Malaysia

The Urban Heat Island phenomenon and its impacts on vulnerable groups

Case study prepared by:
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Focus

The relationship between climate change and public health has become an increasingly important focus of global attention – particularly in cities where the majority of the world's population resides. Elevated temperatures in urban areas have been linked to a variety of heat-related health conditions ranging from mild symptoms such as heat cramps and heat exhaustion, to life-threatening conditions such as heat stroke. A pivotal issue in this nexus is the rise of urban heat islands (UHI) which have been shown to exacerbate heat-related illnesses. UHI occur in cities when natural land cover (trees and vegetation) is replaced with pavements and buildings, and other surfaces that absorb and retain heat.

With its tropical climate and high temperatures, Malaysia presents a compelling case study for heat-related illness. Also, the additional heat load that has occurred through rapid urbanization has made UHI an urgent public health issue in the country.

Project

The research focuses on a number of cities and towns across Malaysia which have differences in population density, built environment and green cover. This spatial diversity allows for a comprehensive understanding of the UHI phenomenon and its health impacts across various urban scales.

Further, the study aims to identify the most vulnerable groups in these areas. Preliminary findings suggest that children, the elderly and women – especially those in low-income households – are disproportionately affected by heat-related illnesses. By isolating other factors such as air pollution, physical activity and underlying health conditions, this investigation aims to quantify the extent to which UHI contributes to heat-related illnesses and provide a focused view of how urban planning can alleviate these health risks and allow for targeted intervention strategies that consider the specific needs of vulnerable groups.

Finally, the study aims to assess strategies that have been employed to mitigate the UHI effect in the past (e.g. green roofing, urban forests and reflective building materials). Previous approaches have often been fragmented or have not 'holistically' addressed the range of health risks presented by UHI. Some even had unintended adverse effects, such as increasing water consumption or displacing low-income communities. Understanding these shortcomings is crucial for developing more effective and sustainable solutions to combat the adverse health consequences of UHI.

The ultimate aim is to inform and influence urban planning policies that both mitigate UHI effects and safeguard public health.

Team

The project's multi-disciplinary team was at the heart of the systems-based approach which encompassed a diverse range of sectors and roles as follows:

1. **Academia**: Researchers from environmental science, urban planning and public health disciplines collaborated to develop the study's methodology and carry out the research. Their work served as the scientific backbone of the project, synthesizing existing data and conducting new empirical studies (collecting data) to explore the links between urban heat islands and public health in Malaysia (Jessani *et al.*, 2020).
2. **Public sector**: Local and national government agencies provided essential regulatory insights and access to publicly held data. They also played a critical role in ensuring the study's findings would be actionable from a policy standpoint (Khan *et al.*, 2023).
3. **Non-governmental organizations (NGO)**: NGOs in both the public health and environmental sustainability realms offered on-the-ground perspectives that helped shape the study and questionnaires. Their community networks were invaluable for participant recruitment and data gathering (Anbazhagan and Surekha, 2020).
4. **Private sector**: Companies in urban development and healthcare provided funding and technical expertise.

Methods and tools

The study employed a multi-faceted 'systems-based' approach. It looked at the structures and functions of health and climate systems, as well as how these systems operated and interacted with each other, to assess the impact of UHI on public health in Malaysian cities. A blend of qualitative and quantitative tools was used to derive comprehensive insights, as follows:

1. Environmental and health assessments were conducted that drew upon participatory mapping data, geospatial analysis and field surveys. These assessments were valuable in identifying 'hot spots' where urban heat and public health concerns overlapped.

2. Mathematical models were used to simulate the impact of temperature rise on specific health outcomes. The models were calibrated using both historical and current climatic and health data to ensure a precise understanding of the climate-health relationship in general, and a robust understanding of the health risks associated with UHI in particular.
3. Multi-criteria decision analyses were performed to evaluate various policy options. These statistical analyses consider multiple objectives such as public health improvement, cost-effectiveness and public acceptance. Interventions are rated to help guide policy makers when prioritizing strategies.

The study also included a thorough cost analysis that compared the multi-faceted, systems-based approach (used in the study) against existing business-as-usual strategies.

End-user engagement

Several strategies were employed throughout the research process to ensure the effective engagement of targeted end-users (policy makers, urban planne[a]rs and health agencies):

1. Initial consultations to ascertain each group's priorities and limitations;
2. Dissemination of preliminary findings to refine the study as it moved forward;
3. Targeted briefings at the end of the study to disseminate key findings and proposed action steps.

Results and products

The study found that initial setup costs for a systems-based approach were higher than business-as-usual approaches. However, the long-term benefits – in terms of improved public health outcomes, resource allocation and policy coordination – far outweighed the costs. For example, the systems-based approach helped identify highly effective, low-cost interventions such as green urban planning, which would not only mitigate heat but also promote public health (Sachs *et al.*, 2019). In contrast, business-as-usual strategies (e.g. the use of air conditioning) contributed to higher electricity consumption and increased greenhouse gas emissions, leading to greater long-term health risks and costs. Therefore, by adopting a comprehensive systems-based approach, the project achieved better health outcomes and policy synergies at a relatively marginal additional cost than business-as-usual.

The systems-based approach also proved to be instrumental in understanding the complex interplay between climate and health, giving it a clear edge over traditional methods that typically tackle these issues in isolation. By employing a multi-disciplinary team and integrating a range of methodologies and tools, the study could offer a more nuanced understanding of the problem. This resulted in more effective, holistic solutions and confirmed the findings of similar public health research that advocates for integrated systems-based approaches (Lacetera, 2019).

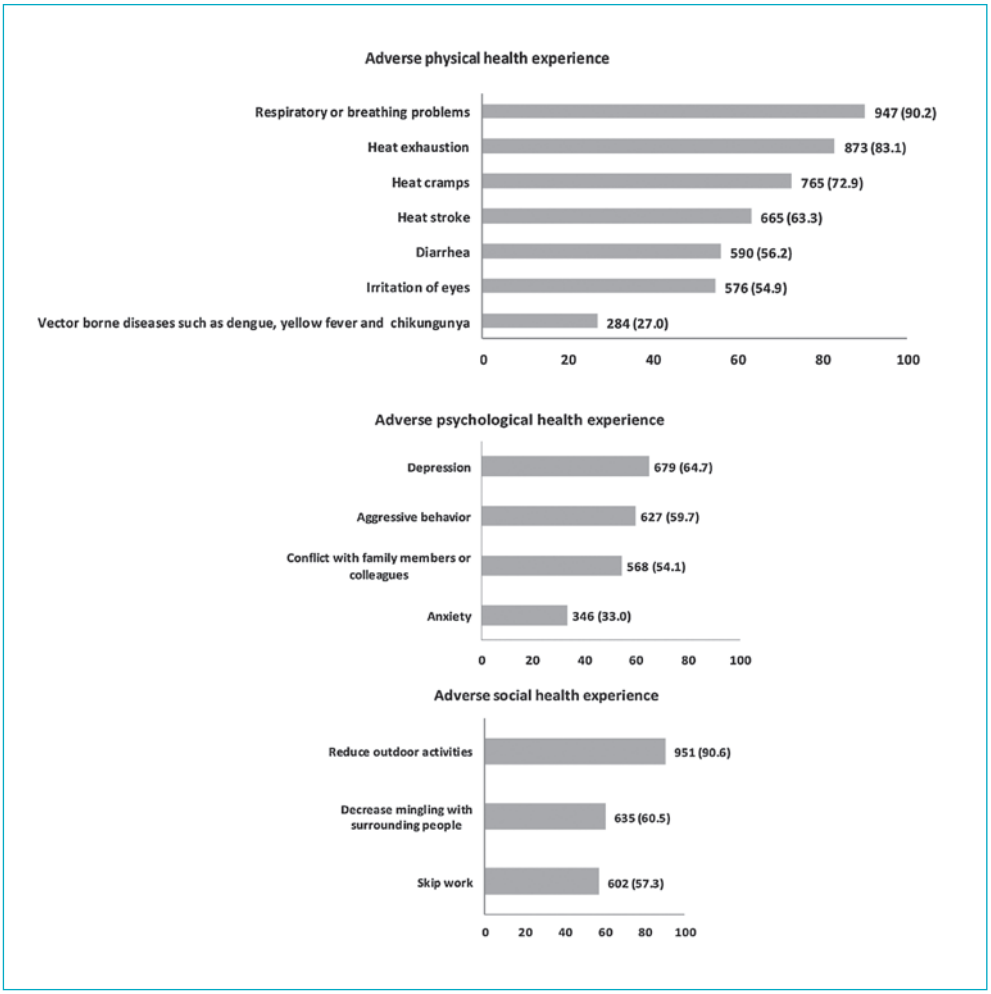

Figure 1: Physical, psychological and social health impacts associated to UHI effects (Wong et al., 2017). Figures refer to numbers of survey respondents (equivalent percentage)

Results show the physical, psychological and social health impacts associated with UHI (Figure 1), as follows:

1. Physical health: respiratory problems were experienced by more than 90% of respondents while heat stroke was reported by more than 63% of respondents. These results underscore the significant strain UHI places on physical health and emphasizes the need for improved urban planning to mitigate heat effects.
2. Psychological health: the prevalence of depression (almost 65%) and anxiety (33%) among respondents reflects the stress and discomfort caused by continuous exposure to elevated temperatures.
3. Social health: heat caused 90.5% of respondents to reduce their outdoor activities. Also, more than 57% of people had occasionally skipped work due to heat. These are clear indications of how UHI can impact social interactions and physical health and affect economic productivity.

Each of these variables not only indicates the direct effects of UHI but also outlines broader socioeconomic challenges. These results emphasize the need for integrated approaches to urban planning that consider the complex interplay between climate and health. This data strongly supports the necessity for multi-disciplinary strategies to effectively address and mitigate UHI impacts.

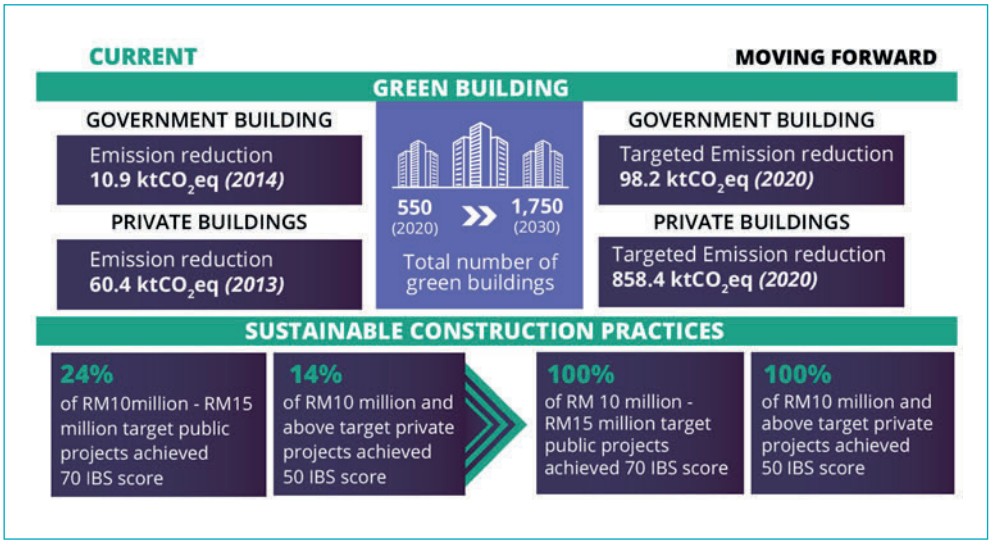

Figure 2: Malaysia Green Building Master Plan from: **https://www.pmo.gov.my/wp-content/uploads/2019/07/Green-Technology-Master-Plan-Malaysia-2017-2030.pdf**

Impact of the research on policy

A significant outcome of this research was the formulation of the new Malaysia Green Building Master Plan (Figure 2) which outlines the country's strategy for promoting sustainable development in the building sector from 2017 to 2030. The plan includes guidelines and targets for reducing energy consumption, increasing the use of renewable energy and implementing green building practices. It emphasizes the importance of creating environmentally friendly and energy-efficient buildings to mitigate the effects of climate change and improve public health.

End-users

The primary end-users of this study are policy makers, urban planners and health agencies. Based on the study's findings, it is these groups that have the authority (and potential) to effect significant change as follows:

1. Policy makers can use the evidence-based recommendations to draft or modify existing policies aimed at reducing heat-related health issues;
2. Urban planners can incorporate these guidelines into their designs for more climate-resilient cities;
3. Health agencies can formulate and execute public health interventions based on identified geographic and demographic risks (Ramirez-Rubio *et al.*, 2019).

The results of this study are already being disseminated via a multi-sectoral approach involving government departments, academic institutions and civil society organizations. Health agencies, which were particularly involved in interpreting the data around vulnerable populations, are currently working on creating targeted health interventions for vulnerable groups. Urban planners and policy makers are also involved in pilot programmes designed to implement some of the study's recommendations in selected urban areas.

Lessons learned

Unintended consequences and trade-offs

The transition to green building materials might initially be more expensive and potentially lead to increased housing costs. Additionally, analyses revealed that while green spaces could mitigate heat, they may also attract vectors for infectious diseases if they were not well-maintained (Patz and Frumkin, 2016).

Systems-based improvement

By considering UHI from a systems-based perspective, the project was more effective in identifying high-impact, low-cost solutions. It was also better suited to identifying and avoiding pitfalls related to unintended consequences or trade-offs.

Enabling factors

Existing laws around environmental conservation and public health meant the study's recommendations could be integrated more easily into urban planning policies. Politically, the timing of the study aligned with policy cycles and governmental interest in public health and environmental conservation.

Challenges and solutions

Bureaucratic inertia often slowed down the pace of policy adoption. Financial limitations were another significant barrier, since the study recommended infrastructural changes that required substantial investment.

Understanding these lessons is essential for scaling the impact of this study and others like it in the future. Recognizing these enablers and obstacles in the science-policy interface allows future research to be designed in a way that is inherently more impactful and relevant.

Conclusion

This study illuminated the significant impact of urbanization on heat-related illnesses in Malaysia, particularly through the mechanism of the Urban Heat Island effect. A multi-disciplinary team including stakeholders from academia, the public sector, NGOs and the private sector, collaboratively worked on this research to ensure a holistic approach. A systems-based methodology not only quantified the specific climate-health relationship but also provided a cost-effective solution compared to business-as-usual approaches.

By actively engaging critical end-users, the study ensured that its results are not just theoretically robust but practically useful, thereby increasing its potential for real-world impact and policy change. The next steps involve refining policy recommendations and executing a pilot program to validate the study's findings. By directly informing urban planning policies, heat-related health risks can be substantially mitigated, paving the way to more sustainable and healthier urban environments.

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