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URBAN GROWTH, CLIMATE CHANGE, AND THE INTENSIFICATION OF HEAT WAVES IN INDIA

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ABSTRACT

India is undergoing rapid urbanization, leading to significant transformations in land use, infrastructure, and population densities. Concurrently, climate change is intensifying heat waves across the country, exacerbating the vulnerabilities of urban populations. This study explores the intersection of urban growth and climate change, analysing how expanding cities, with their heat-absorbing materials and altered landscapes, contribute to the urban heat island effect. The research highlights how extreme heat waves, fuelled by global warming, are becoming more frequent and severe in Indian cities, affecting public health, energy consumption, and economic productivity. Furthermore, this study reviews adaptive strategies being implemented, such as green infrastructure, sustainable urban planning, and climate-resilient policies, and assesses their effectiveness in mitigating the impacts of heat waves. Through an integrated approach combining climate science and urban studies, the paper emphasizes the urgency of rethinking urbanization to build heat-resilient cities in India. underline the importance of immediate policy interventions, public awareness campaigns, and investments in climate adaptation to safeguard the health and livelihoods of urban dwellers in the face of escalating heat risks.

KEYWORDS: Urbanization, Urban Heat Island Effect, Heat Waves, Climate Change Impact, Greenhouse Gas Emissions, Temperature Extremes, Global Warming

INTRODUCTION

India is undergoing rapid urbanization, a trend that is reshaping the country's socio-economic landscape. The swift expansion of cities, fuelled by population growth, industrialization, and infrastructural development, has led to increased demands on natural resources and significant changes in land use. Urban growth, while vital for economic progress, is also contributing to environmental degradation and climate challenges, particularly in the form of rising temperatures. Climate change, characterized by increasing global temperatures, altered precipitation patterns, and more extreme weather events, is further compounding the impacts of urbanization. India, with its diverse geography and vast population, is especially vulnerable to these changes. Among the most alarming consequences of climate change in the country is the intensification of heat waves. These extreme temperature events, which have grown more frequent, longer, and severe in recent decades, are becoming a major public health concern, particularly in urban areas where the effects are magnified by the "urban heat island" (UHI) effect.

The UHI effect, driven by dense construction, reduced green cover, and high energy consumption, traps heat in urban environments, making cities hotter than their rural counterparts. Coupled with climate change, this phenomenon is pushing Indian cities toward

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unprecedented levels of thermal stress, threatening the well-being of millions of residents. This article explores the intersection of urban growth, climate change, and heat waves in India. It examines the ways in which these factors are interlinked, how urbanization amplifies climate vulnerabilities, and what measures are being taken or need to be implemented to mitigate the risks posed by heat waves. Through a detailed analysis, this study aims to contribute to the growing discourse on sustainable urban development in the face of climate change and its increasingly visible impacts on the health, infrastructure, and socio-economic stability of urban India.

The study, published in a brief paper in the journal Nature, says climate change is warming the entire region, but most cities are warming faster than expected. Scientists call this "urbanization-induced warming." This means there is a 37.73% increase in warming in urban areas compared to non-urban areas (up to a decade), which is associated with urban development and is beneficial for all urban climates. The scientists used satellite data to track city boundaries and night-time surface temperature (NLST) data from 2003 to 2020 to estimate the warming. They compared urban climates with non-urban or rural areas, assuming that the warming in rural areas is primarily due to regional climate change, while urban warming is due to a combination of regional climate change and urban influences. This comparison helps scientists understand the contribution of cities to urban warming. According to 2011 census, cities are ranked as the cities with a population of more than 1 million and are most affected by urban heating. Top 10 cities growing on the highway due to growth in cities like Pune, Raipur, Jaipur, Ahmedabad, Patna, Nashik. Ludhiana, Lucknow, Bengaluru and Vadodara. Chemical use for heating is over 50%. Especially in Jamshedpur, urban development is 100% responsible for the heat. It is urbanization and development or increasing temperature due to urbanization.

One possible explanation is that these cities (eastern and central India) have experienced huge urban growth in recent years and hence heat increase in these cities is higher than existing cities and hence development. price is less. Another possibility is that the climate change in the region may be warming more slowly than in these regions. bright; Urban areas face significant risks from both urbanization and climate change. As cities expand, their changing landscapes lose their coolness through evaporation and store heat, leading to the urban heat effect. The study explains that this phenomenon not only increases temperatures but also affects other climate factors such as precipitation and pollution. With economic growth, construction will also increase. Extensive infrastructure is needed to support this growth, which affects emissions and therefore local and regional climate and the environment. Especially in relation to the environment and not just global warming or climate change. However, the rapid growth of cities is also a significant cause of climate warming. "In order to prevent air pollution (here related to high temperatures), the warming caused by local events such as the city economy will be reduced. Resources are allocated to solve environmental problems," he said, while touching on the purpose of the study.

This study draws attention to the fact that development plans and projects in existing cities are focused on health and economic development. However, the current situation in cities requires urban climate development plans that will address future climate-related problems. These plans should address the unique challenges of each city to achieve sustainability goals to build inclusive, safe, strong and stable cities.

REIMAGINING URBAN DEVELOPMENT

The article highlights the need for better urban planning that can help cities reduce the impact of urbanization on global warming. While urban planning cannot prevent climate warming, it

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can reduce the warming caused by urban development, especially in developing cities. The problem of warming that can be effectively addressed is affected by urban development. In cities with high levels of urban warming, efforts to reduce urban pollution (building urban structures, reducing local emissions, energy transition, and engaging in blue and green infrastructure) will have a major impact. Mitigation measures in these growing cities will slow or reverse urban temperatures. However, this may not be the case for cities most affected by climate change-induced warming. Vinoy said these cities have not yet utilised all their natural resources such as land and have greater capacity to imagine, rebuild and guide the future development of their cities in a sustainable manner. The report also suggests that sustainable urban planning and adaptation strategies can be more easily implemented in these cities. For example, Vinoy said these cities can plan to build water bodies, parks to provide thermal comfort and preserve the natural beauty of urban areas. Examples (from Delhi to Hyderabad) point out that these urban areas have exhausted all their resources such as land use. As a result, they have limited space for urban planning without improving the existing infrastructure. "The sustainability plan of the city should therefore be used in many ways for the design and development of the city," the report said. This study highlights the urgent need for solutions. He said that urban economics and global warming are a combination. When it comes to solving problems, there are many ways to move forward. One is urban planning, where researchers and planners can explore various models based on available resources. The second is improving decision support. For example, when severe weather or storms are predicted, people are told not to go outside. Similarly, he added that in case of an emergency, prediction and warning should be made.

In India, urbanization, climate change and rising temperatures are among the challenges that have a major impact on public health, infrastructure and the environment. Here is a comparison of these challenges in India and some developed countries:

1. Urban Growth:India: Rapid urban growth is remarkable, and many cities are experiencing growth. This is leading to increased demand for resources, infrastructure and services. Cities tend to grow more slowly, and their infrastructure and urban planning are more complex.

2. Climate Change: India: India is particularly vulnerable to climate change due to frequent and extreme weather conditions such as warm winds, heavy rain and droughts. And what's worse: rapid urbanization, increasing energy consumption and greenhouse gas emissions. However, they face significant challenges, including rising sea levels, frequent extreme weather events and the safety of urban areas. Heatwaves are becoming more severe:

Heatwaves are becoming more severe and frequent, especially in urban areas where the heat impact is high. Tall buildings and green spaces limit the Developed countries also have more resources to manage and mitigate the impacts, such as air conditioning and cooling, when in crisis. Good measures such as green roofs and related materials.

COMPARATIVE ANALYSIS:

INFRASTRUCTURE AND ADAPTATION:

Developing countries generally have more energy resources and better climate change technologies than India. change and urban planning. Education is generally higher. investment and policy measures are effective. Collaboration between governments, communities and organizations is essential to mitigate the impacts of climate change and accelerate urban development.

URBANIZATION, CLIMATE CHANGE, CHALLENGES

UNPLANNED URBANIZATION

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The rapid growth of Indian cities has resulted in unplanned cities with poor infrastructure, seemingly poor green space and ventilation. This results in urban heat density (UHI), where cities are hotter than rural areas. Dense material dense, dense, dense, dense, dense, dense dense materials (concrete, asphalt) absorb and store heat, resulting in more heat. This demand is mostly met by fossil fuel-based energy generation, leading to greenhouse gas emissions and climate change. Rising temperature results in heat becoming rarefied and concentrated. Low-income people, especially those living in slums, are more vulnerable to heat stroke due to inadequate housing and cold storage. High temperatures cause more evaporation of water. Rapid urbanization is putting great pressure on water resources, and many cities in India are facing serious water shortages. Lack of water during the hot season leads to drought, sanitation and health problems. Other conditions include stroke, dehydration and heart problems. Vulnerable groups such as the elderly, children and outdoor workers are at higher risk during adverse heat events. causes reduced urine output. Urban development also depends on agricultural land in the urban periphery. Food shortages and rising food prices are leading to hunger and poverty in major cities. Hot weather is exacerbated by insufficient trees, poor waste management, and a lack of green spaces in cities. City policies should provide climate change mitigation strategies to mitigate future climate impacts. These areas also tend to have fewer green spaces and open spaces for cooler weather. Slums are unique because their temporary housing often lacks insulation. Early Warning Early warnings are being heard across the country. Many urban dwellers lack adequate knowledge of heating planning and safety measures. Heat protection is not provided. The loss of these ecosystems eliminates the cooling process and increases the effect of heat. Urban policies should integrate ecosystem protection to reduce heat problems.

ACHIEVE CLIMATE-RESILIENT HOUSING

Support building practices that support building materials and designs to reduce indoor heat loss. Treatment and general education on flu prevention. In terms of urban development, climate change and rising temperatures in India need to be addressed in various ways.

SOLUTIONS URBAN PLANNING AND DESIGN:

Green Infrastructure: Integration of parks, green roofs and forests in cities creates vegetation that will help urban areas. Sustainable Building Codes: Implement and enforce building codes that require energy-efficient materials and designs that reduce heat loss and improve ventilation. To reduce heat absorption. Heat-resistant infrastructure: Invest in infrastructure that can withstand hot weather, such as heat-resistant materials for public spaces and airconditioning systems and other renewable energy sources to reduce dependence on fossil fuels that contribute to urban heat islands.

Public Awareness Campaign: Educate the public about the risks of heat and strategies to stay cool, including using drinking water and coolers. People with pre-existing medical conditions are more likely to catch flu. Also consider the impact of heat. Research: Promote research on climate change and climate change across different regions of India to inform interventions. These solutions require collaboration from government agencies, urban planners, communities and individuals to mitigate the impact of urbanization and heat on climate change.

CONCLUSION

Urbanization, coupled with the effects of climate change, has increased the frequency and severity of heat waves in India. Rapid urban development the expansion of slabs and the reduction of green space is making cities hotter, leading to local crises. Climate change is making the problem worse by increasing temperatures and changing weather patterns.

Vulnerable groups, including the elderly, children, and people with pre-existing health conditions, are particularly at risk. In addition, stress on infrastructure and resources can lead to financial hardship and hinder sustainable development. This includes increasing green space, improving the energy efficiency of buildings and using thermal schemes. Collaboration between government agencies, urban planners and communities is essential to develop and implement policies that address the symptoms and root causes of violence. A positive approach to sustainable development, increasing urban resilience and ensuring equity for all segments of the population.

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