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People walk with umbrellas under the hot sun in Singapore. (Photo: Ooi Boon Keong/TODAY)

In Singapore, climate change received due attention during the 2019 National Day Rally, when Prime Minister Lee Hsien Loong announced national strategies to adapt to climate hazards and mitigate carbon emissions.

While PM Lee spoke at length about sea level rise and how to adapt to this long-term threat, there is another critical immediate issue - how do we adapt and mitigate warmer temperatures from global warming and urbanisation in Singapore that will affect our day-to-day lives?

In our daily lives, we have been mostly sheltered from the harsh realities of heat and humidity, thanks to the ubiquitous air-conditioner in our homes, transport modes, offices and most buildings.

However, this does not bode well for a sustainable future. Once outdoors, when taking refuge in air-conditioned spaces is not an option, we are immediately hit by the sweltering heat.

Older Singaporeans may recall that weather forecasts on the television or radio would call for daytime maximum temperatures peaking around 32 or 33 degrees Celsius.

Nowadays, it appears maximum daytime temperatures of 34 or 35 degrees Celsius are not uncommon.

This is validated by the climate data measured in Singapore. 2019 was the hottest year in Singapore in its recorded history and the hottest day was recorded even more recently in April this year.

The early months of 2020 were very warm indeed, with hot night-time conditions giving no respite to the daytime heat.

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The Singapore city skyline as seen from Jubilee Bridge (Photo: Jeremy Long)

THE SCIENCE BEHIND URBAN HEAT

Singapore is subject to warmer temperatures from climate change but it is also warming at twice the global average rate. The increased warming from greenhouse gases is compounded by our high urban density—of buildings, roads and people—within our 720 sq km of land area.

In a highly built up environment, heat tends to get trapped in materials such as concrete, steel and asphalt, leading to what we call the urban heat island (UHI) effect.

To make matters worse, motorised vehicles, industries and other human activities generate even more heat within the city.

Urban heat is a worldwide phenomenon and societies are affected to varying degrees, depending on local conditions. In Singapore, the tropical combination of high temperature, high humidity and low wind speeds have always posed a challenge for urban living.

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People cross a traffic junction in the Orchard Road shopping district in Singapore on May 27, 2017. (File photo: AFP/Roslan Rahman)

But all is not lost. We can adapt and mitigate with science, technology and a common understanding of how cities can be cooler. Research conducted in Singapore previously has produced measurements and models that give us a good idea of what causes the UHI.

In Singapore's early years, when there were much less people than there are today, choosing a well-ventilated building site on higher grounds and architectural features were effective in reducing the effects of tropical heat.

In traditional Kampungs, elevating old Rumah Melayu on stilts met the purpose of enhancing indoor and outdoor air flow.

If you observe old buildings such as the conserved shophouses in parts of central Singapore, you would also notice they had high ceilings and air wells that open towards the sky. These provided natural lighting and ventilation to keep the indoor climate cool.

There were other ways buildings were constructed to optimise comfort – using external shading, orienting buildings based on prevailing winds to maximise cool breezes, among others.

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Older HDB estates such as those in Tiong Bahru were built to accommodate ventilation. (Photo: Flickr/NIann)

However, in recent decades, an increasing population, taller buildings stacked closer together, greater volumes of industrial and traffic activities, and more paved areas replacing natural forested areas have accelerated the UHI effect.

When these happen, places like Orchard Road can hit the mercury up to 7 degrees Celsius warmer than parts of Singapore which are less built up.

WHAT CAN WE DO ABOUT THE HEAT?

The physical consequences of urbanisation, in addition to warmer temperatures from climate change, lead to increasing heat stress and thermal discomfort for citizens, with potentially detrimental effects on health, productivity, and correspondingly, the economy.

Researchers from Singapore universities, agencies and the inter-institutional Cooling Singapore research project initiated by the Singapore-ETH Centre have identified the manifold reasons for high urban temperatures.

The next step is to define precise adaptation and mitigation measures for better outdoor thermal comfort and a cooler Singapore.

In our work, we've often heard a potential solution along the lines of "what about air-conditioning the whole of Singapore?" While this option temporarily reduces one's exposure to heat outdoors, air conditioners here are powered by energy generated from fossil fuels.

More widespread use of air conditioners will only increase Singapore's carbon footprint and its contribution to global warming.

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What we really need are active mitigation measures that address the root of the problem, such as reducing or eliminating urban heat sources, which includes replacing petrol- or diesel-powered cars with electric vehicles that emit less waste heat into the environment.

Singapore has already been actively maintaining more “natural” surfaces in the city. We should continue to introduce more trees, community gardens, and parks, as well as green roofs and walls.

These surfaces absorb and emit less heat, as well as cool the city by evapotranspiration.

Apart from nature-based solutions, engineered solutions such as white roofs and walls that reflect more heat away from the city during daytime and installing photovoltaic panels on rooftops or building facades can help to maximise clean and renewable energy generation.

Widening the scale from the individual building and neighbourhood to the city, urban planning becomes crucial.

The planned Punggol Digital District is a good example of how urban planning can lead to better outcomes.

Punggol Digital District Campus: Having a university and business park so close together will allow greater opportunities for collaboration, said planners. (Photo: JTC)

With a business park housing companies in the key growth industries in the digital economy, an institution of higher learning and other amenities within a primarily residential district, we can expect residents living, studying and working there to have reduced commute time, and correspondingly, less traffic jams, pollution and less heat generated.

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AN INTEGRATED DIGITAL APPROACH

Yet, to drastically rethink an entire urban system is complex. There are many parameters that affect heat and outdoor thermal comfort, which calls for an integrated and holistic approach to urban climate mitigation and adaptation.

Researchers in Cooling Singapore 2.0 will develop the Digital Urban Climate Twin (DUCT), which can represent physical features of a city—such as the geometry of land and infrastructure, local climate, transportation, industry and people—in a digital form to better understand their function, behaviour and effects on the other features.

With the capability to simulate scenarios of entire cities, the DUCT could support planners in creating cooler and more resilient urban scenarios.

There are plans to apply DUCT to analyse urban climate impacts in several new towns in Singapore.

In planning new cities, such as the new capital of Indonesia, the DUCT could prevent the development of unliveable settlements before they are actually built.

Artist impression of the Rainforest Walk weaving through Parc Residences @ Tengah Build-to-Order (BTO) Project. (Photo: HDB)

In existing cities, it could simulate how scenarios such as a phased replacement of internal combustion engines in vehicles with batteries and fuel cells can have positive effects on the local climate, air quality and health.

Urbanisation will continue to be a major economic driver in the coming years, with 70 per cent of the global population living in urban areas by 2050. Closer to home, the urban populations in Southeast Asia are expected to increase by more than 500 million people.

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If unsustainable urbanisation practices were to continue unchecked, we will undoubtedly suffer the negative consequences on local climate, human well-being and the economy.

In Singapore, the Housing and Development Board (HDB), the Building and Construction Authority (BCA), NParks, the new Ministry of Sustainability and the Environment, together with the planning capabilities of the Urban Redevelopment Authority (URA), are key success factors in urban heat mitigation.

With enhanced capabilities in urban climate simulation, adaptation and mitigation, Singapore could play a leading role in the movement towards more sustainable and climate-sensitive urban design in the region and beyond.

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Source: CNA/cr