RUNNING A HIGH FEVER

Urban Heat Island (UHI) effect poses significant risk to people and planet. Hannah Jo Uy of *Climate Control Middle East* spoke to leading scientists to understand the true extent of the problem and explore how a proper diagnosis and holistic approach are vital for the development of a healthier and more sustainable environment…

Many cities across the globe are afflicted by the Urban Heat Island (UHI) effect, caused by a combination of rapid and unprecedented urbanisation, and inefficient cooling approaches, among other likely factors. In addition to the health risks that increased temperatures pose to citizens, UHI could potentially subvert ongoing efforts to mitigate climate change. "Never forget," says Dr Gerhard Schmitt, Professor of Information Architecture at the Swiss Federal Institute of Technology Zurich (ETH Zurich) and Director of the Singapore-ETH Centre, "the city is at the same time the reason and the victim of a combination of global warming and local heat island effect. Cities account for 60-70 % of global anthropogenic warming effects. The problem is in the city, and the answer is in the city. We have to rethink how we plan, run and manage the city."

Concrete infrastructure, lack of vegetation and human activity are some of the causes for UHI effect; however, with temperature spikes urging reliance on mechanical means of cooling, inefficient equipment and outdated designs only serve to aggravate existing symptoms. As such, Schmitt says, manufacturers must be encouraged to develop and distribute products according to only the highest standards. "Air conditioning is among the largest consumers of electricity," he says. "The release of waste heat is often amplified if electricity to run the air conditioners is generated with fossil fuels and if AC systems are not running efficiently." Schmitt adds that improper HVAC design of many high-rise buildings also contributes to UHI. In his view, the stacking effect of air conditioners in buildings makes the system drastically less efficient. "As air conditioner condensers release heat and as the hot air rises, the higher floors get hotter. This means that the air conditioning units on the higher floors have to work harder and the whole system generates more and more heat," he says. Schmitt says that in high-density, mixed-use cities, such as those in Asia, the stacking effect must be taken into consideration even at the city planning stage, given that buildings are so close together.

A NEW LOOK AT OLD ARCHITECTURE

There are a number of mitigation strategies available that could be used to address UHI. Dr Matthias Roth, Professor of Urban Climatology and Deputy Head, Department of Geography, National University of Singapore, points out that an examination of traditional, vernacular architecture provides useful guidelines in this regard. "For example, traditional settlements in dry desert climates are characterized by densely built houses, made of thick walls and painted in light colours, to provide shade between the buildings, lower the thermal responsiveness, to reduce heat retention and to reflect as much incoming solar radiation as possible," he says. "The same solutions do not apply in the wet tropical context, where traditionally light-weight building materials, provision for shade and enhancement of ventilation have been maximised. Across most climatic regions, vegetation is known as one of the most versatile intervention options, which provides insulation to rooftops, evaporative cooling, shade by individual trees or through park cooling effects."

Gerhard Schmitt

Matthias Roth

Schmitt adds that while traditional architecture offers a wealth of wisdom, design adoption must also take into account fundamental shifts in global climate. "Let's take one of the typical passive buildings in Malaysia, Indonesia and Singapore," he says. "They worked well in 1800s, 1900s, up to, maybe, 1950. They were perfectly useful, created a good indoor climate with high thermal comfort and enough breeze and wind. But the traditional way alone is not enough, because the outside temperature has risen 3, 4, 5 or even 6 degrees C. Simply replicating old buildings and materials in today's context will not work. We have to take all the knowledge we can from the past and combine it with high-tech active cooling devices driven by renewable energy."

Kurt Shickman, Director, GCCA, believes that there has been a significant paradigm shift in how stakeholders view cooling and that passive cooling strategies are increasingly being considered in broader conversations when it comes to ensuring communities have greater access to cooling. Dr Ronnen Levinson, Staff Scientist and Leader of the Heat Island Group at Lawrence Berkeley National Laboratory (LBNL) in the United States, adds that growing appreciation for passive cooling strategies is especially evident in cities such as Hong Kong and Singapore, and in his place of work, Berkeley Lab. Natural ventilation, cool paint, and other strategies can be implemented to make buildings that do not have air conditioning cooler, safer and more comfortable during heat waves. "We call this 'cool building solutions for a warming world'," he says. Unlike in the Middle East, he says, many buildings in Europe and parts of the United States lack air conditioning and, thus, are not prepared to withstand the unprecedented high temperatures of recent months.

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Kurt Shickman

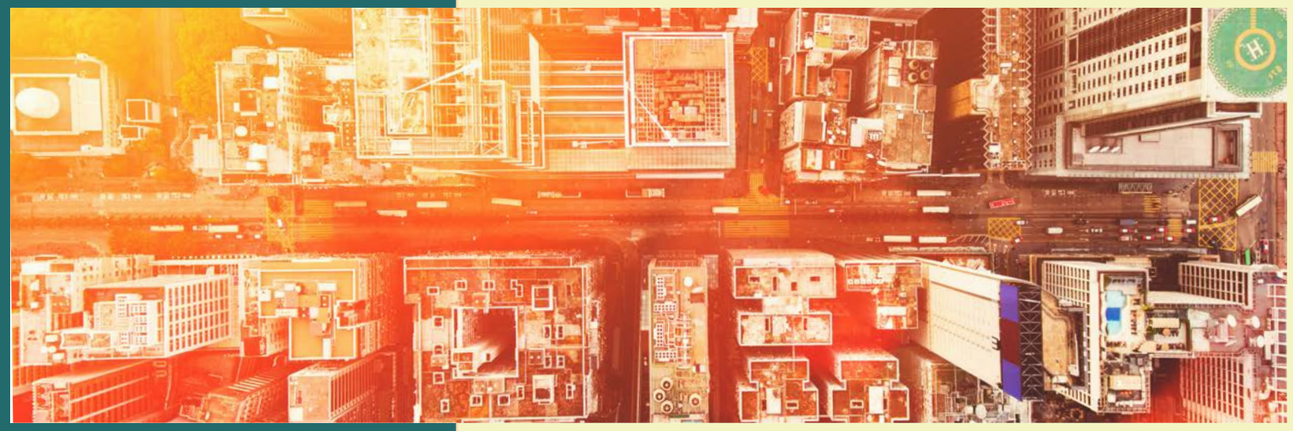
Ronnen Levinson

Levinson points out that the increasingly common occurrence of heat waves must urge stakeholders to reevaluate design of existing buildings that were developed without mechanical air conditioning in mind, and that implementation of passive cooling strategies is especially important when it comes to securing the health, comfort, and well-being of disadvantaged communities.

REFLECTIVE SURFACES

Another UHI mitigation strategy Roth puts the spotlight on is the use of reflective roofs and reflective pavements/ parking lots, which, he says, are a quick and relatively easy first step towards reducing daytime surface temperature and absorption of energy into the respective materials, with the added benefit of lowering air temperature. Levinson shares that at Berkeley Lab, many research efforts are underway to further explore and maximise the potential of reflective surfaces, such as cool walls, roofs, and pavements. Levinson says that Berkeley Lab and its partners, including the University of Southern California and the University of California, San Diego , have investigated how reflective surfaces affect building energy use and urban air temperature. They have also explored the availability of cool roof, wall, and pavement materials, and their abilities to stay reflective over time. Levinson adds that climate simulations evaluating cool roofs and cool walls in Los Angeles found that the urban heat island (UHI) mitigation benefit of reflective walls is comparable to that of reflective roofs, as the outside air temperature reduction provided by cool walls was predicted to be 85 % of that from cool roofs. They also found through building simulations that cool walls are a useful measure for saving energy in buildings across California and the southern half of the United States. "The energy savings from cool walls were typically as great, if not greater than, those from cool roofs. Although walls get half as much sunlight, they also have only half the insulation," he says.

Levinson says that Berkeley Lab, the University of Southern California, and Altostratus, Inc. have completed a study to identify not only urban heat islands but also urban cool islands across the city of Los Angeles by measuring variations in air temperatures, two metres off the ground. For the study, Levinson says, researchers traversed the city in vehicles equipped with a specialized rooftop thermometer and a GPS to map air temperature. "We wanted to identify cool islands and hot islands in the city and correlate them to the use of urban heat island countermeasures, such as cool roofs and vegetation, to verify what's predicted by climate simulation models," he says. "We found that as roofs became more reflective, outside air temperature dropped. We can use this information to help calibrate the models that simulate UHI mitigation."



CUSTOM-TAILORED APPROACH

Roth says that out of the many mitigation options in the market, the use of reflective surfaces, such as cool roofs, is probably the most cost-effective one available. It offers the most immediate impact, but all mitigation options are essentially scale-dependent, he says. "While some are useful at the micro-scale, such as individual buildings, others are best applied at the local-scale or entire neighborhoods," he says. "It is, therefore, important that individual sectors exchange ideas and discuss plans with each other." To demonstrate the complexities associated with many of the mitigation options, Roth says that while increasing vegetation is considered beneficial, provision for water may restrict its application in water-scarce regions.

Schmitt adds that considering every country and every region have different climate zones and geographical conditions, solutions must be tailored to address unique challenges of cities and that there can never be a one-size-fits-all approach. "Every city we look at is different from others," Schmitt says. "The same guidelines and roadmaps in one city, for example in a temperate climate, could cause opposite effects of what is intended in a tropical climate. Different countries and cities are almost like different planets, sometimes."

Another challenge Schmitt cites when it comes to addressing UHI is the fact that the level of understanding policymakers have towards the issue varies greatly in different parts of the world and between developed and developing countries. Roth says that in most developed countries, climate-sensitive urban design and planning practices are becoming routine considerations in city governments. However, Roth adds that in certain countries, where fast provision of relatively cheap housing and essential urban infrastructure is more important, it would not be a surprise if adopting climate-sensitive design is not a high priority. Even when it comes to environmental targets, Roth says, the urban heat island is not always one of the major considerations. "The UHI should primarily be given high priority in the fast-growing cities located in the tropics and sub-tropics and/or where summer heat-waves are experienced," he says. "But in most cities, air and water quality, waste management, etc., are equally important issues. More people, for example, die because of bad air quality than urban heat."

Shickman adds that while efficient cooling is very important, there is a very large group of people for whom efficient cooling won't have an effect because they lack access to cooling services. "Heat mitigation is often not a policy priority because the full extent of its effects on communities is not well understood or quantified in every place. Strategies to reduce heat and improve access to passive cooling are important on their own, but they also often help ease higher priority or more visible challenges in the places they are deployed. While it's clear there are other challenges and problems, we can't lose sight of this. Cooling often takes a backseat to other pressing problems, but focusing on cooling could have an unexpected positive effect on those other problems."

ALL HANDS ON DECK

In view of complex urban systems, administering the treatment required to address UHI requires participation of all stakeholders. Providing the perspective of academics, Levinson says the work of researchers and scientists in the field is mainly directed towards studying strategies to enhance city cooling solutions, but that they also play a role in developing better cool materials for the building envelope, as well as in policy. Researchers at Berkeley Lab, he adds, have contributed to building energy standards and to performing technical analysis to identify what energy savings are achieved and the additional cost required, to better understand what might be considered appropriate incentives. The Lab, he says, also contributed to cool roof provisions in the ASHRAE 90.1 building energy efficiency standard for commercial buildings and in the LEED green building program from the US Green Building Council. Levinson says that Berkeley Lab, along with other institutes, also develops educational materials that are, in turn, used by contactors and builders to understand and integrate cool roofs in construction. Further, it provides material to general audiences, such as home owners, to explain cool surfaces, to promote energy-efficient practices, if the buildings are air conditioned, or enhance thermal comfort, in the event the buildings are not air conditioned. In view of the wealth of available material being offered by the research community, Levinson believes there should be greater effort to educate the public and policymakers on new technologies available.

Roth says that given that addressing UHI is an active and evolving area of research, it is essential that governments collaborate with the research community to be properly informed of the latest developments. Roth also highlights the important role governments play through regulation, recommending that city authorities devise planning guidelines, which offer benefits to developers, while at the same time incentivising adoption of climate-sensitive design. “An example is to mandate developers to retain open green space at ground level in exchange for relaxing building height restrictions,” he says. “Or, ask developers to incorporate the same amount of greenspace built-over into their building design, as skygardens or green walls. Or, how about mandating financial institutions to evaluate their

loans with respect to the environmental impact of a building in terms of the outdoor impact but also regards energy efficiency, use of resources during construction and during operation.”

Shickman suggests that there should be a straightforward policy to require certain procurement specifications in order to receive government funding or development support. “If you are able to get that built in, you’re making tremendous change,” he says. “It is a big challenge, but it also a big opportunity.”

Schmitt says that he believes there is opportunity for manufacturers within the cooling sector to move towards a more service-oriented framework, pointing to a similar shift he has observed in the transportation sector. “It’s becoming more about sustainable mobility, and the automobile industry is more conscious of energy efficiency and reduction of pollution,” he says. “I see the same shift with the HVAC community offering cooling as a service. The industry is taking the efficiency of equipment into greater account and taking a longer-term view of this process of cooling. The service providers see it as their responsibility to change the air filters to ensure that air conditioners are clean and are operating efficiently, which consumers often don’t do, because they don’t know what’s behind these boxes. Providing cooling as a service could be a competitive differentiator. I’m sure there is an excellent business case once one company can charge less because of more efficient equipment, smarter connection of machines and better scheduling of the entire network. That will force others to do the same. I think this will lead to a reduction of cost and increased efficiency in the HVAC industry.”

Identifying the best approach to mitigate UHI can, undoubtedly, be a challenge. Schmitt says this is perceived to be complex and difficult to understand, only because stakeholders are looking at a building in isolation instead of understanding how the building interacts with the rest of city. Essentially, there is a need to move away from traditional concepts of cities to create a positive change. “Every building, every room, every person is part of a context,” he says. “The person is part of the room, the room is part of the building and the building is part of a city. If we change anything, it has impact on the city, on the neighborhood, and to the individual in the building.”

Schmitt proposes that stakeholders must take on the role of doctors and view the city as an organism, sharing insights from the Future Cities Laboratory’s approach of understanding the city through the lens of urban metabolism. “When a person has a fever, you have to identify the source of the fever,” he says. “Then, it will be simpler to make the diagnosis to help with the mitigation. But, it has to be done building by building, case by case and city by city – then it will be successful.” ccme

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