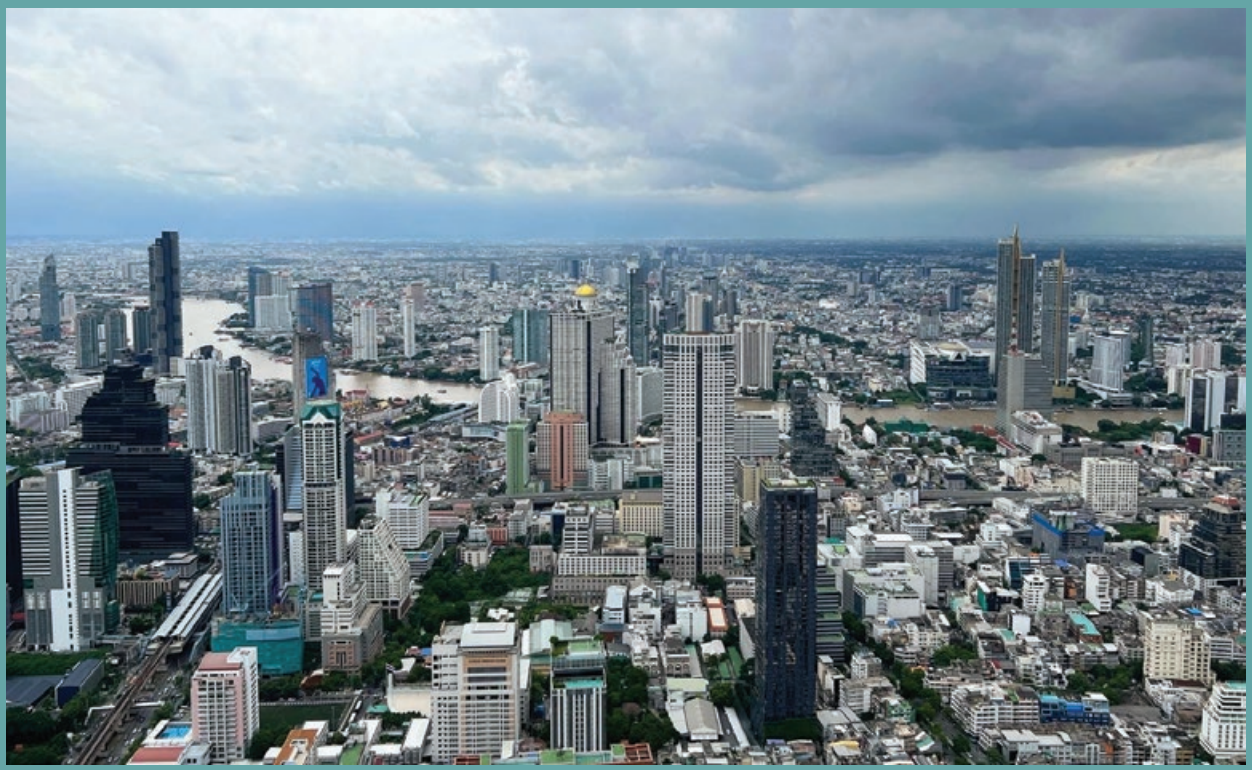
REGENERATIVE CITIES

WINSTON CHOW
Winston Chow is the Co-Chair of the Intergovernmental Panel on Climate Change (IPCC)'s Working Group II on Impacts, Adaptation and Vulnerability. He is a Professor of Urban Climate and Lee Kong Chian Research Fellow based at the Singapore Management University (SMU)'s College of Integrative Studies (CIS).

ELAINE TAN
Elaine Tan is the Director of Research at the Centre for Liveable Cities (CLC), where she oversees research in the areas of climate change, resilience, ageing, and health.

ANDY TAN
Andy Tan is Assistant Director of Research at CLC. He works on resilient and regenerative cities research in partnership with stakeholders across sectors.

Resilient and Regenerative Cities for a Climate-Changed World



Impacts of climate change such as extreme heat and sea-level rise will affect large metropolises in Southeast Asia.
Image: Andy Tan

Can Cities Be the Solution in a Climate-Changed World?

Climate change is happening rapidly. While we know that the causes of global warming mainly arise from accumulated global emissions of greenhouse gases, the impacts felt by cities around the world are local in nature. Cities are affected in different ways by the increased frequency and severity of climate impacts, such as heatwaves, droughts, floods, tropical storms, poor air quality and wildfires.[1] Simultaneously, we are living in a time where more than 55% of the global population are living in urban settlements. Current urbanisation rates will likely result in almost 70% of global population residing in cities by 2050. These cities will not only be hotspots for greenhouse gas emissions, but they will also be vulnerable to increased climate risks, *irrespective of location.*

Recent examples of urban impacts from anomalous weather impacts abound; from cities in East Africa, such as Nairobi, Kenya, being subject to flooding in May 2024 and resulting in close to 300 deaths and almost 280,000 people mostly from informal settlements being displaced, to record multi-day rainfall over Central Europe in September 2024.[2] The latter caused Austrian cities such as Vienna to incur an estimated 1.3 Billion Euro in damages.[3] Extreme heat caused by climate change has been estimated to reduce local GDP by 1.2–3.9% for large metropolitan areas in Southeast Asia, and 1.7–5.5% for other cities in East Asia with warm baseline climates. In Bangkok, without sufficient intervention, a 1°C rise in average temperature could result in more than 2,300 heat-related deaths and 44 billion baht in lost wages from reduced productivity.[4]

While cities are hotspots for emissions and climate risks, they also have tremendous potential to develop solutions for mitigating emissions and local climate risks. Cities can turn challenges into opportunities by optimising the co-benefits of climate strategies to ensure continued liveability and resiliency for people and the built environment, as well as flourishing natural ecosystems. To do so would require cities to plan and implement climate strategies in an integrated manner across urban systems, collaborate across sectors and cities, and tap on a suite of enablers such as technology and green financing.

Challenges Faced by Cities in a Climate-Changed World

First, cities are reaching the limits of sustainability as a model for urban development. Guided by the United Nations (UN) 2030 Agenda for Sustainability Development, sustainability focuses on the reduction and mitigation of environmental degradation for present and future generations. With greenhouse gas emissions projected to rise to 170 $CtCO_2e$ by 2100 under a business-as-usual scenario, the sustainability approach is inadequate in the long term to limit emissions and meet the 1.5°C target set out in the Paris Agreement.[5] As illustrated by *Doughnut Economics*, we need a developmental approach that can meet our livelihood needs without exceeding the thresholds of Earth's systems that support us.[6]

Second, while cities already experience direct impacts of climate-related hazards as illustrated above, there have been significant compounding and cascading risks that will arise as the world continues warming beyond the 1.5°C Paris Agreement limit. Extensive urban flooding can cause critical infrastructure—such as transport, power, water and information and communications—to fail and result in impacts being felt beyond the physical boundaries of a settlement.[7]

Third, rapid urbanisation is occurring globally. The world's urban floor area is growing by 2.3% annually and global building stock is expected to double by 2065.[8,9] To limit the undesirable impact of urban sprawl, cities have to plan for higher density to accommodate the needs of people while managing the pressure on existing urban systems. With higher population and infrastructure density, cities are faced with the challenge of maintaining liveability, or ensuring liveable densification and building resilience to climate risks, while facing land, carbon and other resource constraints.[10]

Fourth, cities, especially rapidly urbanising high-density cities, have to tackle the above challenges while facing three key resource constraints. First, land constraints within city boundaries and the need for urban infrastructure to accommodate spaces for living, working, leisure, transport and utilities. Next, carbon constraints which require lower emission footprint for urban activities to meet emission targets. Lastly, fiscal constraints posed by competing demands compounded by increased disaster risk, the need for climate adaptation, and green energy transition, among other factors in an evolving economic and geopolitical global environment.[11] Internationally, the resource challenge is compounded by the complexities and challenges in supply chains pertaining to raw materials and other essential goods, as evidenced from disrupted global flows during the COVID-19 pandemic.[12]

Addressing these challenges would require cities to plan and implement long-term integrated climate strategies that minimise emissions and reduce climate risks, enhance liveability and natural ecosystems, while ensuring sufficiency of resources for the present and future.

Charting the Way Forward with Nature, Carbon and Circularity

Leveraging Nature

Cities can embrace nature as a partner through nature-based and biomimetic solutions. Nature-based Solutions (NbS) are defined by the International Union for the Conservation of Nature (IUCN) as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".[13] For example, Singapore taps on nature-based solutions such as greenery and naturalised streams and rivers for its cooling, stormwater retention and cleansing, and social benefits. Consistent cooling of 2°C from large and connected urban park spaces can, for instance, reduce risks from urban warmth for residents in Singapore.[14] With a "City in Nature" vision, Singapore is aiming to have 200 hectares of skyrise greenery, green spaces such as parks within a 10-minute walk from every household, and recovery plans for 100 plant and 60 animal species to be carried out by 2030.[15]

Cities can also tap on the intelligence of nature and adopt biomimicry, the emulation of living organisms or ecosystems, in its design process.[16] In the Canary Islands, Grimshaw Architects took inspiration from how Namib Desert beetles captured moisture from fog to create a seawater harvesting system in a building that produced sufficient freshwater to be shared with neighbouring buildings.[17]

With a City in Nature vision, Singapore weaves greenery into its urban fabric to tap on nature's ecosystem benefits.
Image: Chuttersnap, Unsplash (left); Gigi, Unsplash (right)

Carbon-sensitive developments not only reduce emissions, but also produce social, economic and environmental co-benefits for the city.

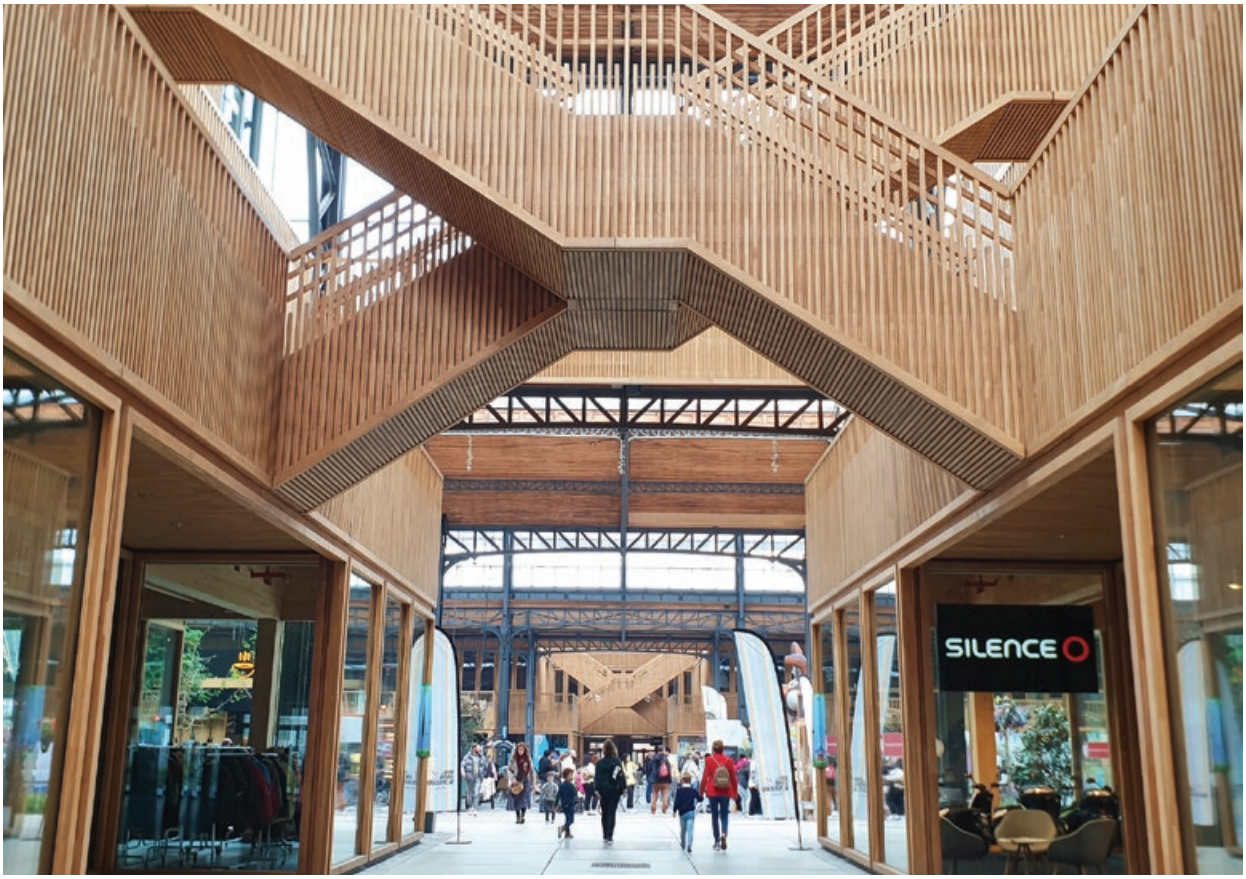
Reducing Carbon

Transitioning towards a low-carbon built environment can be achieved through carbon-sensitive developments. Carbon-sensitive developments not only reduce embodied and operational carbon emissions, but also produce social, economic and environmental co-benefits for the city. The Gare Maritime, formerly Europe's largest freight railway station in Brussels' Tours & Taxis district, was redeveloped into a carbon-neutral mixed-use hub comprising work, event, retail, food and public spaces.

The existing steel structure and original building envelope were restored through an adaptive reuse process. By constructing 12 modular pavilions out of cross-laminated timber instead of traditional concrete, approximately 3,500 tonnes of CO_2 emissions were saved, and the construction process was expedited. Renewable energy sources such as solar panels on 17,000 m^2 of roof space were used to power the building, while geothermal technologies were employed for heating and cooling. The Central Hall was designed with wide pedestrian boulevards lined with greenery, consisting of over 100 large trees and seating areas for community use.

Accelerating Circularity in Resource Flows

Establishing circular resource flows that move away from linear consumption to closed resource



The Gare Maritime in Brussels—a carbon-neutral mixed-use hub, an adaptive reuse of Europe's largest freight railway station.
Image: Nanda Sluijsmans / Flickr

loops help to optimise use of raw materials, reduce and recapture waste for use as resource, and maximise the lifetime value of products. Seoul's resource recovery facilities convert approximately 2,850 metric tonnes of non-recyclable solid waste daily into heating for about 518,000 households, and turn bottom ash residue from incineration activities into construction materials.[18] Similarly, Singapore is setting up an integrated waste management facility next to a water reclamation plant to harness the synergies of the water-energy-waste nexus from used water and solid waste, while optimising land use and cost-savings for waste treatment. Called the Tuas Nexus, it will generate enough electricity to sustain its own operations, and export excess electricity back to the national grid. It is expected to achieve more than 200,000 tonnes of CO_2 savings annually.

An Integrative Approach and Systems View of the Key Enablers

Key Enabler #1—Long-Term Integrated Planning

In Singapore, a Long-Term Plan Review is carried out every 10 years, to plan holistically for its urban development over the next 50 years and beyond. By adopting a source-pathway-receptor approach that includes continued investments and improvements to drainage infrastructure, Singapore has successfully reduced its flood prone areas from 3,200 hectares in the 1970s to less than 25 hectares today. The government also works closely with building owners and the community to strengthen flood resilience and preparedness.

An iconic water management infrastructure is the Marina Barrage, first mooted by Singapore's Founding Prime Minister Lee Kuan Yew in 1987. Construction of Marina Barrage commenced in 2005 to dam the Marina Channel, simultaneously facilitating the creation of Marina Reservoir to augment Singapore's water supply. The tidal gates at Marina Barrage help to control flooding in low-lying areas of the city during heavy rainfall, and its iconic green rooftop serves as a popular recreational spot in the heart of the city.

Looking to the decades ahead, Singapore is planning for the "Long Island" project along its Southeastern coast as a coastal protection measure. "Long Island" will also strengthen the city-state's water supply resilience and create new spaces for housing, jobs and recreation for future generations.

Key Enabler #2—A Collaborative Ecosystem of Stakeholders

Another key enabler is to build partnerships across all sectors—public, private (businesses and industries), academia, people and community, and international organisations. As an example, the Greater London Authority and Cross River Partnership collaborated on a public-private partnership for central London's Business Improvement Districts (BIDs) to increase green cover in privately-owned land and buildings, while providing benefits for the public.[19] Through coordination across the BIDs, incentives such as grants and financial support, retrofitting older buildings to maximise potential for green cover, and a best practice guide put out by the Victoria BID to assist other districts, the collaboration supported 19 green infrastructure audits and 16 green infrastructure installations such as rain gardens, green walls and green roofs.[20]

Having an inclusivity of views from the local community that are facing the brunt of climate impacts are important to sustain resilient and regenerative efforts for the long-term. Such inputs and insights also build community resilience that addresses both local challenges and national efforts, and reduce maladaptive practices due to poor, or misaligned planning.[21,22] In Bangkok, social enterprise Porous City Network partnered with vulnerable communities, such as households along the Lat Prao Canal, to raise awareness of climate challenges, create site-specific design solutions, and lead workshops on site maintenance post-implementation.

Key Enabler #3—Technology and Data

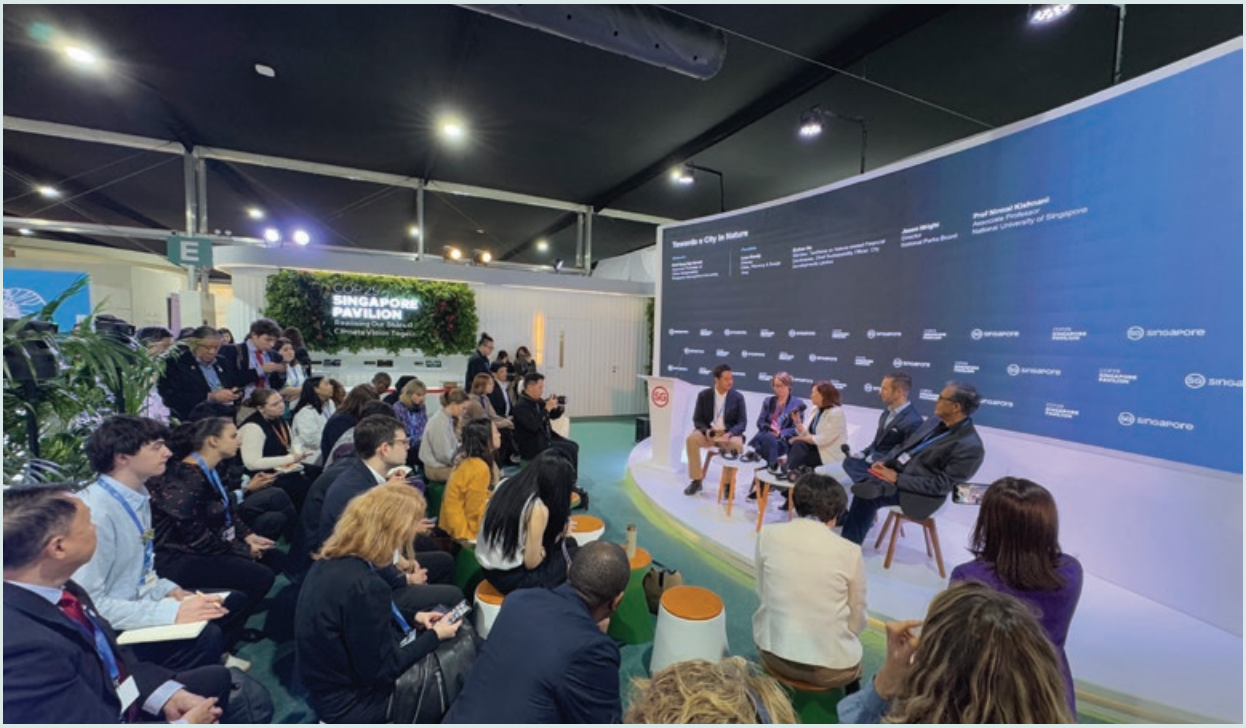
Technology and data are crucial drivers for planning, as well as post-implementation monitoring and assessment. In the planning of Singapore's public housing towns, the Housing and Development Board uses computer simulation and data analytics to examine how environmental conditions interact with the layout and design of the town, precincts and buildings. Using computational fluid dynamics, housing blocks are positioned to capitalise on wind flows, thus increasing natural ventilation and providing a cooler environment. Solar irradiance simulations and shadow analysis also help to identify naturally shady areas, where common amenities such as playgrounds can be sited to optimise thermal comfort.

An analytical framework developed by WOHA and bioSEA in Singapore further enables the assessment and quantification of the social and ecological benefits of nature-centric design in completed developments, providing an evidence-based case for cities to have more of such regenerative-aligned developments.[23]

Key Enabler #4—Sustainable Financing

The importance of ensuring sustainable finance for projects cannot be overstated. The business case for investments in local risk reduction is strong given the increases in exposure to climate hazards. One potential solution is that of blended finance (public-private), as seen in the example of Xi'Xian located in Northwest China.[24] Part of the Silk Road Economic Belt, the city has a green financial mechanism that creates a leverage effect for national funding including the first provincial Green Sponge Development Fund (RMB 1.2 billion) and the Shaanxi Urbanisation Development Fund (RMB 2.64 billion). The city also has a public-private partnership model with a whole-lifecycle-management approach, raising funding of RMB 1.24 billion with a packaged project that includes public pipelines and sewage water treatment facilities.

Together with institutional support coming from special fiscal policies like the national-level New Area and streamlined municipal administrative systems, Xi'Xian was able to build more than 50 km of sponge roads and 1.4 million m^2 of climate resilient parks. The city was also able to establish green coverage of more than 50% of the urban space, enabling everyone to "see green in 100 metres, and step into a garden every 300 metres".[25]



Knowledge platforms such as Singapore's World Cities Summit and the UNFCCC COP Singapore Pavilion's Cities Thematic Day convene leaders and experts to share and exchange best practices and solutions for cities.
Image: Andy Tan

Beyond Sustainability—A Call to Action for Resilient and Regenerative Cities

The strategies and enablers outlined above point to how cities can undertake resilient and regenerative urban development to thrive in a climate-changed world. The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report has highlighted how Climate Resilient Development can combine mitigation and adaptation actions to support sustainable development for humans, ecosystem and planetary health.[26] With a genesis in natural science and increasingly adopted in the built environment realm, regenerative approaches push cities to go beyond simply minimising harm to the environment in urban development, and strive to ensure that urban development also benefits the natural ecosystem.[27,28,29,30,31] Regenerative urban development thus advances conventional sustainability by not just restoring or maintaining, but actively growing social and ecological systems to achieve net-positive outcomes for both people and the natural environment. Taken together, resilient and regenerative approaches to urban development offer pathways for cities to remain highly liveable and resilient, enhance biodiversity, and ensure effective stewardship of resources for the present and future.

In the face of accelerating climate disruption, cities can effect resilient and regenerative urban development using the enabling tools we already have. To build mindshare and collective action, these tools can be shared at platforms such as the World Cities Summit held biennially in Singapore, the Singapore Pavilion's Cities Thematic Day at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP), and the forthcoming IPCC Special Report on Climate Change and Cities. Through self-assessment and city-to-city benchmarking, we can foster cross-exchanges, mutual learning and galvanise collective action for urban climate mitigation and adaptation.

More than just knowing what to do, action is required to reduce the severe risks that will manifest from continued inaction. A pathway towards resilience and regeneration has been put forth by this essay, and commitment for the next steps lie in the hands of all stakeholders—governments, industries, researchers, international and non-governmental organisations, and communities. Together, we can create resilient and regenerative cities for generations to come, in a climate-changed world.

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