Urban Heat Island: Causes, impact and damage control measures

Article *in* Journal of Interior Designing and Regional Planning · September 2024

DOI: 10.5281/zenodo.13772289

1 author:

Tanya Rani
School of Planning and Architecture Delhi

HBRP PUBLICATION
Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

Urban Heat Island: Causes, impact and damage control measures.

Tanya Rani
PG Student, Department of Building Engineering and Management, SPA Delhi

Corresponding Author
E-Mail Id: tanyarani15@gmail.com

ABSTRACT
Climate change is a looming threat to both the planet's ecosystems and human well-being. It stems from various factors and has numerous consequences. Among these consequences, the Urban Heat Island (UHI) effect stands out as a prominesnt feature of urban climates. The fastest-growing phenomena in developing countries is undoubtedly the rapid development of the urban population. UHIs are more evident in urban areas, and they become increasingly pronounced as cities expand and evolve. These heat islands intensify the challenges posed by climate change by elevating local temperatures and triggering a range of environmental and health issues. Furthermore, heat islands have the added consequence of raising cooling demands during the summer, leading to increased energy usage and the emission of more greenhouse gases. There exists a multitude of strategies for alleviating the Urban Heat Island (UHI) effect. This study evaluates different UHI mitigation approaches and assesses their effectiveness in reducing urban temperatures. Its goal is to provide a collection of research- and analysis-based recommendations to counteract the UHI effect. The study emphasizes the significance of each UHI mitigation strategy and offers a series of recommendations specifically tailored for India. These recommendations are intended to guide governmental policies aimed at addressing and mitigating the Urban Heat Island effect.

Keywords: *Urban Heat, temperature, material, reduction techniques, applications, urbanization*

INTRODUCTION

The urban environment is deteriorating due to the effects of increasing industrialization and urbanization. Inadequate control over development is negatively impacting both the urban climate and the environmental performance of buildings.

The urban heat island (UHI) effect, in which metropolitan areas suffer greater temperatures than the surrounding rural areas, is one prominent outcome of these changes. This is primarily because densely populated metropolitan regions have air temperatures higher than the national average due to imbalances in heat distribution.

The term "urban heat island" (UHI) refers to this phenomenon, which is a result of the microclimatic alterations brought about by human-made changes to the urban landscape. Key factors contributing to the UHI effect are human activities, including the concentration of buildings, the presence of asphalt and other heat-absorbing surfaces in cities.

These surfaces absorb and retain heat, leading to elevated temperatures (Adinna, 2009).[1] The UHI effect can have various environmental and health consequences, such as increased energy consumption, air pollution, and heat-related illnesses. Consequently, it is a critical consideration

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

for urban planning and climate mitigation strategies.

One significant reason for temperature variations between urban areas and the countryside is the absorption of heat by buildings, roads, and other structures during the day, which is later released after sunset. Other contributing factors include the lack of vegetation, reduced evapotranspiration processes, the heat retained by construction materials, decreased long-wave radiation losses in urban areas, reduced wind speed, and subsequently, less convective heat dissipation from urban exteriors to the atmosphere.

Urban overheating is the combined outcome of the UHI effect, which is especially prominent in cities with a positive thermal balance, and global warming, which affects urban climates.

As a result, higher urban temperatures have a range of consequences, including an increased concentration of certain pollutants like tropospheric ozone, decreased thermal comfort in cities, exacerbation of health and indoor environmental problems, and a significant rise in the ecological footprint of cities worldwide (Ajit Tyagi, 2021) (Kumar & Singh, 2023).[2,13]

The microclimate generated by the Urban Heat Island (UHI) has several consequences. One significant outcome is the increased demand for energy to cool buildings. This heightened cooling demand necessitates the generation of more power, leading to an increased release of greenhouse gases and contributing to climate deterioration. The formation of UHI is primarily due to the substantial presence of built-up surfaces like concrete and asphalt, which have a high heat capacity (Akbari, 2001).[3]

Additionally, the use of low albedo materials, which are non-reflective and water-resistant, further exacerbates this phenomenon. When these impervious materials replace natural vegetation, an Urban Heat Island is created. This process varies depending on the built-up areas and geographical conditions of a metropolitan area.

Several other factors can worsen the Urban Heat Island effect, including inadequate city planning, the emission of air pollutants from industrial processes and power plants, exhaust gases from vehicles, and the introduction of anthropogenic heat (Bretz, n.d.).[4]

In a typical urban area, surfaces tend to be darker, and there is less vegetation compared to the surrounding regions (Kumar & Singh, 2023).[13,14] This temperature difference between a city and its rural surroundings can be as much as 2.5 degrees Celsius on a warm summer day, resulting in an additional 5-10% municipal peak electricity demand.

However, during the winter season, when the environment is cold, the UHI effect can have a positive impact on city dwellers by providing them with warmer air. Nonetheless, during the summer months, it negatively impacts both daytime and nighttime energy usage as well as human comfort.

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

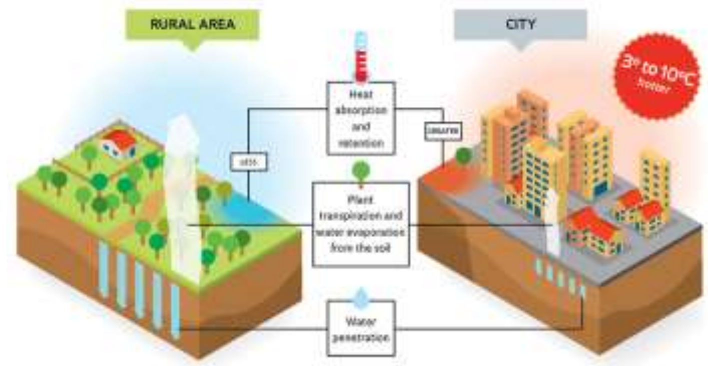

Fig. 1: *Comparision of rural and urban areas (Ajit Tyagi, 2021)*

CAUSES OF URBAN HEAT ISLAND

The causes of UHI are as follows:

- Minimal evapotranspiration due to vegetation.
- Solar radiation absorption as a result of low albedo.
- Obstruction to airflow due to increased rugosity
- High levels of heat release caused by humans

However, there are many factors which play a role in the increase of the urban heat island. The following lists the major contributing causes to the development of UHI.

Low Albedo Materials

Albedo is a term used to describe a surface's reflectivity, more especially, the percentage of incident solar radiation that is reflected back into space (Bretz, 1998) (Das, Rastogi, & Kumar, 2021).7] A material with a low albedo will absorb more sunlight and reflect less of it. Because of their propensity to absorb more heat, these materials may raise the surrounding temperature. Albedo is evaluated by the ratio of the reflected solar energy to the incident solar energy.

Low albedo materials, which absorb more sunlight and reflect less, contribute to the UHI effect in several ways:

Heat absorption

Dark surfaces absorb a lot of solar radiation. Examples of such surfaces are asphalt and dark-colored roofing materials. The urban area's temperature rises as a result of this heat being absorbed and subsequently reradiated into the surroundings.

Reduced heat reflection

Sunlight can be absorbed more by the surfaces made of materials with low albedo because they reflect less of it. This indicates that more solar energy is being converted into heat and that less solar radiation is being reflected back into space.

Limited nighttime cooling

The ability of the urban environment to cool down at night is limited by low albedo surfaces, which can hold onto heat far into the evening. In comparison to the neighbouring rural areas, this may lead to greater evening temperatures.

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

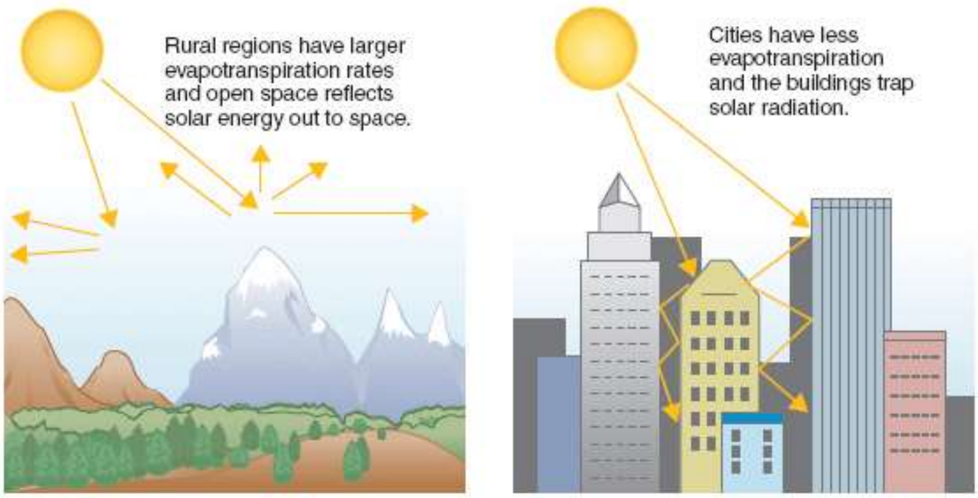

Fig. 2: *SRI of urban and rural area (CIMSS-UW-Madison, n.d.).[6]*

By reflecting heat from the sun instead of absorbing it, a material's ability to remain cool can be gauged using its SRI value. It is quantified on a range of 0 to 100. Standard surfaces with a black SRI of 0 and a white SRI of 100 are considered standard. A material's contribution to the heat island effect decreases with increasing SRI.

Material	SRI Value
Asphalt	5
Grey cement concrete	26
Granite Crete	48

Air Pollutants

In urban areas, pollution is a big issue, especially in the city centres. Air pollution is a result of increased human activity in urban areas, including energy use, transportation, and industrial processes. Particulate matter, nitrogen oxides, and volatile organic compounds are a few of the pollutants that can lead to poor air quality. Solar radiation is trapped by vehicle exhaust gas and industrial pollutants released into the atmosphere (Bretz, 1998).[5] Some chemical reactions in the atmosphere can be accelerated by the elevated temperatures linked to the UHI effect. For instance, higher temperatures can cause a reaction between nitrogen oxides and volatile organic compounds in the presence of sunlight that results in the formation of ground-level ozone, a major ingredient in smog. The UHI effect and air pollutants in urban areas are interconnected, and addressing one aspect often involves considering the impacts on the other.

Urban Canopy

In urban areas, there are multilayer building. The heat reflected by a building is trapped by the nearby taller buildings which is known as the urban canopy. The development of an urban canopy exacerbates UHI. Moreover, it offers shade and encourages vegetation's evapotranspiration (Getter, 2006).[8] Within the urban canopy, trees and other green areas can provide shade, which lowers temperatures by lowering the amount of solar radiation that surfaces absorb (Mishra & Kumar, 2021. The combination of water evaporating from surfaces and plant transpiration results in evapotranspiration, which cools the air around it. The ventilation and airflow in urban areas are influenced by the urban canopy (Kumar K. , Basu, Rastogi, & Paul, 2020).[9-12] In street canyons, tall buildings can trap heat and pollutants by obstructing the natural flow of air. The UHI effect and the urban canopy have a complicated relationship. Compact building designs and dark surfaces are two characteristics of urban development that can help with heat absorption and retention.

Human Activity and Gathering

Due to the abundance of facilities in city centres, where people congregate frequently, there is also a significant CO_2 emission in these areas. The atmosphere gets warmer due to the heat-storing properties of CO_2. The end result is that it greatly contributes to the formation of heat islands. The UHI effect is further exacerbated by the daily activities of a large population concentrated in urban areas, such as commercial activity, industrial production, and commuting, which release heat and pollutants (Pragya & Kumar, 2021)[17] (Levinson, 2002).[15] The heat island effect is exacerbated by the combined effects of human activity, particularly during periods of high activity. Energy use for air conditioning, lighting, and other services may rise during events and gatherings. This increased energy consumption may lead to increased heat emissions, which will amplify the urban heat island effect in the surrounding area.

Increased Use of Air Conditioning

For the purpose of keeping people comfortable during the summer, air conditioner use is increasing. A building's interior is kept cool by air conditioners, which in turn release the heat they absorb into the surrounding air. Consequently, the ambient temperature outside gets warmer, raising the atmospheric temperature (Taha, 1997) (Takebayashi, 2009).[18,19] Localized warming may result from the combined effect of multiple air conditioners running in an urban area, particularly in areas with high building concentrations and dense populations. Elevated temperatures in the vicinity can be caused by power plants emitting more heat as a result of higher energy consumption due tpo high demand of air conditioniong.

Urban Design and Layout

The higher temperatures caused by UHI can be made more severe or minimized depending on how cities are designed and built. The following are some elements of urban layout and design that affect the UHI effect:

Water bodies and features

Including water features in urban planning, such as lakes or ponds, can provide a cooling effect. The presence of water features in the surroundings produces a cooling microclimate through evaporation.

Orientation of buildings

Buildings that are oriented correctly can reduce direct exposure to strong sunlight, which lowers the amount of heat that surfaces absorb and increases cooling energy efficiency.

Cooling strategies for public spaces

Incorporating cooling techniques into public spaces design, such as using reflective materials, water features, and shaded areas, can reduce urban heat island effects.

Building density and arrangement

Compact layouts and high building densities can result in street canyons that restrict airflow, retain heat, and raise ambient temperatures.

Green spaces and vegetation

HBRP PUBLICATION

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

Parks, greenery, and other natural areas can lessen the impact of UHI. In addition to providing shade and lowering surface heat absorption, trees and other plants also help with cooling through evapotranspiration.

Street design and width
In order to help dissipate heat, wide boulevards and streets with avenues lined with trees can enhance ventilation and provide shade. Tall buildings and narrow streets can obstruct airflow and increase heat retention.

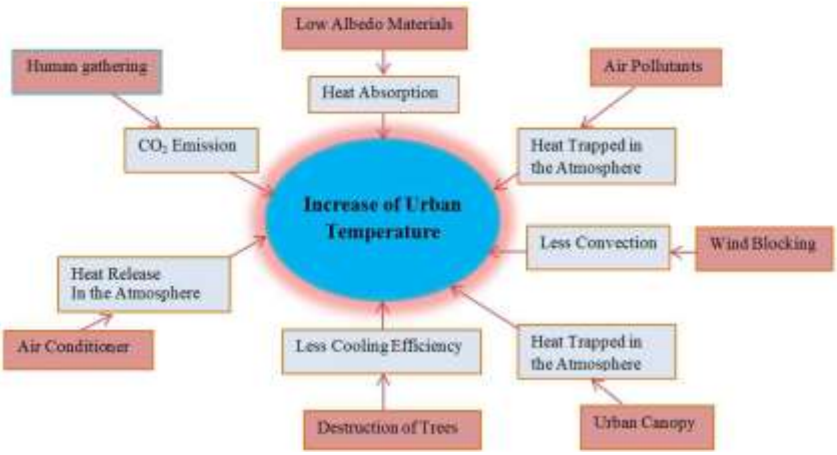

Fig. 3: *Process of urban heat island formation (Nuruzzaman, 2015).[16]*

EFFECT

Health Impact

Exposure to ground-level pollution, which is frequently worse in areas affected by heat islands, can have a negative impact on human health. The population may experience heat stress during hot spells, the effects of which are exacerbated by urban heat islands. Urban heat island-related high temperatures can exacerbate pre-existing chronic illnesses like respiratory failure, cardiovascular disease, diabetes, neurological disorders, and renal diseases (Xu, 2010) (Vaibhav Rai Khare, n.d.).[20,21] They can also cause discomfort, weakness, seizures, fainting, and heat stroke.

In the summer, the effects are particularly severe in tropical and arid areas. Those who live in the middle of the city find it uncomfortable. People with limited endurance experience heat stress due to the extreme heat, which can lead to both illness and death. In addition, more energy will be needed to cool the buildings so that people can feel comfortable due to the rising temperatures. Both public and government spending will increase as a result of this. The worst victims of the microclimate effect are summertime buildings, roads, and open spaces, where energy demand may increase by 2-4% for every 10C increase in temperature. In order to meet the rising demand for electricity, more fossil fuels are burned, which increases greenhouse gas emissions and exacerbates the state of the climate. Meanwhile, greater use of air conditioners exacerbates the effects even further. Nonetheless, because of the higher temperatures during the winter, the UHI effect tends to make people feel more comfortable. The ensuing diagram demonstrates the impact of UHI on human life.

Increased Energy Consumption

The Urban Heat Island (UHI) effect is mainly accountable for the rise in energy consumption in urban areas because of the increased demand for cooling. In urban areas, the UHI effect can prolong the cooling season. Longer periods of warmer

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

weather mean that individuals and organizations need to operate air conditioning systems for a larger chunk of the year. During UHI episodes, there is an increased need for cooling, which raises the grid's overall electricity load. In order to meet the increased demand, power plants might need to produce more electricity, which would increase their energy consumption. In warmer weather, air conditioning systems loose efficiency. Because of this, they might need more energy to reach the appropriate indoor temperatures, which would raise the total amount of energy used.

Air Quality Degradation
Although UHI doesn't directly worsen air quality, it can cause pollutants to form more readily. Higher temperatures can intensify the chemical processes that generate particulate matter and ground-level ozone, which will lower the quality of the air in cities.

Reduced Water Quality
Through influencing water runoff and evaporation rates, HI can have an impact on the hydrological cycle. Urban areas with impermeable surfaces experience increased runoff and may experience urban flooding as a result of the prevention of water seeping into the ground. The quality of the water in urban water bodies can also be impacted by temperature changes.

Reduced Productivity and Thermal Comfort
Residents may experience less thermal comfort as a result of UHI, which will make outdoor activities less enjoyable. The general standard of living in metropolitan areas can be impacted by uncomfortable living circumstances.

BENEFITS OF URBAN HEAT ISLAND REDUCTION
Buildings, cities, suburban areas, and the world at large can all benefit from mitigating the urban heat island effect. There may exist a:

- Lower energy costs in air-conditioned buildings, and unconditioned buildings can be cooler in the summer.
- Roofs with less thermal expansion have longer lifespans.
- Summertime peak electric demand is lower due to lower building cooling loads.
- During periods of extreme heat, the negative effects on mortality and health may lessen.
- Better air and water quality.
- Improving social and environmental equity can be achieved by addressing a city's urban heat island.

STRATEGIES TO REDUCE URBAN HEAT
Use of High Albedo Materials
Heat from the sun is absorbed by dark roofs, which keeps residences warm. On the other hand, light-colored roofs with comparable insulation qualities do not warm up a lot when they reflect sunlight. Thus, the colour of the roof can affect how much the temperature drops. Low-albedo roofing materials absorb solar heat and warm the home, which increases energy use for air conditioning. Thus, using high albedo roofing materials is one of the mitigation strategies. There is no additional cost to the roof if cool surfaces are achieved through colour changes.

The EPDM materials, which have similarities to rubber, don't affect the price of colour changes. Roofing materials can be made of white materials with an albedo greater than 0.60 rather than black materials with an albedo of 0.05 to 0.10. By Using roofing materials with varying albedos, from 0.20 to 0.60, it has been discovered that the roof temperature decreased by 250C for 0.60 albedo compared to that of 0.20 albedo. The efficacy of UHI effect mitigation strategies

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

is influenced by the convection of roofing materials. The fact that soot causes the reflection ability of reflective roofs to diminish with time is one of their drawbacks. Nevertheless, by routinely cleaning it, it is easily made up for.

Again, aesthetics is a problem with cool roofs. Commercial buildings don't have to worry about it, but homeowners of residential buildings typically use dark coloured roofs to make their buildings appear less dirty over time. Conversely, cooling roofs glare during the day. It is not something to think about for a roof that is parallel to the street level. However, a sloping roof may produce enough glares to impair drivers' vision, potentially leading to collisions.

Vegetation and Urban Forestry

With the majority of its effects on the various terms of the surface energy balance, vegetation in urban open spaces has a noteworthy influence on the urban heat island phenomenon. High-quality urban living can benefit greatly from the presence of vegetation in urban open spaces. It is essential to the urban thermal environment because it has the ability to block radiation, slow down the wind, and lower air temperature.

In urban open spaces, trees effectively reduce heat radiation and help to lower the sky view factor (SKF) in these areas. Through absorption and reflection, trees can block a significant amount of incoming short-wave solar radiation. Because it caused transpiration, which lowered the surface temperature, vegetation assisted in both blocking short-wave and long-wave radiation. It has been discovered that in the summer, the ground beneath the trees, shrubs, and lawn have the lowest surface temperatures. Thus, in order to add vegetation and, as a result, lower surface temperatures and enhance the outdoor thermal environment for the composite climate, researchers advised using vertical greenery.

Installation of Water body

The ability of water bodies to cool the air through evaporation is their main effect on the urban thermal environment. In addition, the temperature of the water bodies was lower than that of the nearby structures and surroundings due to their high thermal capacity.

Convective heat transfer is facilitated by the higher temperature gradient between the water's surface and the surrounding air due to the water body's lower temperature. Furthermore, radiation from a cooler water surface is reduced. Water has a thermal capacity of 4200 J/kg/°C, which is almost four times greater than that of pavement materials like marble, granite, gravel, and asphalt. Water bodies can be considered as heat sinks in urban areas because the evaporation of the water absorbs surrounding heat. In addition, convective heat transfer between the water's surface and the surrounding air cools the air. The temperature of a waterbody can drop the surrounding air temperature by 2–6°C, which helps to cool the air in urban areas.

Green Façade and Living Wall

Vertical ecosystems known as "green walls" produce a microclimate that significantly reduces the building envelope's temperature and boosts energy efficiency. Because these walls increase the thermal mass of the building, they aid in minimising noticeable temperature variations.

In addition to these advantages, these green installations also shield the building envelope from UV rays, collect particulate matter in the air, and shield walls from graffiti. They can be mounted on fences, phone poles, light standards and any kind of building. However, care must be taken with regard to the state of the host

DOI: https://doi.org/10.5281/zenodo.13772289

structure, which needs to be able to support the weight of the vegetation, as well as the potential of the chosen type of vegetation. Simple vegetation maintenance includes pruning, weeding, and checking the supporting structure.

Urban Planning and Design

Encouragement of mixed land use, which combines commercial, residential, and green areas, can help disperse heat more uniformly and lower the amount of impermeable surfaces in the area. Creating well-planned, compact urban areas can minimise the amount of impermeable surfaces, lower heat absorption, and improve walkability.

Energy Efficient Building Designing

Lowering interior temperatures and lowering the need for air conditioning can be achieved by implementing energy-efficient building designs, such as those that include cool roofing, insulation, and adequate ventilation. One way to lower the total energy consumption for cooling buildings is to install energy-efficient heating, ventilation, and air conditioning (HVAC) systems. Zoned heating and cooling is a feature of VRF systems that enables precise control over distinct areas. When it comes to energy efficiency, these systems outperform conventional HVAC systems. Energy-efficient LED lighting can replace conventional lighting systems, which not only uses less electricity but also produces less heat indoors, making buildings feel colder overall. By using smart building technologies, like BAS, lighting, HVAC, and other building components can be controlled more effectively, optimising energy use based on current conditions.

Covered Parking Strategies

As much as 50% of a city's land can be devoted to parking lots, which offers an amazing opportunity to address issues related to the urban climate. Reducing the urban heat island effect can be achieved by switching from asphalt-covered parking areas to grass-covered parking areas. The following techniques can be used to cover the parking area: have one of the following roof coverings: (a) SRI coated; (b) vegetated; or (c) equipped with energy-generating devices like wind turbines, photovoltaic cells, and thermal collectors.

A sizable portion of the impermeable and non-permeable surfaces in urban areas are parking lots with asphalt coverings. The nearby water bodies are also impacted by parking lot runoff. The water's quick flow shortens the time it takes for evaporation, which hinders the air's natural cooling process. To make room for parking lots, trees and other vegetation that provide shade and help to moderate temperature are also removed, which adds to the urban heat island. Therefore, it is crucial to focus on the development of green parking space. It is possible to plant vegetation all the way around parking lots. The idea is to give paved surfaces some shade. In addition to shielding the pavement from large temperature fluctuations, the trees' shade will increase the pavement's life expectancy. It is also feasible to vegetate entire surfaces using different modular systems made of concrete, PVC, or other plant-growing materials in order to lower the surface temperature of parking lots. These modules are placed on top of a layer of permeable soil that supports loads of up to 376 t per square metre and encourages rainwater to naturally percolate into the ground.

Cool Pavements

A cool pavement, in contrast to a cool roof, has no official definition. The reflected heat from urban infrastructure can be absorbed by surrounding buildings, increasing the urban heat island effect by warming the interior of the building. This is because additional heat is emitted from

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

the infrastructure. A variety of developing materials that aid in lowering pavement surface temperatures and heat absorption are referred to as "cool pavements." It assisted in lessening the issue of urban heat islands, which in turn caused paved surfaces' temperatures to drop somewhat (Yamamoto, 2006).[22] Pavements were investigated by a number of communities in an effort to reduce heat islands. Following the successful implementation of permeable pavements, which permit vapour, water, and air to enter the pavement's voids and keep the material cool when damp, some practitioners have expanded the use of permeable pavements to include cool pavements. The following circumstances influence pavement temperatures but not roofing materials:

- Pavement surface properties are affected by fouling of a surface brought on by foot and vehicle traffic.
- Convection brought on by changes in traffic over the pavement.
- Shading from nearby buildings, vehicles, vegetation, and people.

A few attempts have been made to focus on lowering the need for pavement, especially over vegetated areas, as these areas have many advantages, such as lowering air and surface temperatures. Communities have used a variety of tactics to cut back on the quantity of paved surface areas. These strategies include narrowing streets, integrating parking and mass transit services, lowering the requirement for parking spaces, and offering incentives for multi-level parking as opposed to surface lots. Although there is no direct correlation between air temperature and surface temperature, it can contribute to lowering the temperature both during the day and at night.

Because urban infrastructure releases more heat, reflected heat from these structures can be absorbed by surrounding buildings, warming their interiors and intensifying the urban heat island effect at night.

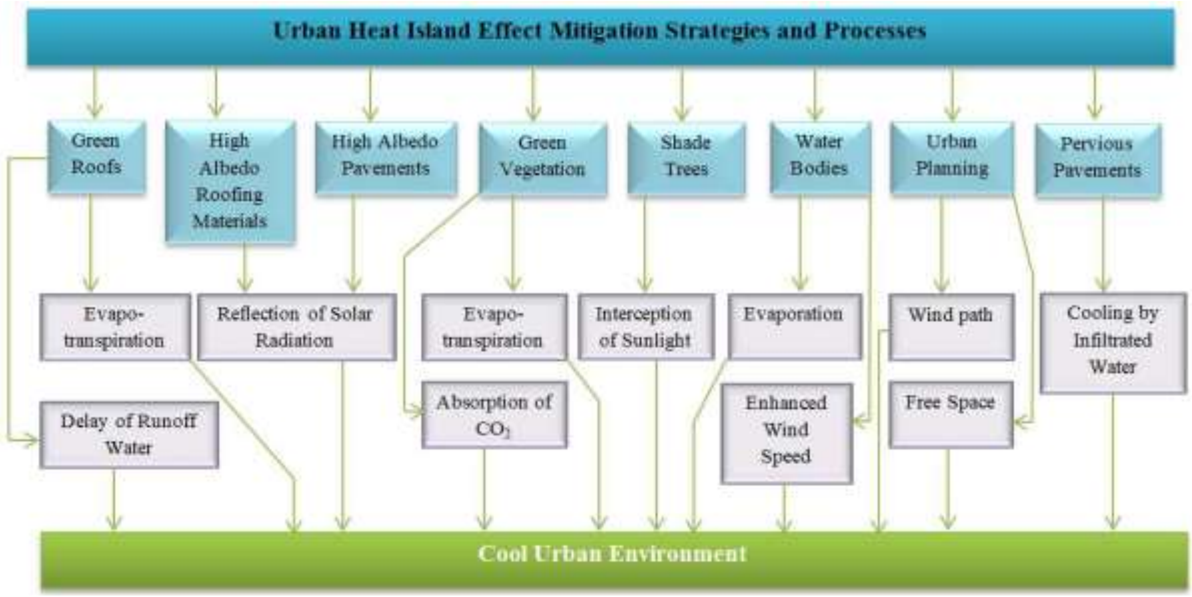

Fig. 4: *UHI mitigation strategies and procedure (Nuruzzaman, 2015).*

RECOMMENDATION

Heat islands can be lessened through the use of smart growth development strategies, which are largely influenced by urban design. By implementing tactics that empower people to make educated decisions about the built environment, smart growth boosts the local economy

HBRP PUBLICATION

Journal of Housing and Advancement in Interior Designing
Volume 7 Issue 3
DOI: https://doi.org/10.5281/zenodo.13772289

and protects the environment. Smart growth not only mitigates the heat island effect but also offers a framework for greater regional environmental protection, community character enhancement, and local economic growth.

The suggestions for India to reduce the UHI derived from the field research and studies are summarized below. The paper identifies supporting actions for each recommendation, grouping them according to suggested timeframes: short term: 1 to 3 years; long term: 3–8 years.

	Short term	Long term
Cool Roof	• Effective promotion and implementation of cool roofs by making it mandatory in ECBC rather than as a prescriptive measure. • Large and densely populated cities can take leadership and develop programs on actions like cool roofs and pavements that would bring about a positive change in UHI.	• The increase in the roof albedo could reduce the absorption of solar radiation along-with roof temperature and thus heat ingress into the buildings, for a tropical country like India. • Setup a cool roof rating council in India that oversees a labelling program for roofing products and rates the reflectivity and emissivity for paint or coating.
Reducing off-street parking	Replacing surface parking lots with naturally vegetated pavements that transfer heat to the atmosphere.	Providing on-street parking, compact planning, and pedestrian-oriented development will promote transportation choices and will help in minimizing the size and number of parking lots
Promoting the covered parking	Including the covered parking strategies in the building design stage by reducing the open parking areas to at least 75%	
Promoting infill and higher density development	Growth within existing communities can protect open space and help counterbalance heat islands and their aftereffects	
Increasing public education and outreach	• UHI mitigation strategies should reflect local variation in the built environment, as well as local preferences and attitudes. • Policies should be customized to meet the requirements, based on stakeholder feedback, and efficiently conveyed to the public.	• A committee/organization could be formed to propagate the information to the community, seek advice, and incorporate problems and concerns into action plans • Committees formed to address urban heat mitigation should include representatives from citizen groups, local government, non-governmental organizations, universities, and others concerned about the future growth of the community.

CONCLUSION

Green vegetation appears to be the most effective way to combat the UHI effect out of all the mitigation strategies. Its efficacy has also been demonstrated, and experts generally agree that it is a very effective mitigating measure. But there are a few disadvantages. However, high albedo materials and pervious pavements may be used in cities where large-scale tree planting is not practical. In this situation too, green roofs might be crucial. However, given its limitations, shade trees can be used in the house garden where there is sufficient space as a small-scale mitigation measure. Appropriate planning is necessary in expanding cities to reduce the impact on the economy. According to some studies, the existence of water bodies in urban areas is a contentious issue; further research should be done to support this mitigation strategy. The use of high albedo pavement is not very effective and has many drawbacks. As such, it ought to be considered the final resort when it comes to UHI mitigation.

REFERENCES

1. Adinna, E. C. E. I. &. O. A. T., 2009. Assessment of urban heat island and possible adaptations in. Journal of Geography and regional planning.
2. Ajit Tyagi, M. K. S. C. B. R. M. a. Y. S., 2021. Review of Urban Heat Islands: Monitoring, Forecast and Impacts. Research gate.
3. Akbari, H. P. M. &. T. H., 2001. Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas.. Solar energy.
4. Bretz, S. &. A. H., n.d. Durability of high-albedo roof coatings and implications for cooling energy savings.. 1994.
5. Bretz, S. A. H. &. R. A., 1998. Practical issues for using solar-

reflective materials to mitigate urban heat islands.
6. CIMSS-UW-Madison, n.d. [Online] Available at: https://cimss.ssec.wisc.edu/.
7. Das, S., Rastogi, A. & Kumar, K., 2021. Applicability of Risk Assessment Tools and Techniques for a Construction Project. Journal of Research in Infrastructure Designing, 4(3), pp. 1-18.
8. Getter, K. L. &. R. D. B., 2006. The role of extensive green roofs in sustainable development. Hortscience.
9. Kumar, K., Basu, D. C., Rastogi, A. & Paul, V. K., 2020. Retrofitting the existing requirements for an institutional building Framework for Enhancing the Functionality. IJSDR, 5(3), pp. 362-368.
10. Kumar, K. & Paul, V. K., 2022. A Critical Review of Risk Factors and Reliability Assessment Issues of Fire and Life Safety in Buildings. NICMAR JOURNAL OF CONSTRUCTION MANAGEMENT, XXXVII(III), pp. 23-33.
11. Kumar, K. & Paul, V. K., 2022. Risk and Reliability Assessment of Smoke Control Systems in the Buildings. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 10(X), pp. 576-581.
12. Kumar, K. & Paul, V. K., 2023. Significance of Fire Protection System Reliability for Structure Fire Safety. STRUCTURAL ENGINEERING DIGEST, Issue October-December, pp. 42-25.
13. Kumar, K. & Singh, D. D. P., 2023. Assessing the Dynamics of Urbanization: A Comprehensive Review of Associated Risks and Mitigation Strategies. Journal of Research in Infrastructure Designing, 6(3), pp. 1-10.
14. Kumar, K. & Singh, D. P., 2023. Urban Risk Identification and Assessment in the Face of Climate Change. International Journal of Sustainable Building Technology, 6(2), pp. 33-38.
15. Levinson, R. &. A. H., 2002. Effects of composition and exposure on the solar reflectance of portland cement concrete.. Cement and concrete research.
16. Nuruzzaman, M., 2015. Urban Heat Island: Causes, Effects and Mitigation. Science PG.
17. Pragya & Kumar, K., 2021. A Review of Performance of Green Roofs for Retrofitting Existing Structures. Journal of Research in Infrastructure Designing, pp. 1-7.
18. Taha, H., 1997. Urban climates and heat islands: albedo,evapotranspiration, and anthropogenic heat. Energy and buildings.
19. Takebayashi, H. &. M. M., 2009. Study on the urban heat island mitigation effect achieved by converting to grass- covered parking. Solar energy.
20. Vaibhav Rai Khare, A. V. ,. D. G., n.d. A big picture of urban heat island mitigation strategies and. Science direct.
21. Xu, J. W. Q. H. X. Z. X. &. L. G., 2010. Evaluation of human thermal comfort near urban waterbody. Building and environment.
22. Yamamoto, Y., 2006. Measures to mitigate urban heat islands.. Science and Technology Trends Quarterly Review.

Cite as:
Tanya Rani. (2024). Urban Heat Island: Causes, impact and damage control measures. Journal of Housing and Advancement in Interior Designing, 7(3), 1–12. https://doi.org/10.5281/zenodo.13772289