Urbanization Committee

Re-approaching city management to mitigate the effects of urban heat islands

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RESEARCH REPORT

Forum: Urbanization Committee

Issue: Re-approaching city management to mitigate the effects of urban heat islands

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Introduction

Urban heat islands (UHIs) are a result of poor city management and climate change, resulting in warmer temperatures than those in rural areas. Urban areas absorb more heat than rural areas due to their dark and barren surface. Urban heat areas are one of the more prominent factors that reflect how much human activity affects the world and its inhabitants. It depends on the population, size, and density of the buildings and constructions. As more buildings are constructed by cutting down trees and decreasing green areas, the effect of UHIs increases. They are dependent on how much of the light energy is absorbed and how much of it is reflected. As urbanization increases the effects of UHIs become more noticeable. The issue at hand aggravates at an increased rate every year making it a subject of utmost importance and should be combatted as soon as possible.

Definition of Key Terms

Urban heat island: "'Urban heat islands' occur when cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat."[1]

City parameters: "In the urban planning and design practice, there are several important parameters such as sky view factor, floor area ratio, site coverage ratio and building stories. These parameters can determine the urban morphology."[2]

Population Density: "Urban density is a concept used in city planning, urban studies, and related fields to describe the intensity of people, jobs, housing units, total floor area of buildings, or some other measure of human occupation, activity, and development across a defined unit of area."[3]

Urban geometry: "Urban geometry, namely the quantitative relationship of building volumes and open spaces (i.e. built density) and their spatial configuration (i.e. urban layout), is a major modifier of urban microclimate."[4]

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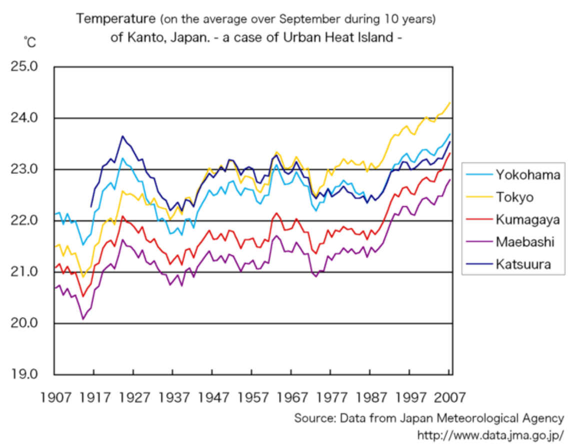
[1] "Reduce Urban Heat Island Effect | US EPA." 23 Mar. 2022, https://www.epa.gov/green-infrastructure/reduce-urban-heat-island-effect. Accessed 24 Feb. 2023.
[2] "Impact of Urban Morphology Parameters on Microclimate." https://www.sciencedirect.com/science/article/pii/S1877705816332192. Accessed 24 Feb. 2023.
[3] "Density, Urban | SpringerLink." https://link.springer.com/10.1007/978-94-007-0753-5_698. Accessed 24 Feb. 2023.
[4] "The impact of urban geometry on the radiant environment in outdoor ...." http://www.meteo.fr/icuc9/LongAbstracts/udc2-1-3141027_a.pdf. Accessed 24 Feb. 2023.

General Overview

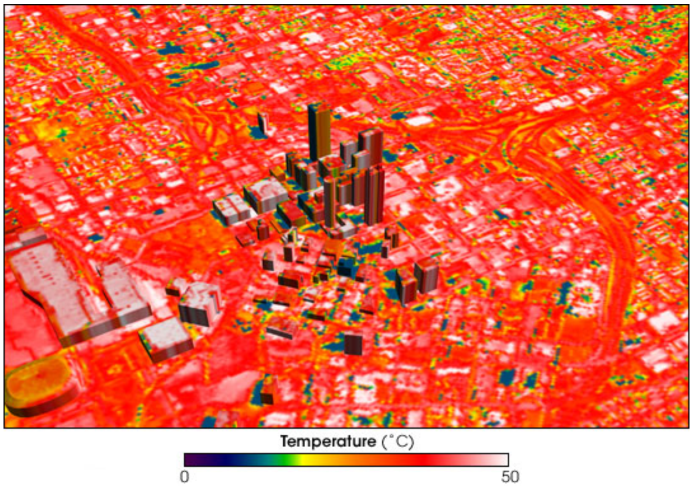
Initially identified by scientists in the 1800s, the effect of heat islands started being observed in warmer cities than their rural surroundings, especially in the summer. Daytime solar radiation absorption is higher on urban surfaces made of asphalt, concrete, and other materials (sometimes known as "impervious surfaces"). A large portion of the heat is released into the atmosphere of cities at night, resulting in a warm bubble that may be up to 3°C (1°F) warmer than the surrounding rural areas.



Luke Howard, even though he did not name the phenomena, was the one to explore and explain it for the first time in the 1810s. The nineteenth century saw a persistent interest in urban atmospheric studies. In Europe, Mexico, India, Japan, and the United States, scholars in the developing subject of local climatology or microscale meteorology explored novel approaches to comprehend the phenomena between the 1920s and the 1940s. Albert Peppler used the phrase "staedtischen Waermeinsel" in 1929, which is thought to be the earliest use of an equivalent to "urban heat island." Around 30 studies each year were published between 1990 and 2000; by 2010, that number had risen to 100, and by 2015, it had surpassed 300. Additionally, in order to organize and oversee efforts to mitigate the effects of urban heat islands, a number of cities throughout the globe started to establish Chief Heat Officer roles in the 2020s.

As mentioned above UHIs are affected by the absence of green areas. However, there are other factors that contribute to the formation and severity of heat islands such as geometric effects. Many metropolitan areas' tall structures' surfaces reflect and absorb sunlight, altering how effectively urban areas are heated. The "urban canyon effect" refers to this. The obstruction of wind by buildings is another consequence, which also hinders convection cooling and prevents pollutants from dispersing. UHIs is also a result of waste heat from several sources, including industry, air conditioning, and transportation. Because various types of pollution alter the radiative qualities of the atmosphere, high amounts of pollution in metropolitan areas can also increase the severity of UHIs. Ozone is a greenhouse gas whose synthesis will accelerate with the rise in temperature, hence UHIs not only elevate urban temperatures but also increases ozone concentrations, damaging the ozone layer and contributing to climate change in a greater sense.

UHIs have been shown to have a number of negative effects on energy consumption, body temperature comfort, people's health and well-being, and air quality. UHI consequences caused by human activity are well established and provide significant challenges to urban systems, human life, and ecosystems. Yet, the majority of researchers have discovered that UHIs significantly increase summer cooling energy usage. UHIs has also negatively impacted the thermal environment of cities; considerations to consider include air quality, human health, and exterior thermal comfort. The repercussions of global warming (including those on human health and well-being, several ecosystems, and levels of energy and water use) may be more prominent in urbanized areas due to UHIs.



UHIs have the ability to have a direct impact on urban people's welfare and health. An average of 1,000 people each year pass away in the United States alone as a result of excessive heat. UHIs, which are characterized by higher temperatures, have the potential to lengthen and intensify heat waves in urban areas. According to research, the death rate during a heat wave rises exponentially with the highest temperature, and the UHIs worsen this impact. The warming caused by UHIs increases the number of people who are exposed to high temperatures. During a heat wave, the nocturnal effect of UHIs can be especially damaging since it denies urban inhabitants the nightly cool reprieve that prevails in rural regions. Heat exhaustion, heat syncope, heat cramps, and heat stroke have all been linked to higher temperatures.

According to US research, different geographical areas have different relationships between high temperatures and death rates. Cities in the north of the country are more likely than those in the south to experience an increase in mortality risk due to heat. For instance, higher rates of disease and mortality are anticipated when midsummer temperatures in Chicago, Denver, or New York City are exceptionally high. Conversely, regions of the nation with mild to hot weather throughout the year have a decreased danger to the public's health from high heat. According to research, inhabitants of southern cities like Miami, Tampa, Los Angeles, and Phoenix are more used to hot weather and hence less at risk of dying from it. Even though the citizens are slowly getting used to it, several precautions could be taken. First and foremost, an increase in awareness and more buildings that consider this issue would improve living circumstances.

In conclusion, UHIs not only carry risks of their own but also worsen other pre-existing problems in cities. These factors underline the importance of sustainable urbanization and urban layouts t in the development of city landscapes.

Major Parties Involved and Their Views

China

The findings show that the patterns of UHIs intensity in 32 significant Chinese cities between 2003 and 2017 are largely consistent with the broad consensus that summertime UHIs intensity is 4.57 K greater than wintertime UHIs intensity. The varied energy interactions between vegetated/paved surfaces and the atmosphere, as well as variations in background temperature and precipitation, are largely to blame for the spatial variations that affect UHI intensity. The contribution of latent heat to UHIs changes decreases by almost 40% from a semi-arid/arid climate in the north to a subtropical humid climate in the south, while the contributions of other fluxes remain stable. Yet, the temporal variations of these fluxes' effects reflect more complicated processes. The seasonality of background temperature, precipitation, and vegetation is shown by the fact that the contributions of sensible heat and latent heat to fluctuations in UHIs intensity are, respectively, three and eight times greater in the warm season than in the cold season. The small contributions of these fluxes during the winter season also point to the importance of other driving forces, such as anthropogenic heat, particularly in climatic zones with semi-arid and semi-humid conditions. Now, China's urban planning is defined as a top-down system, high-density urban development, and substantial urbanization. During the long history of the country, there have been several shifts in China's urban planning theories and methods as a result of changes in the political and economic systems.

United States of America

Research has shown that water quality is also harmed by UHIs. Stormwater, which is dumped into streams, rivers, ponds, and lakes after draining into storm sewers, is heated by the surplus heat that hot pavement and rooftop surfaces impart to it. A loss in aquatic variety is another effect of elevated urban water body temperatures. Rains over Cedar Rapids, Iowa, in August 2001, caused the local stream to rise by 10.5C (18.9F) in just one hour, killing all the fish. The chilly rain might be ascribed to the city's scorching pavement because of how heated the pavement was. Identical occurrences have been reported in the United Midwest, Oregon, and California. By allowing water to percolate through the pavement and into underground storage spaces where it may be absorbed and evaporated, permeable pavements might lessen these consequences.

Evaluation of Previous Attempts to Resolve the Issue

Preferring white roofs instead of dark colors

Light-colored surfaces are very beneficial because they reflect light instead of absorbing them. One of the many factors that contribute to UHIs are dark surfaces. When they absorb light they increase the overall temperature. That’s why cities with many buildings tend to be warmer.

Preventing Heat Illness and Deaths Act of 2020

The National Integrated Heat Health Information System Interagency Committee (NIHHIS) would be empowered under Bill S.4280, which was presented to the U.S. Senate in 2020, to address excessive heat in the country. If this legislation is passed, NIHHIS would get five years of funding, and NIHHIS would also establish a $100 million grant program to support and encourage urban heat mitigation projects, such as those that use cool roofs and pavements and those that enhance HVAC systems. The measure has not advanced past submission.

Implementation of policies

In reducing urban heat islands, the Seattle Green Factor, a complex approach for urban landscaping, has had great success. The initiative focuses on places like commercial districts that are prone to high pollution levels. This platform enables developers to visibly examine their pollution levels while experimenting with different building techniques to determine the most efficient course of action. There are rigorous regulations for any new structure that surpasses around 20 parking spots. Seattle has consequently created a "score sheet" that communities may utilize when designing their cities.

Possible Solutions

A successful UHI mitigation approach has been identified as increasing the amount of vegetated land in metropolitan areas at the expense of paved or other man-made surfaces (including conventional roofs). Vegetated regions speed up evapotranspiration, which speeds up evaporation. By increasing the number of trees and other types of vegetation the effects of UHIs should decrease significantly. The implementation of regulations increasing green coverage and surfaces will not only lessen the environmental impacts of UHIs but also benefit human health.

Specific courses that focus on UHIs and how they are affected by urbanization and deforestation. This would not only raise awareness but also promote new ideas that could be implemented. The course would revolve around how the situation could be handled and improved under different circumstances. It would also include different countries' situations regarding the issue at hand and the increasing rates, including other data, would be debated upon.

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