (Giridharan & Emmanuel, 2018). A variety of climate processes contribute to the creation of a UHI. This creation can be explained by events that occur in the Urban Boundary Layer (UBL) or the Urban Canopy Layer (UCL). The UBL is governed by mechanisms relevant to the meso scale, with the higher altitude thermal inversion prominent during the daylight, and the latter by those at the micro scale, with the lower altitude inversion dominant during the nighttime (Figure 1&2).

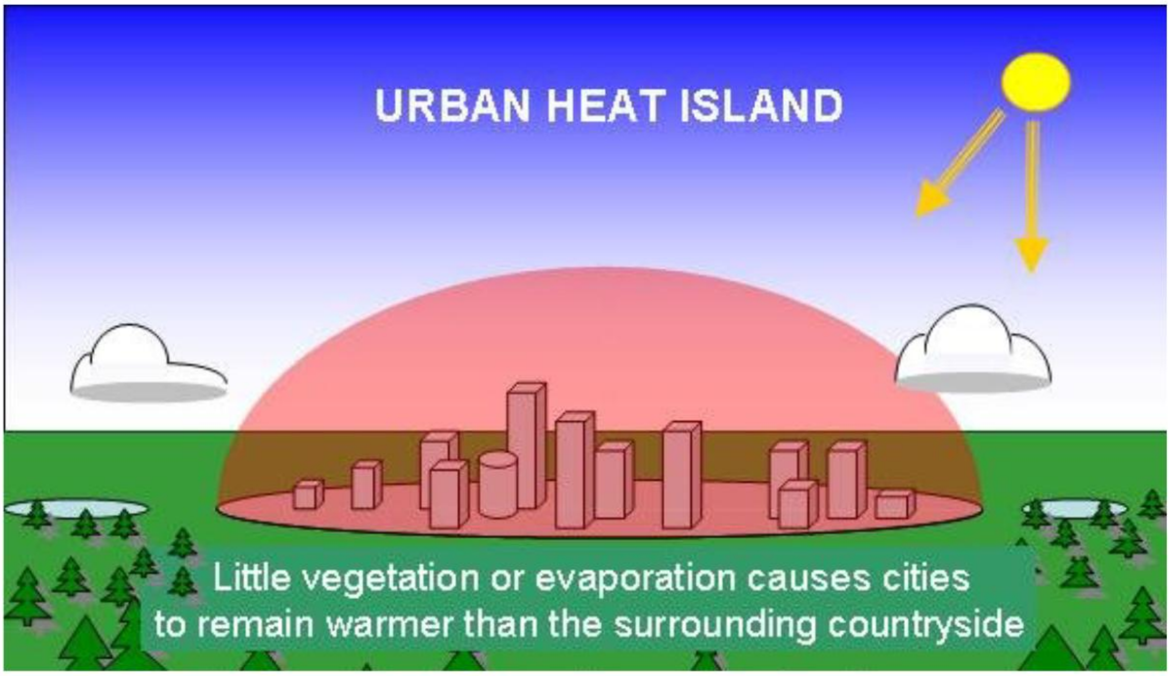

Figure 1; Urban Heat Island. Source; (Ningrum, 2018)

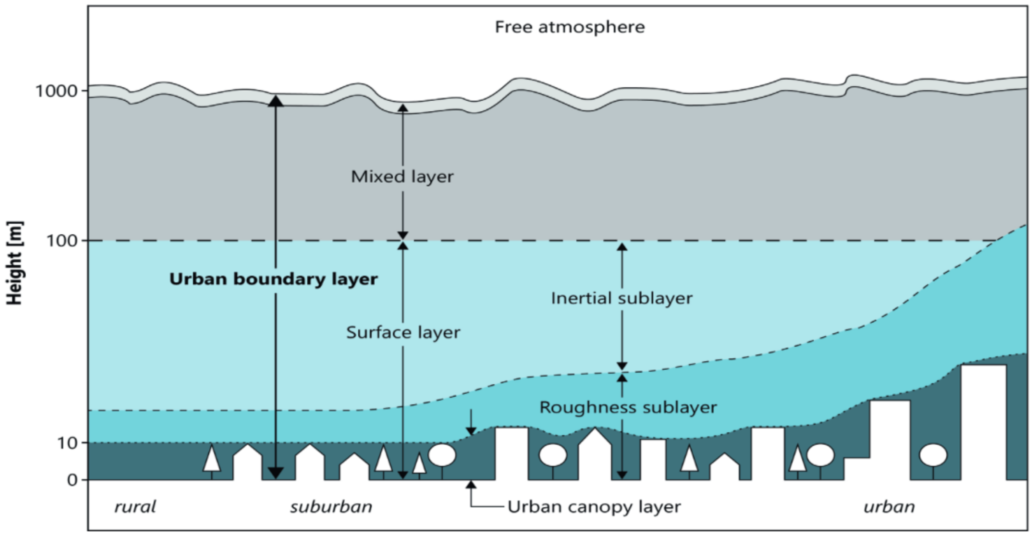

Figure 2; Schematic illustration of the urban boundary layer (UBL) structure by day. Source: (Brozovsky, 2022)

UHI is produced by various causes that differ between urban and non-urban locations. These characteristics include the release of anthropogenic energy from air conditioning systems, energy emissions from industrial operations and motor vehicles, the ratio of mixed surfaces, and the differential in heat capacity between building materials and natural structures (Ahmed, *et al*., 2020). Field verifications revealed that the majority of hotspots in metropolitan areas were located on metal roofs, industrial buildings, warehouses, airport runways, railways, high-density parking lots, and solid waste disposal facilities. Almost all hotspots have few or no green spaces (Umar & Kumar, n.d.).

Variations in albedo cause temperature differences in various regions(Shareef, 2022). Man-made structures, such as roads and buildings, often have lower albedo than natural surfaces, absorbing more visible sunlight (Martilli et al., 2020). The urban surface is typically hotter than the natural surface that contains water. Evaporation from water removes energy from the surface and lowers its temperature(Garuma, 2023). The urban surface quickly releases water, in contrast to natural surfaces such as plants, which can retain water. Anthropogenic heat sources include heating and ventilation systems, industrial activities, and internal combustion engines. Energy usage will generate heat as a by-product. Solar radiation falling on the built area (asphalt, concrete) causes the surrounding air temperature to increase because the heat capacity of asphalt and concrete is lower than other types of surfaces(Ahmed Khozema *et al*., 2020).

The UHI effect is a type of urban heat build-up caused by urban building and human activity (Nwakaire et al., 2020). It is regarded as the most evident urban climatic characteristic. Increased land surface temperatures caused by UHI effects will inevitably affect the flow of materials and energy flows in the urban ecological system, as well as alter their structure and function, resulting in a variety of ecological and environmental effects on urban climates, urban hydrological situations, soil properties, atmospheric environments, biological habits, material cycles, energy metabolism, and population health (Lee & Kim, 2022).

UHI has a significant effect on residence energy use both directly and indirectly. UHI is associated with air conditioning equipment and raises monthly electricity bills (Ahmed et al., 2021). The increased usage of air conditioning has an impact on electric energy waste and pollution, which contributes to the greenhouse effect. Electricity use increases sulphur dioxide emissions, carbon monoxide, nitrous oxides, and carbon dioxide, all of which are greenhouse gases that contribute to global warming and climate change(Brozovsky, 2022). Furthermore, during the dry season, the heat island will hasten the creation of hazardous fog, including nitrous oxides (NOx) and volatile organic compounds (VOCs), which react with photochemistry to produce ozone on the surface (Wong et al., 2021).

The various urban forms have a considerable impact on the urban microclimate and the outdoor thermal effect. Compared to urban geometry, vast building area is not the primary factor influencing urban microclimate (Emmanuel et al., 2020). The average building height provided enough urban shade, which is a key component in determining temperature. Normally, a courtyard building model provides higher outdoor thermal comfort, but a simulation revealed that the distance between the buildings is more essential than the building type (Martilli et al., 2020). Other site-specific characteristics, such as the amount of green space, anthropogenic heat, and distance to water bodies, should be considered in addition to meteorological circumstances to explain changes in intra-urban UHI intensities(Steeneveld et al., 2014).

Given the effects and causes of UHI as discussed above, this paper aimed at reviewing relevant literature to assess the adaptation and mitigation strategies employed worldwide. This was achieved through a critical literature review.

Methodology

This study utilizes a systematic literature review to explore the various factors contributing to Urban Heat Island (UHI) effect and the mitigation strategies employed globally. The review aims to provide a comprehensive understanding of UHI causes and potential solutions for managing urban temperatures.

This research approach allows for a thorough analysis of the existing knowledge base on UHI, key factors such as:

1. **Land Use and Cover Changes:**

The conversion of natural land to impervious surfaces (concrete, asphalt) and the reduction of vegetation cover contribute significantly to UHI.

2. **Anthropogenic Heat Release:**

Energy consumption in buildings, transportation, and industrial processes generate heat that contributes to the urban heat.

3. **Local Climate and Topography:**

Factors like urban density, latitude, elevation, and atmospheric stability influence the intensity of the UHI.

4. **Air Pollution:**

Pollutants like aerosols can absorb solar radiation, contributing to surface warming and influencing the UHI.

Mitigation Strategies:

The review also examines a wide range of mitigation strategies, including:

a) **Urban Greenery:**

Increased vegetation cover through planting trees, establishing green roofs, and creating urban forests can help to lower temperatures through evapotranspiration and shading.

b) **Cool Materials and Surfaces:**

Using reflective pavements, cool roofs, and other high-albedo materials can reduce heat absorption and surface temperatures.

c) **Urban Planning and Design:**

Optimizing building orientation, layout, and design can minimize heat exposure and improve natural cooling.

d) **Passive Cooling Techniques:**

Incorporating shading structures, optimizing airflow, and utilizing evaporative cooling methods can reduce the need for air conditioning.

e) **Smart Growth Principles:**

Adopting sustainable urban planning practices that prioritize compact development, mixed-use zoning, and green infrastructure can help to mitigate UHI.

By systematically reviewing the literature, this study provides a comprehensive overview of the UHI effect and its mitigation, which can inform urban planning and policy decisions to create more sustainable and liveable cities.
Google Scholar was used as the primary source of literature. The process of searching and filtering articles was done in stages.

Searching for relevant literature

The keywords “urban heat island” were typed in the search bar of Google Scholar and 1490000 articles were displayed as the result of the search. With this high number of articles, it will be extremely difficult to filter these articles to find the most relevant for this study. As such, the second search was done. The keywords “urban heat island mitigation” were typed in the search bar. The result displayed shows 183000 articles. This number is still too large for effective selection and filtering of relevant literature to be reviewed. This led to the third search stage. The keywords “urban heat island mitigation strategies” was typed in the search bar. 171000 articles were displayed as the result of the search. To reduce redundancy, the filtering of the articles was done with year of publication.

Table 1: showing the keywords search

S/N	Search Words	Number Of Articles
1	urban heat island	1490000
2	urban heat island mitigation	183000
3	urban heat island mitigation strategies	171000

4	2016-2024	17000
5	2020-2024	300

The search was set for articles published from 2016 to 2024 and the number of the articles reduced to 17000. Then another search was done, and the year of publication was set at 2020 to 2024. The results displayed about 300 articles. These articles include duplication and those not directly addressing UHI and its mitigation/adaptation strategies.

Exclusion Criteria
The generated set of 300 articles was skimmed so the authors could familiarize themselves with the discussed themes. During this initial analysis, it was noticed that most of the articles were duplications. Therefore, criteria were developed for which articles to include in the review and which ones to exclude (see Table 2 for details).

Table 2. Shows the exclusion criteria

Exclusion criteria	Number of articles
Total articles after data collection	300
Articles corrupted after download	43
Duplicates	83
Articles on surface urban climate	51
Articles without UHI on the abstract	63
articles without mention of UHI in the abstract	30

After the exclusion exercise, 17 articles were selected for the review process cutting across different geographical regions and climate zones.

Discussion
To ensure a spread in the review process, the selected articles cut across all climate zones, geographic locations, and some countries from Africa, Asia and Europe (see table 3).

Table 3; shows the selected articles and their geographic locations.

S/N	AUTHORS	TITLE	LOCATION
1	(Leal Filho et al., 2021)	Addressing the Urban Heat Islands Effect: A Cross-Country Assessment of the Role of Green Infrastructure	14 cities in 13 countries.
2	(Abulibdeh, 2021)	Analysis of urban heat island characteristics and mitigation strategies for eight arid and semi-arid Gulf region cities	arid and semi-arid regions
3	(Rahayu & Yusri, 2021)	Bogor Botanic Gardens as a nature-based solution for mitigating urban heat island and microclimate regulation	NA
4	(C. Wang et al., 2021a)	Cool pavements for urban heat island mitigation: A synthetic review	US
5	(Zheng et al., 2022)	Evaluating Urban Heat Island mitigation strategies for a Subtropical City Centre (a case study in Osaka, Japan)	Japan
6	(Balany et al., 2020)	Green Infrastructure as an Urban Heat Island Mitigation Strategy—A Review	Australia
7	(Wong et al., 2021)	Greenery as a mitigation and adaptation strategy to urban heat	Singapore
8	(Martilli et al., 2020)	Is the Urban Heat Island intensity relevant for heat mitigation studies?	NA
9	(Qi et al., 2020)	Ontology-based knowledge representation of urban heat island mitigation strategies	Australia
10	(C. Wang et al., 2021b)	Perceptions of urban heat island mitigation and implementation strategies: survey and gap analysis	US

11	(Irfeey et al., 2023)	Sustainable Mitigation Strategies for Urban Heat Island Effects in Urban Areas	Australia
12	(Shareef, 2022)	The Influence of Greenery and Landscape Design on Solar Radiation and UHI Mitigation: A Case Study of a Boulevard in a Hot Climate	Dubai, UAE
13	(Garuma, 2023)	Tropical surface urban heat islands in east Africa	East Africa
14	(Degirmenci et al., 2021)	Understanding policy and technology responses in mitigating urban heat islands: A literature review and directions for future research	Australia
15	(Jain et al., 2020)	Urban heat island intensity and its mitigation strategies in the fast-growing urban area.	India
16	(Nwakaire et al., 2020)	Urban Heat Island Studies with emphasis on urban pavements: A review	Malaysia

The articles reviewed contained researches done across all the geographic locations and climate zone as seen in table 3. All the reviewed articles simply reviewed(Degirmenci et al., 2021; Irfeey et al., 2023; Martilli et al., 2020; Nwakaire et al., 2020; C. Wang et al., 2021a) or study the UHI effect, it formation and mitigation strategies(Abulibdeh, 2021; Garuma, 2023; Leal Filho et al., 2021; Qi et al., 2020; Rahayu & Yusri, 2021; Shareef, 2022; C. Wang et al., 2021b; Zheng et al., 2022).

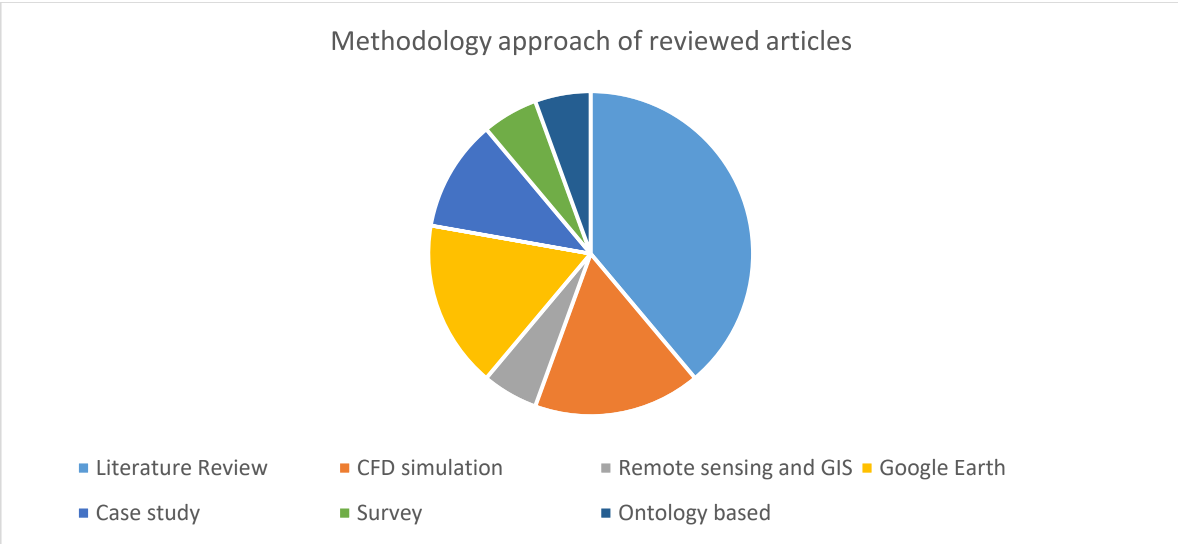

Figure 1; showing the methodology approaches used in reviewed articles.

As can be seen from figure 1, different methodologies can be employed to carry out study on UHI, and mitigation/adaptation strategies. Numerical simulation studies was done through computational fluid dynamic software called ENVI-Met(Shareef, 2022; Zheng et al., 2022). Remote sensing and GIS is another methodological approach that can be employed by researchers in the study of UHI (Abulibdeh, 2021).

Table 4 provides a complete list of the reviewed articles with their main findings and methodology used.

Table 4; showing the main findings of reviewed articles.

S/N	Research	Main findings	Methodology
1	(Leal Filho et al., 2021)	Keeping and increasing urban green resources leads to various benefits that may directly or indirectly reduce the impacts of UHI.	Case study

2	(Abulibdeh, 2021)	difference in temperatures between the bare areas and the urban areas ranges between 1 and 2 °C, between the bare areas and green areas ranges between 1 and 7 °C, and between the urban areas and green areas ranges between 1 and 5 °C.	Remote sensing and GIS
3	(Rahayu & Yusri, 2021)	Heat mitigation is proven to be one of the environmental services provided by Bogor Botanic Gardens (BBG).	Time series analysis using Google Earth Engine
4	(C. Wang et al., 2021a)	Six gaps in existing cool pavement research and five gaps related to the implementation of cool pavements in building codes, standards, and municipal projects.	Literature review
5	(Zheng et al., 2022)	The increased albedo of urban fabric material (scenario B Cool pavement model) showed the most efficient to mitigate UHI.	CFD simulation using ENVI-Met.
6	(Balany et al., 2020)	It was observed that the majority of the research was conducted on a limited spatial scale and focused on temperature and human thermal comfort	Literature review
7	(Wong et al., 2021)	The cooling potential varies markedly, depending on the scale of interest (city or building level), greenery extent (park shape and size), plant selection and plant placement.	Literature review
8	(Martilli et al., 2020)	Demonstrates that the Urban Heat Island intensity has little relevance for urban heat mitigation and suggest the term “urban heat mitigation” to more accurately describe strategies aimed at cooling cities.	Literature review
9	(Qi et al., 2020)	A prototype for the UHIMS representation is introduced covering the use of ‘UHIM techniques’ having ‘Planning and design variables’ on ‘The place of application’ to address ‘UHI problems’ in ‘Urban settings’ with the evaluation by ‘Performance metrics’.	ontology-based representation of UHIMS
10	(C. Wang et al., 2021b)	Four knowledge and implementation gaps identified: the lack of public education on UHI mitigation and implementation measures, the lack of effective communications between researchers and code writers, the lack of implementing UHI mitigation strategies in some countries, and the lack of trustworthy information shared on social media.	Questionnaire survey
11	(Irfeey et al., 2023)	Materials such as reflective street pavements, coating materials including light-colored paint, phase-change materials, colour-changing paint, fluorescence paint, and energy-efficient appliances are considered sustainable materials, whereas green infrastructure like green roofs, green walls, green parking and pavements, and shaded streets are considered to mitigate the urban heat island effect	Literature review

12	(Shareef, 2022)	The results showed that 12 m trees and the cylindrical tree are the most effective vegetation in reducing the air temperature; the variation between these scenarios and the existing case reaches 0.70 ∘C and 0.66 ∘C, respectively.	Case study and CFD simulation using ENVI-Met
13	(Garuma, 2023)	The mean temperature contribution to regional climate from 2000 to 2020 is 0.64^{0}C during the day and 0.34^{0}C during the night, a mean total of around 0.5 ∘ C, and a 0.25^{0}C increase per decade and a quarter in global surface temperature, ≈ 1.09^{0}C from 2011 to 2020 compared to the 1850–1900 level.	Quantitative analyses using earth observation information
14	(Degirmenci et al., 2021)	(a) evidence base for policymaking including timescale analysis, effective policymaking instruments as well as decision support and scenario planning; (b) policy responses including landscape and urban form, green and blue area ratio, albedo enhancement policies, transport modal split as well as public health and participation; (c) passive technologies including green building envelopes and development of cool surfaces; and (d) active technologies including sustainable transport as well as energy consumption, heating, ventilation and air conditioning, and waste heat.	Literature review
15	(Jain et al., 2020)	It is evident from the observation that the temperature is very high within the city core as well as certain surrounding areas of the city, especially on the southern side.	Time series analysis using Google Earth Engine.
16	(Nwakaire et al., 2020)	Addressing the harmful effects of UHI would involve adoption of effective mitigation strategies that can improve the environmental, societal, and economic sustainability of urban structures and landscapes	Literature review
17	**(Oke, T.R. 1982)**	The Energetic Basis of the Urban Heat Island. This foundational paper lays out the energetic basis of UHI, including the role of solar radiation, anthropogenic heat sources, and the effect of urban structures on energy balance.	Oxford Bibliographies.
18	**(Oke, T.R. 1981)**	City Size and the Urban Heat Island. This study explores the relationship between city size and the intensity of the UHI, highlighting how larger cities tend to exhibit stronger UHI effects.	Oxford Bibliographies.
19	**(Voogt, J.A., and Oke, T.R. 2003)**	Urban heat island effects and mitigation: A review. This review provides a comprehensive overview of the UHI, its causes, and various mitigation strategies, including cool roofs, green roofs, and urban planning techniques.	Research Gate.

20	**(Feyisa, G.L., Dons, K., and Meilby, H. 2014)**	Efficiency of parks in mitigating urban heat island effect in Addis Ababa. This study investigates the effectiveness of urban parks in reducing UHI intensity, focusing on factors like canopy cover, species composition, and spatial design.	Taylor and Francis Online
21	**(Li, X., Stringer, P., and Dallimer, M. 2021)**	Topography and construction materials as contributing factors to UHI. This research examines the role of topography and building materials in influencing the intensity of the UHI, highlighting the importance of considering these factors in urban planning.	Taylor & Francis Online.
22	**(Wong, S.W.Y., et al. 2017)**	Impacts of urban heat island effect on human health and thermal comfort. This study explores the health impacts of UHI, including increased thermal stress, respiratory illnesses, and heat-related mortality.	ScienceDirect.com
23	**(Li, Y-Y., Zhang, H. and Kainz, W. 2012)**	Monitoring patterns of urban heat islands of the fast-growing Shanghai metropolis, China: Using time-series of Landsat TM/ETM+ data.	*International Journal of Applied Earth Observation and Geoformation, 19: 127-138.*
24	**(Kato, S. and Yamaguchi, Y. 2005)**	Analysis of urban heat-island effect using ASTER and ETM+ data: separation of anthropogenic heat discharge and natural heat radiation from sensible heat flux.	*Remote Sensing of Environment, 99: 44 - 54.*
25	**(Yuan, F. and Bauer, M.E. 2007)**	Comparison of impervious surface area and normalized difference vegetation index as indicators of surface urban heat island effects in Landsat imagery.	*Remote Sensing of Environment,* 106: 375 - 386.
26	**(Zhou, D., Zhao, S., Liu, S., Zhang, L. and Zhu, C. 2014)**	Surface urban heat island in China's 32 major cities: Spatial patterns and drivers.	*Remote Sensing of Environment, 152: 51-61.*
27	**(Peña, M.A. 2008)**	Relationships between remotely sensed surface parameters associated with the urban heat sink formation in Santiago, Chile.	*International Journal of Remote Sensing. 29(15): 4385 - 4404.*
28	**(Rasul, A., Balzter, H. and Smith, C. 2015)**	Spatial variation of the daytime Surface Urban Cool Island during the dry season in Erbil, Iraqi Kurdistan, from Landsat 8.	*Urban Climate, 14(2): 176-186.*
29	**(Gluch, R., Quattrochi, D.A. and Luvall, J.C. 2006)**	A multi-scale approach to urban thermal analysis.	*Remote Sensing of Environment, 104: 123-132.*

30	**(Dousset, B. and Gourmelon, F. 2008)**	Satellite multi-sensor data analysis of urban surface temperatures and land cover.	*ISPRS Journal of Photogrammetry & Remote Sensing, 58: 43-54.*
31	**(Buyantuyev, A. and Wu, J. 2010)**	Urban heat islands and landscape heterogeneity: linking spatiotemporal variations in surface temperatures to land-cover and socioeconomic patterns.	*Landscape Ecology, 25: 17-33.*
32	**(Baumann, P.R. 2009)**	Urban heat island lesson.	*Geocarto International, 24(6): 473-483.*
32	**(Peterson, T.C. and Owen, T.W. 2005)**	Urban heat island assessment: metadata are important.	*Journal of climate, 18(14): 2637 - 2646.*
33	**(Rosenzweig, C., Solecki, W.D., Parshall, L., Chopping, M., Pope, G. and Goldberg, R. 2005)**	Characterizing the urban heat island in current and future climates in New Jersey.	*Environmental Hazards, 6: 51 - 62.*
34	**(Francesco, M. 2016)**	*Counteracting Urban Heat Island Effects in a Global Climate Change Scenario.*	(Springer, Cham).
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37	**(Kim, Y.H. and Baik, J.J. 2002)**	Maximum urban heat island intensity in Seoul.	*Journal of Applied Meteorology, 41(6): 651 – 659.*
38	**(Voogt, J. A. 2002)**	Urban Heat Island.	*Encyclopaedia of Global Environmental Change.*
39	**(Arnfield, J.A. 2003)**	Two decades of urban climate research: a review of turbulence, exchanges of energy and water, and the urban heat island.	*International Journal of Climatology*, 23: 1 – 26**.**

40	**(Baik, J.J. and Kim, Y.H. 2000)**	Dry and moist convection forced by an urban heat island.	*Journal of Applied Meteorology, 40(8): 1462-1475.*

Degirmenci et al., (2021) looked into policy and technology responses to increased temperatures in urban heat islands (UHIs) and identified the following; (a) evidence base for policymaking including timescale analysis, effective policymaking instruments as well as decision support and scenario planning; (b) policy responses including landscape and urban form, green and blue area ratio, albedo enhancement policies, transport modal split as well as public health and participation; (c) passive technologies including green building envelopes and development of cool surfaces; and (d) active technologies including sustainable transport as well as energy consumption, heating, ventilation and air conditioning, and waste heat. Based on the findings, presented a framework to guide future research in analysing UHI policy and technology responses more effectively in conjunction with each other.

Previous studies focused on studying Urban Heat Islands (UHI) on a specific level, (Shareef, 2022) investigates the impact of greenery on different levels and three types of UHI, pedestrian, canopy, and boundary, to provide a holistic image of greenery impact on the atmosphere, and simulate different scenarios based on vegetation type and Leaf Area Density (LAD) using ENVI-met.

The effectiveness of UHI mitigation measures can be affected by public perceptions during planning and implementation processes, Wang et al., (2021b) leverages the results of a carefully designed survey to fill this research gap. The perceptions of professional respondents are largely affected by the geographic areas they work in and partially affected by how familiar respondents are with the UHI-related building codes and regulations and the lack of public education on UHI mitigation and implementation measures, the lack of effective communications between researchers and code writers, the lack of implementing UHI mitigation strategies in some countries, and the lack of trustworthy information shared on social media(C. Wang et al., 2021b).

Conclusion

In conclusion, mitigation strategies and different methodological approaches to UHI study have been reviewed and discussed. Researchers are at liberty to choose the method that will suit their research needs and employ in their future research work.

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