ARUP 思匯 CIVIC EXCHANGE ice Hong Kong RESILIENT CITIES NETWORK 世界资源研究所 WORLD RESOURCES INSTITUTE

Post-COP27

Building a more climate-resilient Asia

Call for action: the built environment needs to brace for climate change

Urgency of the situation

Throughout 2022, climate change had a dramatic impact on our planet and populations, from catastrophic floods in Pakistan to record-breaking droughts in South Asia. These are just a few examples of the climate impacts we are suffering at only 1.15°C above pre-industrial temperatures.[1] However, based on current policies,[2] we are heading for much higher temperatures with a 2.8°C rise predicted by the end of the century. The worst is yet to come.

While mitigation is crucial to limit further warming, ambitious and accelerated action is urgently needed to adapt to climate change impacts through a Race to Resilience.

Purpose of this position paper

This paper is the result of a continuous collaboration between undersigned organisations seeking to honor scientific findings, formulate appropriate policies and strategies, and facilitate capacity building. It discusses key insights around resilience from various angles.

- The second section of this paper highlights latest climate change insights, referring to the International Panel on Climate Change's (IPCC) Synthesis Report for the Sixth Assessment Report.
- The third section elaborates on outcomes of COP27 (the 27th United Nations (UN) Climate Change Conference), convened in November 2022 in Egypt, and puts them in an Asian context.
- The fourth section summarises expert presentations and discussions that were part of the Race to Resilience Asia event series.
- The fifth section includes perspectives on the way forward, suggesting several ways to address climate change in the built environment.
- The sixth section lists out several useful resources with additional information, insights and strategies.

While the themes and context from related events, discussions and publications vary, one overall message is clear: Both the challenges and solutions to achieving climate mitigation and adaptation lie within our cities.

By bringing together diverse stakeholders to share experiences and approaches, as well as to identify the need to empower local and regional state and non-state actors, we can create more sustainable, resilient and liveable cities, both now and in the future.

The climate action roadmap and associated five steps shown in the diagram on the next page outline a shared vision and industry-wide actions needed to achieve net zero in the construction, operation and decommissioning of buildings and infrastructure. They also describe the steps required to make our built environment more resilient to climate shocks and stresses.

We all have a role to play

While global efforts in adaptation planning, financing and implementation continue to make incremental progress, they fail to keep pace with increasing climate risks. This calls for ground-breaking acceleration in scientific research, innovative planning, improved financial backing, scaled-up implementation, increased monitoring and evaluation, and deeper international cooperation.

Shared problems call for shared solutions, and as city stakeholders we all have a role to play – sharing ideas, providing insights and using our unique spheres of influence.

For ourselves and our future.

Signatories

Dr Vincent Cheng
Fellow and East Asia Sustainability Leader,
Arup

ARUP

Lawrence lu
Executive Director,
Civic Exchange

思匯 CIVIC EXCHANGE

Louis Wong
Chairperson, Institution of Civil Engineers,
Hong Kong Association

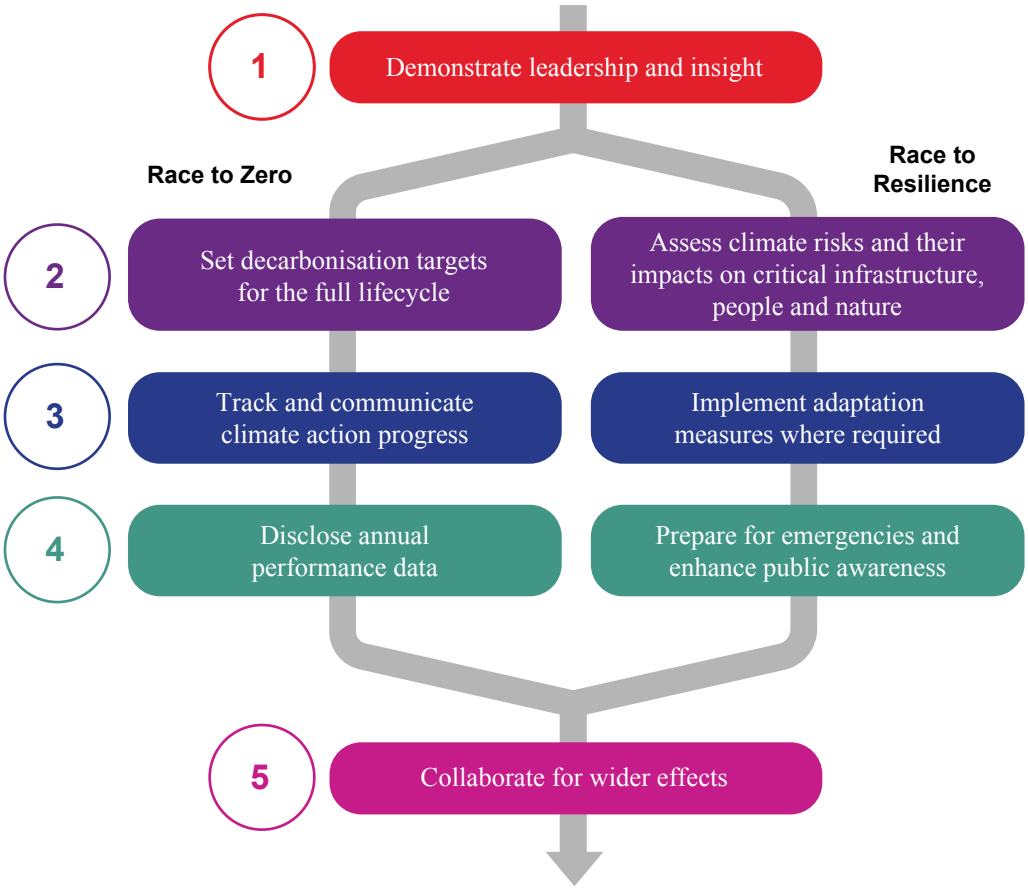
ice Hong Kong

Lauren Sorkin
Executive Director,
Resilient Cities Network

RESILIENT CITIES NETWORK

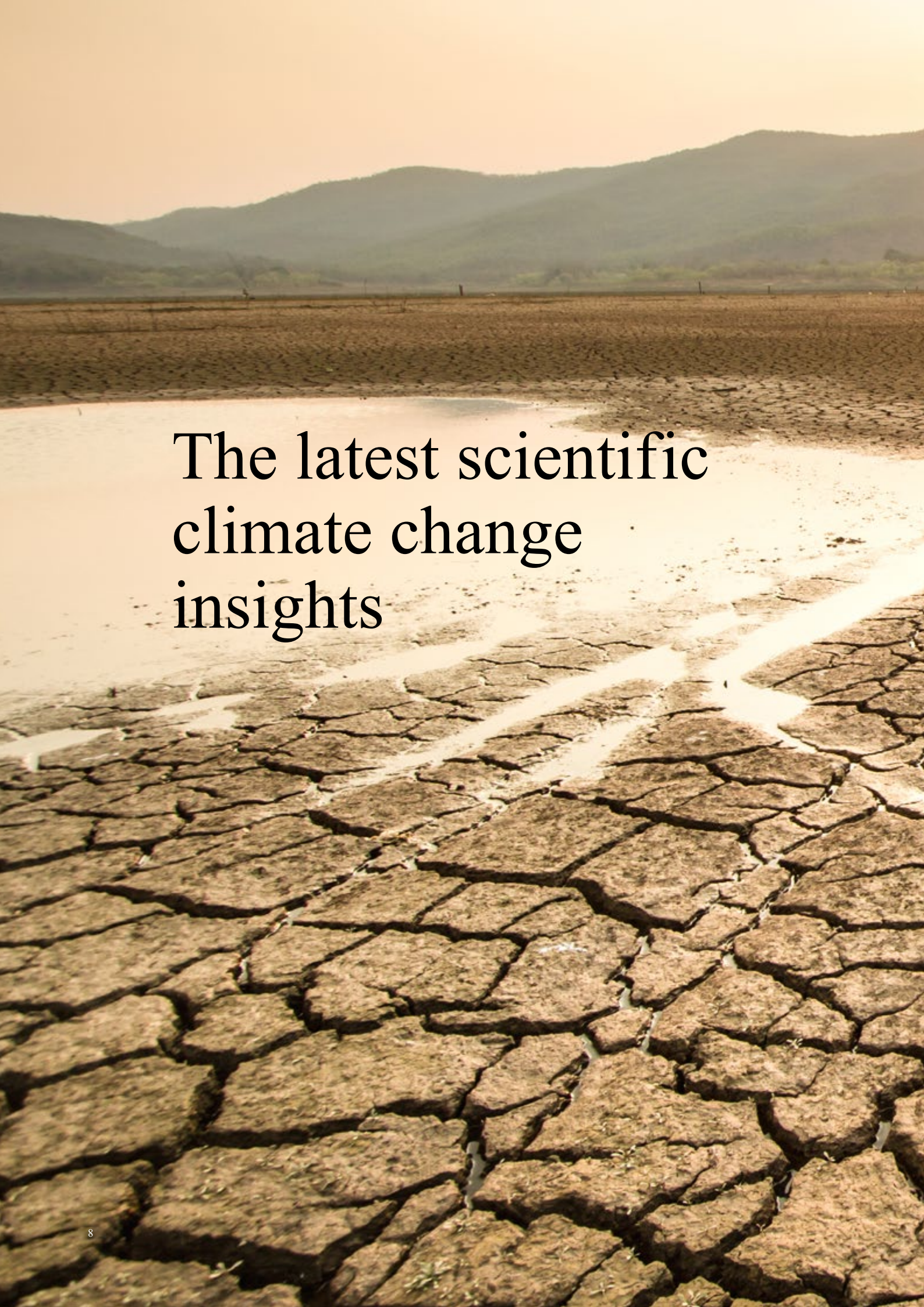
Dr Li Fang
Country Director of China,
World Resources Institute

世界资源研究所 WORLD RESOURCES INSTITUTE



Climate action roadmap: Five steps to take

Content



The latest scientific climate change insights

What changes in climate and sea levels must we be resilient against?

Alexis Lau, Head and Chair Professor Division of Environment and Sustainability, Hong Kong University of Science and Technology

J Robert Gibson, Fellow Civic Exchange and Adjunct Professor Division of Environment and Sustainability, Hong Kong University of Science and Technology

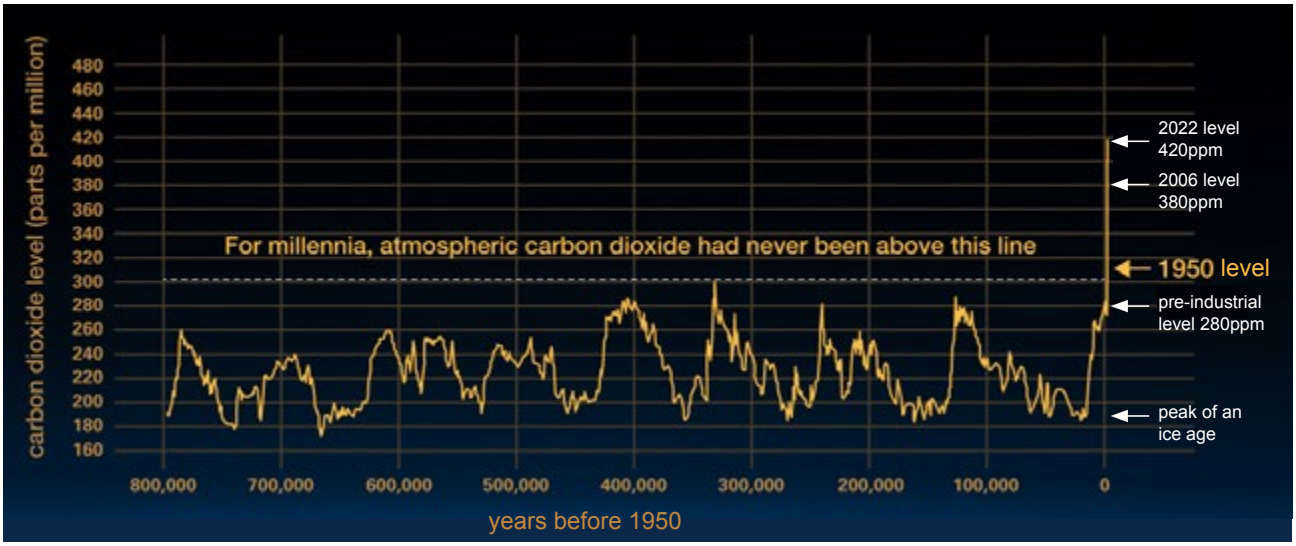
As highlighted by the IPCC's AR6 Synthesis Report: Climate Change 2023 (see the box below), countries have taken inadequate action to curb Greenhouse Gas (GHG) emissions in the 30 years since the UN Framework Convention on Climate Changes was created.

Latest confirmation can be found in the UN Environmental Programme's (UNEP) Emissions Gap Report 2022,[3] which states that current policies lead to global warming of 2.8°C by 2100, reduced to 2.6°C if countries deliver on the unconditional pledges they have made. Prudent adaptation planning should take this into consideration, as well as including contingency plans for the IPCC's 'low likelihood, high impact' scenarios – in particular, for a much faster rise of sea levels.

Why does global warming happen?

The figure below shows the changes in carbon dioxide which is the main GHG. The massive increase can be seen from comparing recent changes to those during ice-ages. As noted in Al Gore's film 'An Inconvenient Truth', the increase between pre-industrial and 2006 levels was about the same as the 100ppm change between the peak of an Ice-Age and last interglacial period when human civilisation developed. In the 16 years since 2006, the level has increased by a further 40ppm which equals to 40% of this change.

Other greenhouse gases have also increased. The most significant, methane, had its highest recorded yearly increase in 2022.



Comparing current carbon dioxide levels with the changes which caused ice-ages over the last 800,000 years[6]

Global warming is caused by the energy of high-frequency radiation the Earth receives from the sun exceeding the energy of lower-frequency radiation the earth emits into space. This 'radiation imbalance' has been caused by the Greenhouse Gases mankind has dispersed into the atmosphere, blocking some of the radiation emitted by the Earth. As the Earth warms, it radiates more - leading to the balance being restored at a higher temperature.

The Earth has not, however, reached a new equilibrium temperature yet as 90% of the heat from the radiation imbalance goes into warming oceans and about 3% into melting ice. Both are slow process causing decades to pass between increasing greenhouse gas levels in the atmosphere and reaching a new equilibrium temperature. Thus we have not yet felt the full impact of increase we have made in the Greenhouse Gases in the atmosphere. Looking forward, two uncertainties will play a key role.

Uncertainty over how much nature's absorption of GHGs will reduce

In the last decade, nature has absorbed about 54% of the GHGs mankind has put into the atmosphere.[4] This net absorption is, however, slowing down as the earth warms. A major cause is summer thawing and decomposition of permafrost in the Arctic. Another major cause is the increase in forest fires.

Uncertainty over how much mankind's GHGs will reduce

The UN's Framework Convention on Climate change was created in 1992 to prevent dangerous climate change.[5] As shown in the chart above mankind's GHG emissions have, however, increased significantly over the last 30 years, with carbon dioxide alone reaching 420 ppm in the atmosphere. While the UNFCCC's Paris Agreement is to keep temperature increase below 2°C progress on reducing greenhouse gas emissions is insufficient.

The IPCC March 2023 Synthesis Report's advice on future Climate Change, Risks, and Long-Term Responses[7]

Current Progress in Adaptation and Gaps and Challenges (A.3) - Progress on adaptation planning and implementation is inadequate. Limits where adaptation cannot help have been reached in some ecosystems and regions.

Future Climate Change (B.1) - Current GHG emissions will lead to global warming reaching 1.5°C in the near term. Every increment of global warming will intensify hazards.

Climate Change Impacts and Climate-Related Risks (B.2) - Projected long-term impacts are multiple times higher than currently observed. Climatic and non-climatic risks will increasingly interact, creating compound and cascading risks that are more complex and difficult to manage.

Likelihood and Risks of Unavoidable, Irreversible or Abrupt Changes (B.3) - Higher global warming levels increase the likelihood of abrupt and/or irreversible changes and the probability of low-likelihood outcomes with very large adverse impacts, such as greater sea level rise.

Adaptation Options and their Limits in a Warmer World (B.4) - With increased global warming (a) adaptation options become constrained and less effective; (b) losses and damages increase; and (c) additional human and natural systems will reach adaptation limits. Flexible, multi-sectoral, inclusive and long-term planning can improve adaptation.

Urgency of Near-Term Integrated Climate Action (C.1) Climate change is a threat to human well-being and planetary health. Choices and actions implemented during this decade will have impacts now and for thousands of years.

Mitigation and Adaptation Options across Systems (C.3) - Rapid and far-reaching transitions across all sectors and systems are necessary to achieve emission reductions. Feasible, effective and low-cost options are available.

The paragraphs in this box highlight key messages from the IPCC Synthesis Report by paraphrasing its lead paragraphs and giving their numbers (e.g.(A.3)).

The consequences of increased GHG levels in the atmosphere

As current extreme weather events around the world demonstrate, global warming makes the climate more energetic, with increased extreme weather including heatwaves, droughts, wildfires and heavy rainfall. These climate events occur at the current average temperature increase of 1.15°C. Extreme weather events will increase significantly if global warming reaches the 2.6-2.8°C by 2100 under current policies, for which, we suggest, prudent adaption planning should be taken into consideration.

Sea level rise

Besides climate change, sea level rise is also a major concern for countries with low-lying coastal cities and productive agricultural deltas. The IPCC acknowledges deep uncertainty in ice-sheet processes, meaning it cannot rule out sea level rise approaching two metres by 2100 and more than fifteen metres by 2300.[8] Severity of the impact of even a one metre rise in India/Bangladesh, Thailand, Vietnam and Southern China is shown in the figure.

Besides direct threat to the population, a major concern is the impact on food production. Taking Vietnam as an example, the World Bank notes: "The Mekong Delta contributes 50 percent of the country's rice production, 65 percent of aquaculture production, 70 percent of fruit production, and a third of its agricultural GDP." [9]

Climate change impacts in Asia

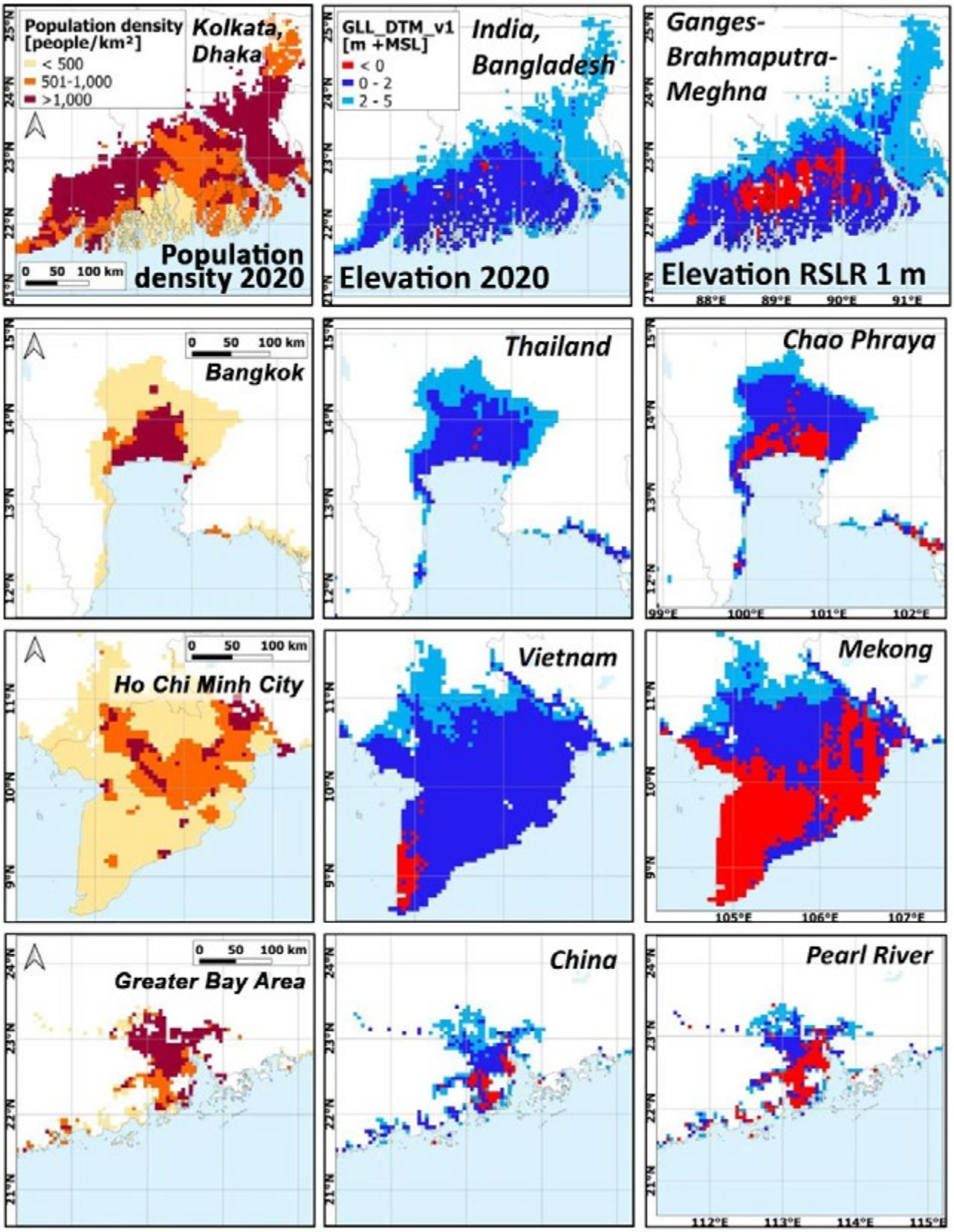
The IPCC's Regional Fact Sheet for Asia[10] provides a summary of the impacts of climate change in the region.

- Observed and projected climate change impacts: Rising temperatures increase likelihood of the threat of heatwaves, droughts and floods.
- Ecosystems: Observed biodiversity or habitat losses of animals and plants have been linked to climate change. The risk of irreversible loss of marine and coastal ecosystems increases with global warming, especially at 2°C temperature rise or more.
- Health: Increasing hazards such as heatwaves, flooding, drought and air pollutants will lead to more vector- and water-borne diseases, undernutrition, mental disorders and allergy-related illnesses, infant mortality and heat-related deaths.
- Cities and settlements: Climate change has caused direct losses due to damage in infrastructure, disruption in services and affected supply chains, and will increase risk to infrastructure; as well as providing opportunities to invest in climate-resilient infrastructure and green jobs.
- Water: By mid-century, the international trans-boundary river basins of the Amu Darya, Indus and Ganges could face severe water scarcity challenges due to climatic variability and changes acting as stress multipliers (high confidence). Asian countries could experience an increase in drought conditions (5-20%) by the end of this century.
- Cryosphere: Glacier lakes outburst floods will threaten the security of local and downstream communities in High Mountain Asia. Climate change results in permafrost warming and increased thaw depth, exacerbated by human activities in built-up areas.
- Food: Increased floods and droughts, together with heat stress, will have an adverse impact on food availability and prices, resulting in increased under-nourishment in South and Southeast Asia.
- Energy: Together with population growth, hotter summer climate increases energy demand for cooling. Decrease in precipitation also influences energy demand, as desalination, underground water pumping and other energy-intensive methods are increasingly used to supplement water supply. Among 13 developing countries with large energy consumption in Asia, 11 are exposed to high-energy insecurity and industrial systems risk.

Planning ahead

At the start of this section, we noted that prudent adaptation planning should consider "high-end" scenarios with temperature increases of 2.6-2.8°C by 2100 and include contingency plans for the IPCC's "low likelihood, high impact" scenarios, in particular, for a much faster rise of sea levels.

The increasing rate of sea level rise is a further warning. In addition to planning for likely "high end" scenarios, scientists, decision-makers and policymakers must take account of trends which may mean greater than predicted deterioration. This requires an improved planning "for a trend" system with monitoring and early warning infrastructure – as well as a decision management system enhancing our preparedness and resilience against the changing climate.



Densely populated, agriculturally productive deltas which are vulnerable to sea-level rise [11]

Left column	**Population density in 2020**
Middle column	**Land surface elevation in 2020**
Right column	**Land surface elevation after 1m relative sea level rise (RSLR)**

- **Less than 500 people/km²**
- **Between 500 and 1,000 people/km²**
- **More than 1,000 people/km²**
- **Below average sea level**
- **Between 2 and 5m above average sea level**
- **Between average sea level and 2m above average sea level**

Reflecting on COP27


27
022
ENTRANCE
GENDER
YOUTH & FUTURE GENERATIONS
DECARBONIZATION

COP27 adaptation outcomes

Jasper Hilkhuijsen, East Asia Sustainable Development Manager, Arup

Countries united at COP27 in Sharm el-Sheikh, Egypt in November 2022 to deliver effective implementation, maintain the promise of "keeping 1.5° alive" and prioritise assistance to the most vulnerable populations affected by climate change. Below are some key takeaways from an adaptation perspective.

Establishment of a Loss and Damage Fund

COP27 delivered an historic statement of intent to set up a financial support structure and dedicated fund to address loss and damage faced by the most vulnerable developing countries. Much remains to be agreed and a transitional committee is to propose suggestions on how to put into effect the governance structure for the fund, identifying who will contribute and how to allocate available funding. The Loss and Damage Fund could potentially provide lifelines for poor families whose houses are destroyed, farmers whose fields are ruined, and islanders forced from their ancestral homes.

However, challenging decisions need to be made on developing clear eligibility criteria, establishing an independent governance structure and mobilising resources to finance the fund. Equally important is a transparent and participatory decision-making process that involves the most vulnerable countries in designing and implementing the fund. As Asia hosts 99 of the world's 100 cities most exposed to a range of environmental and climate-related risks,[12] it can be anticipated that support from the Loss and Damage Fund will be eagerly sought after from Asian nations.

Adaptation Fund

The Adaptation Fund was created in 2001 under the Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC) with the mandate to finance concrete adaptation projects in developing countries that are particularly vulnerable to the adverse impacts of climate change. At COP27, multiple countries pledged a joint US$230 million to the fund, yet it fell 35% short of the US$356 million pledges at COP26, which is still very small compared to the size of the challenge.

The shortfall has happened despite a UN call to developed countries for substantially increased adaptation financing. As climate-change damage is likely to magnify in the absence of adequate adaptation safeguards, the fund crunch will impact developing and vulnerable countries. So far, the fund has approved 140 projects globally in about 100 developing countries. Funded projects in Asia for example, are in Cambodia, Indonesia, Malaysia and Vietnam. Efforts so far have helped but without a step change in financial support, adaptation actions will be outstripped by accelerating climate impacts, which would further widen the adaptation implementation gap.

Nature-based solutions

Nature-based solutions (NBS) for urban resilience are environmentally sustainable, cost-effective and adaptive in addressing social and economic challenges while providing social well-being and biodiversity benefits. These solutions can be applied across spatial scales and settings in and around cities.

NBS have gained importance as a key multi-pronged approach to combat climate change and were included for the first time in a COP cover decision:

"Emphasises the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement temperature goal, including through forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gasses and by protecting biodiversity, while ensuring social and environmental safeguards." [13]

The inclusion means that parties now have oversight to ensure NBS are implemented with integrity; meaning they are people-led and biodiversity based, providing positive social outcomes locally, and are implemented in tandem with, not instead of, drastic cuts in GHG emissions.

NBS have the potential to facilitate sustainable urban development while achieving climate adaptation and mitigation targets. NBS projects are widely implemented across Asia, including small-scale green spaces on buildings; landscaped bioswale channels; green corridors along streets and water bodies; urban parks and forests within city boundaries; and larger areas with wetlands and forests upstream or along the coast. However, there is still room for further work, particularly in ensuring uniformity in implementing NBS across diverse regions.

Adaptation Agenda and National Adaptation Plans

Underlining the importance of adaptation, COP27 also launched the Sharm-El Sheikh Adaptation Agenda, a comprehensive, shared agenda to rally global action around 30 adaptation outcomes to achieve a resilient world by 2030.[14] The agenda aims to accelerate transformative actions by countries, regions, cities, businesses, investors and civil society to help vulnerable communities adapt to the acute climate hazards they face.

It puts forth recommendations on infrastructure systems and planning to tackle climate change, including goals such as providing affordable and climate-resilient energy access to all, promoting low-cost and resilient transportation infrastructure, implementing evidence-based adaptation plans for cities and companies, ensuring universal access to climate risk information, as well as operationalising National Adaptation Plans (NAPs) and Locally-Led Principles. These measures are crucial for enabling country-driven and consultative adaptation to address climate change at both local and global levels.

Recommended actions include sustainable agriculture, improving water security, smart and early warning systems, securing finance for mangroves and the development of actionable adaptation plans.

Similar to the Loss and Damage Fund, implementation and progress monitoring details of the Adaptation Agenda need to be further developed.

How the agenda will play out in Asia is uncertain, yet it is safe to say that it will capitalise on existing NAPs across the region. The approach for nations to develop their own NAPs was established under the Cancun Adaptation Framework (CAF) during COP16 in 2010 and was re-emphasised in the Paris Agreement. The two overarching objectives of NAPs are to:

- Reduce vulnerability to the impacts of climate change by building adaptive capacity and resilience.
- Integrate adaptation into new and existing policies and programmes, especially development strategies.

Since then, Asian countries have drafted and adopted some form of NAP. While the governance, form and contents are diverse, most actions focus on agriculture, water, ecosystems and cross-cutting sectors, primarily addressing rainfall variability, drought and flooding.


South Korea
3rd National Climate Change Adaptation Plan 2021-2025
China
National Strategy for Climate Change Adaptation 2035
Japan
Climate Change Adaptation Plan
Hong Kong
Climate Action Plan 2050
Thailand
National Adaptation Plan (outline only)
Cambodia
Cambodia Climate Change Strategic Plan 2014-2023
Philippines
National Climate Change Action Plan 2011-2028 (NCCAP)
Vietnam
National Climate Change Adaptation Plan 2021-2050
Malaysia
Eleventh Malaysia Plan
Singapore
Singapore's Climate Action Plan
Indonesia
Rancana Aksi National – Perubahan Iklim (RAN-API)

NAPs in Asia

The Race to Resilience Asia event series


Organiser
ARUP
Endorsed by
Strategic partners
CIVIC EXCHANGE
ice
RESILIENT CITIES NETWORK
WORLD RESOURCES INSTITUTE
Ir Alan Tang
Civil Engineering and Development Department,
HKSAR Government
Ir Joy Lee
Drainage Services Department,
HKSAR Government
Sandy Song
Hong Kong Observa
HKSAR Government
Race to Resilience

Uniting Asia to build resilience

Wing Tsang, Research Analyst, Civic Exchange
Olivia Boedijanto, Research Assistant, Civic Exchange

Introduction

Asia is one of the world's most vulnerable regions to climate change impacts due to its densely populated coastal cities, extreme event-prone cities and low-lying inhabited islands. The increased intensity and frequency of extreme heat, weather disasters and rise in sea levels often result in massive floods, landslides and droughts, impacting the lives of millions, especially the urban poor. The population boom in Asia is predicted to lead to increased demand for resources and generate greater emissions, exacerbating climate change impact and reducing the resilience of communities and infrastructure. Urbanisation can also lead to loss of green spaces, which are crucial for climate resilience.

As action is needed, urgently and systematically at scale and pace, the Race to Resilience Asia event series was held prior to COP27. Participating cities included Ho Chi Minh City, Hong Kong, Jakarta, Kuala Lumpur, Manila and Singapore. Endorsed by the UN, the series was part of a global campaign to encourage climate resilience efforts.

Renowned speakers from across governments, industries and relevant sectors discussed topics ranging from flood management to inclusive design and transport strategies, sharing their insights, experience and opinions on what they believe is most needed to work towards a climate-resilient Asia.

Overwhelming positive feedback the series received is a strong confirmation of the pivotal role designers, planners, engineers and sustainability consultants can play in this space – not only by providing technical excellence but also by bringing together various stakeholders and jointly accelerating action plans.

Registrations
~5,700

Attendance (virtual & in-person)
~3,000

6 hosting cities across Asia

40+ influential speakers

40 partnering organisations

7 events within one week

Pre COP27

Race to Resilience

Asia event series

Uniting Asia to build resilience

Watch more

Opening session: Building a climate resilient Asia, what is most needed?

Ho Chi Minh City: How can flood management improve city resilience and development

Hong Kong: What is the key to a flood resilient Hong Kong

Kuala Lumpur: Are our transport strategies on track to ensure mobility resilience?

Jakarta: Why is inclusive design crucial for community resilience

Manila: How do we ensure energy resilience for the economies of the future?

Singapore: Hydrogen: how do we unlock its potential as a resilient energy carrier?

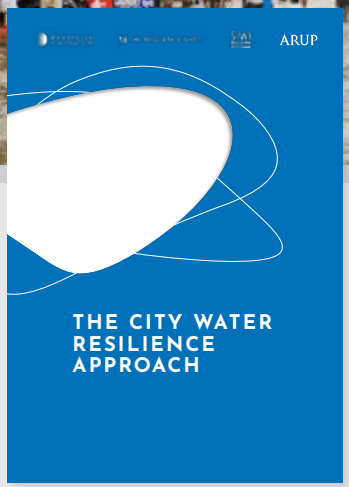
Note: The links above direct you to a YouTube channel where the recordings of the series, all in English, are uploaded. Accessibility might depend on your location.

What is key to a flood resilient city?

While climate change has already triggered recent unprecedented extreme flooding in various parts of Asia, a recent report published by Nature Climate Change[15] highlights that the threat of rising seas combined with increased precipitation affecting Asia megacities could be far worse than anticipated. In addition to too much water, too little water in the form of droughts is also a major challenge. During the sessions hosted in Hong Kong and Ho Chi Minh City, it become clear that regardless of differences between the cities, the common enemies of flooding and droughts and the approach to battle them share many similarities. For example, while Ho Chi Minh City is known to be mostly built on low-lying land, it is less known that 27% of Hong Kong's population lives on reclaimed and low-lying land, as outlined by China Water Risk.[16]

Anticipating uncertainty

Climate scenarios from the IPCC's Sixth Assessment Report explore possible future emissions pathways and it is up to each stakeholder to decide which scenario and associated climate impacts to consider and assess. As global climate data becomes more widely available, utilising a scientific and evidence-based approach to determine adaptation strategies that go beyond existing planning and building codes is highly encouraged. However, assessments strongly hinge on the data available. In Hong Kong, the Hong Kong Observatory has captured an abundance of local data, enabling more accurate projections of, for example typhoons, to understand the likelihood and rate of overtopping.



City Water Resilience Approach

This approach provides clear insights on the most effective sequencing and prioritisation with a water programme, helping clients to engage with the complexity of the water system and prepare for changes in demand and use.

However, in Ho Chi Minh City, local data is not readily available, requiring more flexibility in what sources are being used and what scenarios should be designed for. Progress is being made through projects such as the Geographic Information Systems (GIS) mapping of Ho Chi Minh City's drainage system through the Global Cities Future Programme.

Integrated systems thinking

It is crucial to see water as part of a wider system that includes, for example, people, ecology and the economy. To allow for informed decision-making, the integration and interconnectivity with other systems need to be properly understood and addressed. In addition, due to its complexity and multifaceted nature, effectively combating water-related climate risks requires cross-departmental collaboration. Examples discussed include Hong Kong's governmental Climate Change Working Group on Infrastructure (CCWGI) and the Airport Authority Hong Kong's (AAHK) Climate Resilience Study, which involved 20 internal departments. In Ho Chi Minh City, stakeholders such as the Asian Development Bank and the Foreign, Commonwealth & Development Office (FCDO) support local government departments in fostering collaboration and increasing capacity and capability.

Blue-green infrastructure

The speakers agree that blue-green infrastructure, meaning the use of blue elements such as rivers, canals and wetlands, and green elements such as trees and fields in urban planning, is an essential part of the solution that should be deployed at various levels and scale. However, rather than large-scale engineering projects implemented in the past, they argue for smaller projects. Besides being able to better respond to local contexts, smaller projects are often also much easier to finance, especially in cities such as Ho Chi Minh City where funding is usually difficult to secure.

Blue-green infrastructure and related nature-based solutions are critical in improving "sponginess" and enhancing the ability of cities to manage water and floods to build resilience. In addition, they can positively contribute to biodiversity, absorb carbon emissions, and improve the health and well-being of citizens. Water sensitive urban design, integrated flood control planning, decentralised infrastructure and utilisation of digital tools are all key components of future water strategies.

Increasing awareness among investors

Investors are increasingly aware of potential climate risks including flooding to their existing and future assets. This is partially driven by initiatives such as the Task Force on Climate-Related Financial Disclosures (TCFD), which advocates clear, comprehensive, high-quality information on the impacts of climate change for financial markets. The TCFD suggests that companies and financial institutions utilise scenario analysis to evaluate the impact of climate-related risks and opportunities on their business and to assess and improve their resilience.

While investors evaluate climate-related issues using comprehensive regulations and guidelines that are readily available, they mainly rely on the sound advice of practitioners. While these privately implemented resilience measures typically do not help much to address city-wide flood resilience due to their scale, they do provide valuable blueprints to their peers on what can be done on a single asset.

Adopting a progressive adaptive approach

A key message from the Race to Resilience Asia sessions is that adopting a progressive adaptive approach is essential to ensure short-to-midterm flood resilience, while keeping design flexibility to address uncertain worst-case long-term climate change scenarios with future, possibly more extensive interventions. This ensures cost-effectiveness and limits future impacts on coastal structures.

This approach should be complemented with strategies such as the delineation of areas where temporal flooding is acceptable and the application of smart and flexible flooding barriers. Designing with water, rather than fighting against it, is key. Inspiration should be sought in practices such as houses on stilts on the Mekong Delta, which for centuries have been built to accommodate and respond to fluctuations in the water level.

Shanghai Urban Drainage Masterplan, Greater China

This visionary blue, green and grey approach for the city of Shanghai integrates strategies to achieve design goals, improve well-being, serve urban redevelopment and enhance water resilience. A detailed analysis of the land uses of the Shanghai urban area was conducted using an understanding of the city's history to establish a total of 12 different land use typologies. By applying remote sensing imagery and machine learning technologies, we were able to categorise the study area into different development types with respective green infrastructure used accordingly.

How to ensure energy resilience?

The energy sector in Asia is undergoing significant changes, driven by population growth, urbanisation and industrialisation. The region is home to both developed and developing countries, each facing their own energy challenges, mainly consisting of energy security and physical risks from climate change.

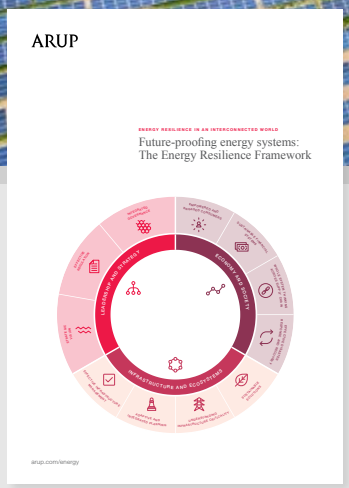
Many countries in Asia rely heavily on imported fossil fuels to meet their energy needs. Building resilience in the power sector can help reduce dependence on foreign energy sources and increase energy security by diversifying energy sources and improving energy efficiency.

This session of the Race to Resilience series featured speakers from Singapore and the Philippines, who elaborated further about the current challenges and future prospects of their respective energy sectors.

Energy access and resilience are critical in vulnerable areas

Despite the urgency and importance of decarbonising the energy sector, some rural areas in developing countries still lack access to reliable electricity, as they are not connected to the national grid. For example, in outlying Philippines islands such as Hilabaan and Eastern Samar, electricity is only available for around four hours a day. Furthermore, the power plant operator's lack of knowledge and expertise in maintaining system reliability has been identified as a major challenge, leading to frequent power outages and disruptions in the country's power supply.

In addition to energy security, these areas are also susceptible to natural disasters such as typhoons, earthquakes and floods. As such, building a climate change resilient energy network is of utmost importance to utilise the limited power supply currently available in these areas.



Energy resilience framework

Energy is critical to our daily lives. Increased integration and complexity mean ensuring energy systems are resilient has never been more challenging. The Energy Resilience Framework can diagnose, for any energy system, where challenges and opportunities for improvement lie.

Decentralising grids to improve resilience

Vulnerability of the energy sector has pushed the local government to construct a decentralised renewable energy system model on these outlying islands. This idea is further supported with initiatives to mark potential competitive renewable energy zones that can source from offshore wind energy, which is abundant in the areas. One of the speakers cites the World Bank's Offshore Wind Roadmap for The Philippines,[17] which states that an estimated 178 MW of power generation prospect has been found and may attract investments in this field. This new system, along with timely monitoring, is expected to create a more stable and reliable source of energy for outlying islands in the Philippines.

High cost and energy loss pose challenges for hydrogen

Singapore is encountering multiple challenges around implementing hydrogen at scale, despite growing interests sparked by the National Hydrogen Strategy.[18] Foremost, hydrogen, as a fuel itself, has a high rate of energy loss due to its volume density, meaning the expected output has about 20-30% of its original input.

In relation to hydrogen-sourced energy production, expenses pose a major concern to leading members of the industry. The high operational expenses require financial engineering and forecasting; hence banks are reluctant to lend money due to uncertainties.

Industry leaders optimistic about hydrogen opportunities

Regardless of the growing challenges, industry leaders are optimistic there will be upcoming opportunities, particularly in the fertiliser and refining industry as the manufacture process is compatible with green hydrogen as a feedstock and energy source. Further expansion of hydrogen fuels' potentials can be seen in the recent developments of hydrogen fuel cell automotives for long-distance travel, including the marine and aviation sectors. By 2050, Singapore targets the use of hydrogen to be 5-15% of total energy use for the transportation industry. As for now, a gradual transition to hydrogen fuel will be promoted by mixing gas-sourced energy supply to lighten the cost burden.[19]

Singapore plans to be a hydrogen leader in ASEAN

The speakers also addressed a growing potential for Singapore to commercialise hydrogen projects in Association of Southeast Asian Nations (ASEAN) countries. Singapore envisions being Asia's Renewable Energy Hub by forecasting about 1.6 million tonnes of hydrogen produced annually by 2050, becoming the largest renewable energy and hydrogen project globally.

As one of the world's key trading hubs, Singapore can create a further impact by decarbonising its maritime sector. Currently, Singapore is constructing its first floating Energy Storage System, striving to facilitate incoming and outgoing international vessels. The system will provide more flexibility and readiness for working together with international shipowners.

ASEAN countries could potentially benefit from the adoption of modern technologies, as Singapore could transfer its expertise and channel capital to nations in need of a steady energy supply, such as the Philippines.

Promote renewables with advanced technologies, subsidies and investment incentives

Speakers agreed that the renewable energy transition should be promoted through the adoption of advanced and interoperable ICT technologies, nuclear power, and a shift to electric vehicles. Domestic consumption should be promoted through government subsidies and tax credits, and certification, long-term certainty, and tax rebates should be implemented to promote investments in renewable energy projects.

Aboitiz Cayanga Solar Power plant, the Philippines

Located in a mountainous area of Pangasinan Province of the Philippines, the project will occupy about 1,960,000m². A key ambition is to retain the overall character of the existing hillside terrain and improve landslide-prone areas through hillside and forest restoration. The project aims to increase usability of the surrounding land, provide clean renewable energy to the grid and improve employment opportunities for local communities.

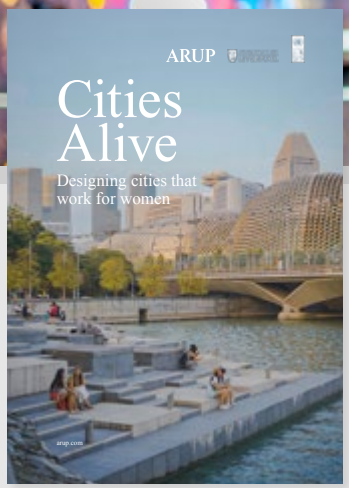
Why is inclusive design crucial for community resilience?

People who contribute the least to climate change are often the most affected by it. An estimated 68 to 135 million people[20] could be pushed into poverty by 2030 because of climate change. At the same time, inequality between countries could also rise further.

In Indonesia, rapid urbanisation is set to intensify challenges such as a widening the rich-poor divide, as well as climate risks such as flooding and pollution. Navigating these challenges towards sustainable development requires a determined focus on vulnerable communities to reduce inequality and enable cities to thrive.

Hearing all voices

Building community resilience requires a highly localised understanding of place and the interactions between people, nature, infrastructure and cultural practices. A first step to understanding and developing appropriate and meaningful interventions to enhance community resilience is to ensure the voices of marginalised citizens are being heard and have a more diverse representation in decision-making. Obtaining a comprehensive set of views can be challenging as there are many aspects to consider. For example, people may express themselves differently, and there is no one-size-fits-all survey



Cities Alive: Designing cities that work for women

A gender-inclusive and responsive approach is essential to create places where everyone can live, work and thrive. By designing urban areas that are responsive to the needs of all women - and increasing the participation of women in urban governance, planning and design - our cities will become safer, healthier, fairer and more resilient.

format. As such, a variety of engagement tools, inclusive strategies and participatory techniques should be adopted to provide multiple platforms and formats for people to express their views.

Capitalising on nontangible aspects

Community resilience hinges strongly on the resilience of people and local social networks. The speakers emphasise the importance of building upon these intangible aspects rather than seeking for resilience in large-scale infrastructure projects. Many lessons can be drawn from communities that have experienced climate shocks with severe impacts yet were able to overcome them and build back better. Making sure that a community is mentally prepared and organised, for example by implementing a communication strategy or formulating an emergency relief plan to respond to possible climate shocks, could be much more effective than any hardware intervention.

Other elements that go beyond the typical infrastructural approach to resilience include mental and physical well-being, as well as economic resilience. For example, what are the economic implications of a community being hit by a climate shock? Do they have the short- and medium-term means to ensure food, energy and shelter?

Embracing the 10-minute city concept

Even when working on extremely large-scale projects such as planning for the new Indonesian capital city, it is important to look at the human scale and particular outcomes around liveability and place. The example of the 10-minute city was given; a concept that everyday needs of citizens such as education, work, healthcare, groceries and recreation are within a 10-minute walking or cycling distance from their homes. This local autonomy of a neighbourhood enhances community resilience, as it reduces reliance on larger city infrastructural networks while fostering stronger bonding between people.

The challenge of integrated solutions

Poverty and community resilience are multidimensional issues that require integrated solutions. However, in Indonesia and other developing nations in Asia, it is challenging to design and implement integrated solutions.

First, there is limited cross-sectorial data and data access, making it difficult to adopt an evidence-based approach as well as to measure the actual impacts of interventions.

Second, there is limited horizontal and vertical coordination. Stakeholders from private and public sectors alike either do not communicate sufficiently, lack the capacity to operate outside their boundaries, or are simply hesitant to take responsibility for ownership of multidimensional interventions.

The third challenge is funding. Even if funding is eventually secured, it is not unusual in Indonesia for it to be mainly spent on capital expenditure (CAPEX), leaving little or no funding for operational expenditure (OPEX), let alone for upscaling the capacity and capability of the required operators and other stakeholders.

Utilising inclusive design to enable a shift to low carbon transport, Semarang and Makassar, Indonesia

A range of participatory planning approaches, including journey mapping, photo voice and perception surveys alongside night-time assessments, were deployed to understand the experience of vulnerable groups around mobility. This insight will inform the co-design of tactical urbanism for cost-effective solutions to improve accessibility to low-carbon transit options for all.

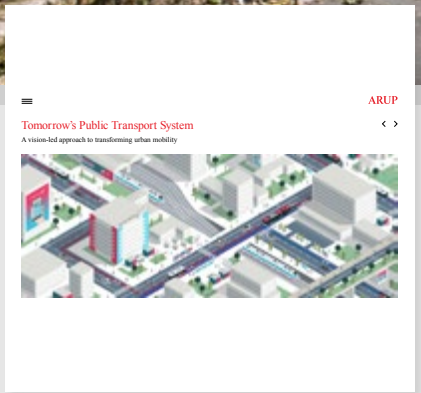
What is needed to improve mobility resilience?

A functioning mobility network is evident for cities to operate and be competitive. However, due to the growing impacts of climate change, cities in Asia increasingly encounter failures of their mobility networks. Examples range from flooded roads and subways to deformed railways caused by severe heat waves, resulting in a lack of mobility options, disruption of services, congestion and threats to citizens' safety.

While the discussion focused on Kuala Lumpur, the experts agreed that cities across Asia are commonly aware of the need to get people out of their cars and foster the use of public transit and active mobility modes. In addition to improving the network efficiency, this approach also brings additional benefits such as reduced emissions and improved health and well-being of citizens. As one of the speakers notes, an advanced society is one where affluent people use public transport.

Creating integrated multi-modal integrated systems

Cities that mainly rely on a single mode of transport are in general less resilient, as a single failure could impact the entire system. The more options available, the higher the level of resilience. One key element to consider, however, is the integration between different systems. Seamless transitions are essential for various modes to supplement each other and offer users alternatives in case one of them fails. In addition, only through the adoption of an integrated approach can public transit become a feasible replacement of cars.



Tomorrow's public transport system

The future of public transport is characterised by uncertainty. While the climate crisis requires a fundamental shift in travel behaviour to secure a transition to net-zero, exponential technological progress is beginning to significantly impact transport business models and has the potential to reshape how we think about personal mobility.

Delivering user-centric solutions

In the constantly changing Asian cityscapes, mobility is hyper localised in terms of the various modes, routes and transport user patterns and preferences. One of the panellists claims that, apart from status and comfort, a reason why private cars are so popular is a false sense of reliability and resilience they provide. The one behind the wheel is in control, while public transport predominantly follows fixed routes, eliminating the flexibility to avoid congested or blocked streets or tracks. Real-time transport data need to be made available and utilised to allow users to make more informed decisions. A truly user-centric solution should go beyond arrival times at stations and bus stops and allow comparison of complete end-to-end journeys across various mobility modes.

Improving active mobility

Encouraging walking and cycling as viable means of transport is a challenge in cities like Kuala Lumpur. While the numerous highways accommodate cars to move from one district to another, they form major barriers for pedestrians and cyclists. Walkways are too narrow, if present at all, and their maintenance is often poor. As the highways are not expected to disappear anytime soon, one panellist suggests a solution could be subways and bridges, or perhaps converting one of the lanes to a pavement or cycling track. Another barrier is many gated communities scattered across the city. Improving their permeability would require engagement with the local community and possibly the provision of dedicated slow traffic routes, open to the public, at least during peak hours.

Addressing safety

Safety is another key component to foster active mobility. Considerations include the use of streets with sufficient width and limited traffic, yet also the provision of adequate signage, particularly oriented towards cyclists and pedestrians, rather than current vehicle-oriented signage. Inclusive and well-being considerations discussed include the provision of universal access, sufficient lighting and the mitigation of the heat island effect, which will only increase due to climate change. This can be achieved through designing for shade and breezeways, implementing more greenery, using light-coloured materials, and incorporating water features.

Making buses more reliable

Like Kuala Lumpur, buses are an important part of the public transport network in many Asian cities. Often, their ridership and efficiency are negatively impacted by their reliability. One recommendation is to make buses more demand responsive. For example, this includes allowing them to deviate from fixed routes based on congestion and passenger preferences. Empty or largely empty buses should not be departing; and smaller sized vehicles can be deployed, which in turn will also be easier to manoeuvre through congested and smaller streets.

Davao high-priority bus system, the Philippines

This project entails the replacement of nearly 7,000 existing jeepneys, which are unsafe and polluting, with a modern bus system, representing a step-change in transport in the city of Davao. The system includes 29 bus routes, 1,000 buses (including more than 300 e-buses), three new bus terminals, five modern bus depots and transit priority elements such as dedicated bus lanes and transit signal priority.

Perspectives

Adopting an integrated design approach

Jasper Hilkhuijsen, East Asia Sustainable Development Manager, Arup

Increasing complexity when designing the built environment

Climate change itself is a set of integrated and constantly developing phenomena, leading to related shocks and stresses. Planning for and responding to the effects of these adversities is typically considered as good practice by designers, engineers, policymakers and other built environment professionals. In the past, these were generally defined by local building codes or through best practices.

However, predicting and anticipating future conditions raises a different set of challenges, ranging from climate change mitigation and adaptation considerations to addressing the wider impacts on biodiversity and people. Reflecting the complexity and interlinkages of various resilience indicators, the City Resilience Index [21] that Arup developed with support from the Rockefeller Foundation elaborates four dimensions - health & well-being, economy & society, infrastructure & environment and leadership & strategy.

Shared problems call for shared solutions

If not already, climate change is rapidly becoming one of the top priorities among stakeholders of the built environment. Although the concept of resilient design might seem straightforward, having an effective and systematic process for assessing risks, evaluating risk exposure and making cost-effective and informed decisions is key to achieving a resilient built project. Various stakeholders have different roles to play during this process, and it is only by tapping into collective wisdom that can we optimise a project's wider impacts and long-term resilience. As no entity alone can solve this complex climate resilience puzzle, fostering effective collaboration from the onset of any built environment project is the only way forward.

Smart Green Resilient approach

Arup's Smart Green Resilient (SGR) approach is an exemplar model for adopting an integrated design approach to combat climate change. It aims to enable pragmatic concerns to be addressed simultaneously with major environmental issues, structuring long-term resilience in urban planning strategies and masterplans with sustainability frameworks for a wide range of contexts.

Derived from design practice, observations and collective research on East Asia's energetic urbanisation that left many cities and landscapes vulnerable to climate change, the approach adopts the holistic resolution of critical issues related to contemporary cities with an equal focus on the organisation of urban systems and their management, as well as physical design, including infrastructure and buildings.

Arup's Smart Green Resilient planning approach

The SGR approach is characterised by three important elements:

- People Oriented: Designing for end-users, the need to broaden stakeholder engagement, formulate broad alliances with concerned parties, and realise community benefits.
- Contemporary Relevance: Espousing the importance of addressing current issues using a composite systems approach that can lay the foundation for a structured long-term implementation, as well as revealing territorial relationships.
- Future Proofing: Supporting capacity-building, the utilisation of appropriate technology and scenario-testing to ensure plans have adequate built-in flexibility to adapt to various conditions.

The approach highlights how collaborative action between the public and private sectors is essential. By bringing together experts in engineering, planning, design, finance, development and operations, highly effective strategies and projects that address the impact of climate change can be delivered.

Fostering cross-boundary collaboration

Wing Tsang, Research Analyst, Civic Exchange
Olivia Boedijanto, Research Assistant, Civic Exchange

Asia faces immense threat from Climate Change

Unabated climate change has resulted in severe social, economic and environmental consequences that are clearly apparent across Asia. To date, a series of climate change acts conducted in Asia have aligned to provide local and international stakeholders with insights on common priorities in terms of adaptation and resilience. One notable example of mobilising knowledge took place in the 7th Asia-Pacific Climate Change Adaptation Forum hosted by the Asia Pacific Adaptation Network (APAN), UNEP.[22] Over 900 practitioners from 62 countries gathered virtually, with international stakeholders sharing learning on cutting-edge science and local stakeholders elaborating on how historical disasters impacted their communities. However, current action is slow, if happening at all.

Countries, especially those in Southeast Asia, share a range of similarities in the face of climate hazards. These could unfold a potential pathway on cross-boundary compliance on jointly tackling complex climate change issues.

Governance

Shared cultural and historical norms have laid the foundation for Asian countries' modes of governance. Similar levels of socio-economic development expedite these countries to transfer and apply best practices.[23] The APAN's 7th Asia-Pacific Climate Change Adaptation Forum saw climate governance as one of the enablers to facilitate resilience. To this end, participants exchanged transnational knowledge on ways to foster a whole-of-society approach, bringing systematic inclusion into the discourse.

Geography

Most of the megacities in Asia, including Bangkok, Manila, Ho Chi Minh City and Shanghai, are low-lying or coastal, and highly vulnerable to rising sea levels, floods and other impacts of climate change, potentially affecting the lives of millions of people.

Economic resilience

Many less mature economies of Asia depend mainly on manufacturing and trade. The many workers living from pay-cheque to pay-cheque are highly vulnerable to a sudden loss of their daily livelihood in the event of a climate shock. The Climate Economics Index[24] shows how unmitigated climate change is affecting economies around the world. Unsurprisingly, countries such as Indonesia, Malaysia, the Philippines and Thailand are marked as highly vulnerable, with a loss of economic output totalling more than seven times their 2019 GDP by 2050.

Adoption of technologies

Asian countries plan to increase renewable energies into the current energy mix, at the expense of coal.[25] With the cost of renewable energy sources reducing, the region is actively sourcing the ideal renewable energy infrastructure to cope with rising electricity demands. Hydropower is an attractive clean energy source for countries along the Mekong River, as Asian tropical rivers hold greater spillway overflow discharge. Hydropower dams support stable economic gains and even offer around a third of Vietnam's total electricity production.[26]

Channelling finance to improve climate resilience

One example on how to address common climate vulnerabilities is through financial support. Channelling finance towards initiatives aimed at enhancing climate resilience and promoting sustainable development are crucial.

For instance, the Mekong Sustainable Infrastructure Partnership launched a multi-partner platform in 2019, which has been supporting the Mekong Water Data Initiative (MWDI) through mobilising US$7 billion in private and public financing on sustainable infrastructure projects in the Mekong subregion. The MWDI is an open data space for government officials, professionals and civil societies from the Lower Mekong region to access water-related data points and technologies in hydrological modelling to facilitate combating climate change.

Acceleration through cross-boundary collaboration

Collaborative efforts to tackle climate change should not only be conducted in the glare of public scrutiny. Joint efforts aided through the creation of platforms for cross-boundary dialogues, harnessing each other's diverse expertise and collaborative opportunities, are essential to accelerate action in the fight against climate change.

Systems thinking is a must for enhancing infrastructure resilience

Wan Kai Hong, Regional Director, Hong Kong Institution of Civil Engineers

A lack of systems thinking makes infrastructure vulnerable

When it comes to addressing existing and emerging systemic vulnerabilities in infrastructure, a lack of systems thinking is one of the main issues.

Individual infrastructure assets do not exist in isolation and are interdependent to a greater or lesser extent. For instance, the power grid is necessary for electrified rail, while wastewater treatment is impacted by increased water use. Meanwhile, uninterrupted wireless data connectivity is required for the establishment of a connected and autonomous transport network.

A siloed approach does, however, permeate the sector. While individual asset vulnerabilities and risk management strategies are well understood, system resilience and the interrelationships between infrastructure assets are less appreciated and understood. The ability to share best practices or institutional insights is hindered by barriers that prevent communication and collaboration between infrastructure sectors. This restricts the infrastructure's effectiveness as a system and makes it harder to find and take advantage of synergies. In some cases, it even raises the price of building, maintaining and decommissioning infrastructure assets.

What changes are needed?

It is increasingly important to ensure that definitions and language used around resilience are consistent and commonly used to simplify cross-sector understanding and cooperation.

Infrastructure operators must have a better understanding of the other networks and systems on which they rely and with which they are interdependent. A failure in one sector will increasingly impact another. For instance, if flooding knocks out the electric grid, other flood defences reliant on pumps may also malfunction, leaving trains stranded and telecom services inaccessible.

Moving forward, a major focus must be on creating resilience and contingency between infrastructure assets and sectors. This can be accomplished by encouraging cooperation, teamwork and opportunities to better comprehend and address interdependencies. As with any process of cultural transformation and mindset change, focal points need to be formulated and pioneers willing to lead or be tasked with ensuring integration need to be identified.

Changes to governance and decision-making structures are essential to support and entrench systems thinking in the planning, delivery, operation and recovery of infrastructure assets and systems. There must be a consistent commitment by planning, advisory and decision-making bodies in considering resilience as a fundamental part of their process.

Now is the time to close that gap by adopting systems thinking, systems engineering and systems integration to create an industry that is fit for the challenges and opportunities of the 21st century, and to develop infrastructure resilience that future generations deserve.

The future is urban. Cities need a stronger voice

Lauren Sorkin, Executive Director, Resilient Cities Network

Cities at the forefront of climate change

The biggest stage of the global climate emergency today is being played out in cities. Many of the greatest challenges are happening in an increasingly urban world. Yet the need to invest in urban climate resilience and the urgency of cities to participate in global decision-making processes, such as the annual COP, continues to be ignored.

Cities are home to more than half of the world's population, responsible for more than 70% of GHG emissions and account for 80% of the world's wealth.[27] To continue to prosper, it is in their own interest to adopt equitable and sustainable measures.

Cities are leading the way in adaptation and resilience

Cities are magnets for development, growth and opportunities, which goes a long way toward explaining their continued expansion. However, this has occurred at a time when conditions around the globe have begun to shift. According to the UN-Habitat's World Cities Report 2022,[28] it is cities that are the most affected by climate change, health epidemics or armed conflicts.

Quite a few cities have already been addressing the situation with measures that seek to respond to the challenges. Semarang, the capital and largest city of Central Java province, for example, has recognised the dual threats related to freshwater supply and flooding, and implemented initiatives such as mangrove planting, rainwater harvesting and flood warning systems.

The case for investing in cities in low-income countries

While there is widespread recognition that the world is becoming increasingly urban, we must also be mindful of how this future urbanisation is likely to occur. The same World Cities Report 2022 estimates that between 2020 and 2070, the number of cities in low-income countries will increase by almost 80%, whereas in high and lower-middle-income countries the figure will be around 20%, and in upper-middle-income countries it will be 6%.

Funding for developing countries and their cities to adapt to and mitigate climate change has not yet reached the minimum agreed levels. In Sharm ell Sheikh, developing countries expressed dissatisfaction with the failure to meet the target of transferring US$100 billion a year by 2020.

Meanwhile, cities are beginning to explore other opportunities, such as private-sector investments. By building capacity in early-stage project preparation, portfolio building and project support, private-public-philanthropic partnerships can help bridge the climate finance gap.

Bringing cities together

The voice of municipal authorities in global forums remains limited to an explanatory role. Yet the irony is that the most dedicated advocates and those who best know the reality of their communities and have a deep understanding of the urban context are the local and municipal leaders. One could argue that this alone is reason enough for them to have a seat at the multilateral climate governance table.

At COP27, the Resilient Cities Network (R-Cities) went with member cities to elevate their role in addressing the climate crisis. Global city networks such as R-Cities, the world's leading urban resilience network, bring cities together to share best practices and advocate for policy changes. By learning from each other, cities can act faster and smarter to address climate challenges. By working together, they realise that urgent action is needed not only to translate climate commitments into real and lasting action but also to ensure their participation in global decision-making.

Embedding climate adaptation economics

Wenyi Xi, Research Associate, Climate and Energy Program, World Resources Institute

A growing climate adaptation funding gap

The importance of funding for climate adaptation actions is increasingly recognised by the world. At COP26, developed countries pledged to double the total value of collective funding for climate adaptation by 2025 from 2009 levels, equivalent to around US$40 billion. In addition, at COP27, the establishment of a loss and damage fund was confirmed. However, there is still a huge financial gap to adequately support climate adaptation. According to the UNEP's Adaptation Gap Report 2020,[29] the annual climate adaptation funding needs of developing countries alone are estimated to be between US$140 billion and US$300 billion by 2030; by 2050, this figure will grow to between US$280 billion and US$500 billion. Globally, the scale of climate adaptation investment is currently only US$30 billion per year. The funding gap for climate adaptation is therefore highly significant and only expected to grow. Therefore, there is an urgent need to accelerate the uptake of investment in climate adaptation measures at all levels.

The triple dividend of resilience

One of the reasons why the scale and intensity of investment in climate adaptation is far from adequate is that government departments, private investors and the public lack a comprehensive understanding of the benefits of adaptation actions and therefore lack the incentive to invest more. The Global Commission on Adaptation's 2019 flagship report Adapt Now: A Global Call for Leadership on Climate Resilience[30] suggests that adaptation actions could generate triple dividends – avoiding losses while bringing economic, social and environmental benefits. The Triple Dividends serves as a useful framework for analysing the benefits derived from taking climate-resilient measures.

- Avoiding future losses means that investing in climate-resilient measures can avoid or reduce future losses to economic assets due to damage to infrastructure and disruption of economic behaviour caused by climate hazards.
- Economic benefits refer to the added economic value of investing in climate-resilient measures to reduce the impact of climate risks on productivity and drive innovation.
- Socio-environmental benefits refer to the positive impact on society and the natural environment that can result from, for example, the inclusion of nature-based solutions in climate resilience measures.

Based on the Triple Dividends, government and financial institutions could work collectively to develop standard economic valuation frameworks, accounting standards and audit procedures; and establish a value conversion system to fully identify the benefit of climate adaptations and help fund-raising initiatives for these actions.

Attracting public and private capital

Currently, climate adaptation activities are constrained by limited public finance. It is hard to attract private capital, as most benefits provided by adaptation actions are enjoyed by multiple stakeholders, which makes it difficult to translate into tangible investment returns for private investors. To address these challenges, the following methods are suggested:

- Accelerate the establishment of climate-related investment project libraries at both national and local levels and identify high-quality climate adaptation projects.
- Support the research and development of new financing mechanisms to support climate resilience, and strengthen the disclosure, monitoring and control of climate risks in various industries.
- Encourage local governments to increase fiscal incentives and explore new financing mechanisms that can better leverage private capital.

Just as UN Secretary-General António Guterres called for the global share of funding for climate adaptation and resilience to increase to 50% of total climate finance from the current less than 25%,[31] all countries should greatly enhance ambitions on climate adaptation, and work together for innovative and practical methods and practices to accelerate financial support for global adaptation actions.

Additional resources

Additional resources

The organisations behind this paper have an abundance of publicly accessible resources available, aiming to foster industry wide awareness, accelerate capacity building and advocate for appropriate policies to be adopted.

The selected resources below provide further information, insights and strategies on how to make our cities more climate ready.

Combatting climate change in Hong Kong and beyond

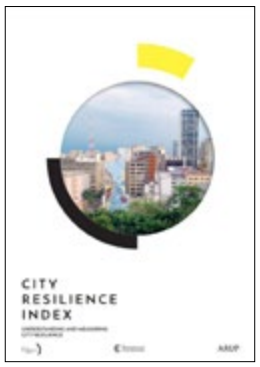
This paper offers insights into how city stakeholders can contribute to - and capitalise on - the outcomes of COP26. The document sets out a series of strategies and measures to reduce carbon emissions, while optimising wider benefits and opportunities. These will make Hong Kong a leading example in combatting climate change.

Urban resilience white paper

(Chinese only)

This white paper details the Arup approach to resilience and some of the tools Arup has developed with its partners across the globe. The paper includes thoughts and latest works on helping cities build resilience from different perspectives, including planning, security and risk, healthcare, socio-economics, transport infrastructure, ecosystem, water, buildings and organisations.

City Resilience Index

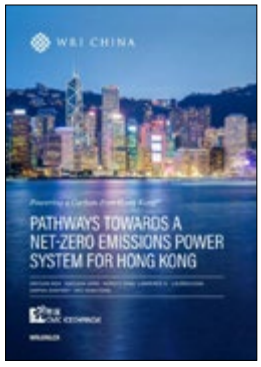


The City Resilience Index, provides a comprehensive, technically robust, globally applicable basis for measuring city resilience. It comprises 52 indicators, which are assessed based on responses to 156 questions; through a combination of qualitative and quantitative data. The responses are aggregated and presented in relation to the 12 goals in the City Resilience Framework.

Decarbonising Hong Kong's roads: pathways towards a net-zero road transport system

This report provides a feasibility analysis on Hong Kong's decarbonisation of road transport and offers recommendations for the government, private sector and civil society. The message is clear: we can only achieve net-zero in the transportation sector if government and society take collective action immediately.

Powering a carbon free Hong Kong: pathways towards a net-zero emissions power system for Hong Kong



This report evaluates potential decarbonised power technologies and develops five energy mix scenarios involving different technological combinations. These scenarios consider the economic, social, and environmental impact of building a decarbonised power system. Our recommendations can inform Government planning in its pursuit of the mid- and long-term targets laid out in the Climate Action Plan.

Meaningful measurement for whole-life carbon in infrastructure

Civil engineers, as the designers, builders and maintainers of infrastructure, have a duty to minimise the harmful impacts on our climate by understanding and reducing the whole-life carbon in infrastructure. This paper describes a consistent methodology for how civil engineers can successfully measure, share and benchmark carbon impacts.

A systems approach to infrastructure delivery

As a response to requests from the infrastructure sector to provide more practical insights into how to deliver a systems approach, this report draws wherever possible on real-world project experience to elaborate on how infrastructure projects, programmes and supply chain businesses are using systems thinking to deliver better outcomes.

Urban Eats: how cities can leverage opportunities to build resilient food systems through circular pathways

This report provides guidance to city stakeholders and key actors in the food system on how a circular economy transition can further their resilience efforts without harming their capacity to adapt and transform. Urban Eats is a campaign launched by the Resilient Cities Network to mobilise its network to take action to improve food circularity and sustainable waste management.

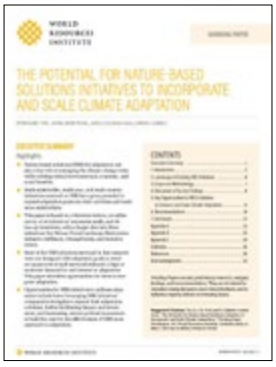
Toolkit for resilient recovery

The toolkit for a resilient recovery is based on best practices from Resilient Cities Network member cities. It enables each city to define its own path to recovery by considering four iterative activities: assessing and analysing the situation; defining a portfolio of actions; improving the proposals; and deepening learning.

Accelerating climate-resilient infrastructure investment in China

This report focuses on the three types of climate risk – namely agricultural drought risk, urban waterlogging and coastal storm surges – that China is most likely to face in the future. We assess the expected costs and benefits associated with climate-resilient infrastructure investment and explore potential financing instruments and mechanisms that could help leverage finance.

The potential for nature-based solutions initiatives to incorporate and scale climate adaptation



This paper explores the potential for existing NBS-centred initiatives to better incorporate climate adaptation. It explores the barriers these initiatives face to offering enhanced adaptation support, as well as existing and new opportunities for accelerating adaptation actions, while improving monitoring and evaluation and capturing lessons learned.

References

1 World Meteorological Organization (2023). State of the Global Climate in 2022. Retrieved from https://public.wmo.int/en/media/press-release/wmo-annual-report-highlights-continuous-advance-of-climate-change

2 United Nations Environment Programme (2022). Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies. Retrieved from https://www.unep.org/emissions-gap-report-2022

3 United Nations Environment Programme (2022). Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies. Retrieved from https://www.unep.org/emissions-gap-report-2022

4 IPCC (2021). Climate Change 2021: The Physical Science Basis 2021. Retrieved from https://www.ipcc.ch/report/ar6/wg1/

5 United Nations (1992). 7. United Nations Framework Convention on Climate Change. Retrieved from https://treaties.un.org/doc/Treaties/1994/03/19940321%2004-56%20AM/Ch_XXVII_07p.pdf

6 Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record. Retrieved from https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/ Some description added.

7 IPCC (2023). Synthesis Report of the IPCC Sixth Assessment Report – Summary for Policymakers (2023). Retrieved from https://www.ipcc.ch/report/ar6/syr/

8 IPCC (2023). Summary for Policy Makers. Retrieved from www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

9 World Bank (2022). Vietnam country climate and development report July 2022. Retrieved from: https://openknowledge.worldbank.org/server/api/core/bitstreams/a27f1b05-910d-59ab-ba2c-84206bf107c2/content

10 IPCC Working Group II – Impacts, Adaptation and Vulnerability (2022). Fact Sheet Asia – Climate Change Impacts and Risks 2022. Retrieved from https://www.ipcc.ch/report/ar6/wg2/about/factsheets/

11 Hooijer, A., Vernimmen, R. (2020). Global LiDAR land elevation data reveal greatest sea-level rise vulnerability in the tropics. Nat Commun 12, 3592 (2021). Retrieved from: https://doi.org/10.1038/s41467-021-23810-9. Creative comments license: http://creativecommons.org/licenses/by/4.0/. Changes made include adding names of affected cities and cropping out the maps of the Amazon and the Niger.

12 Verisk Maplecroft (2021). Environmental Risk Outlook 2021, Verisk Maplecroft Analysis. Retrieved from https://www.maplecroft.com/insights/analysis/asian-cities-in-eye-of-environmental-storm-global-ranking/#report_form_container

13 Conference of the Parties (2022). Sharm el-Sheikh Implementation Plan, UNFCCC. Retrieved from https://unfccc.int/sites/default/files/resource/cop27_auv_2_cover%20decision.pdf

14 Climate Champions (2022). COP27 Presidency launches Adaptation Agenda to build climate resilience for 4 billion by 2030, Climate Champions. Retrieved from https://climatechampions.unfccc.int/cop27-presidency-announces-ambitous-climate-resilience-agenda

15 M, Becker., M, Karpytchev., A, Hu. (2023). Increase exposure of coastal cities to sea-level rise due to internal climate variability. Nature Climate Change. Retrieved from https://www.nature.com/articles/s41558-023-01603-w.epdf?sharing_token=SPyUXFfWKGdl3cC6teMVaNRgN0jAjWel9jnR3ZoTv0M6ZTw9FU9eVGdQttBi0LxKwxfrL3_nU_A_fr0pLrqZOlG-4l53aDx68JHjhGU7Xdc1ckxxIAlJd8tFldZSno59dehDmxQHQQjx6_sVlzpQLcl5NpweJBuE1Ern6Uzg-nHibLR5JVQSNJBB5cOVJJZC0o4XtiTIMP6UNGKdAVDZ1eqmB_ekYKbq4kJzZG-sNUE%3D&tracking_referrer=edition.cnn.com

16 Mirando, D (2022). Assets at Risk due to Short-term Climate Risk Assessments. China Water Risk. Retrieved from https://www.chinawaterrisk.org/resources/analysis-reviews/assets-at-risk-due-to-short-term-climate-risk-assessments

17 Offshore Wind Development Program (2022). Offshore Wind Roadmap for the Philippines. World Bank. Retrieved from https://documents1.worldbank.org/curated/en/099225004192234223/pdf/P1750040b777da0c30935a0e2aa346f4e26.pdf

18 Ministry of Trade and Industry (2022). Singapore Launches National Hydrogen Strategy to Accelerate Transition to Net Zero Emissions and Strengthen Energy Security. Government of Singapore. Retrieved from https://www.ema.gov.sg/media_release.aspx?news_sid=202210246JoalvsFYBOc#:~:text=Hydrogen%20could%20supply%20up%20to,net%20zero%20emissions%20by%202050

19 Climate Analytics (2021). What is Singapore's pathway to limit global warming to 1.5°C?. Climate Analytics. Retrieved from https://1p5ndc-pathways.climateanalytics.org/countries/singapore/sectors/transport

20 World Bank (2020). Global Action Urgently Needed to Halt Historic Threats to Poverty Reduction. World Bank. Retrieved from https://www.worldbank.org/en/news/feature/2020/10/07/global-action-urgently-needed-to-halt-historic-threats-to-poverty-reduction

[21] Arup, The Rockefeller Foundation (2016). City Resilience Index: Understanding and Measuring City Resilience. Arup, The Rockefeller Foundation. Retrieved from https://www.arup.com/perspectives/publications/research/section/city-resilience-index

[22] United Nations Environment Programme (2022). Enabling Resilience for All: The Critical Decade to Scale-up Action: 7th Asia-Pacific Climate Change Adaptation Forum Summary Report. Asia Pacific Adaptation Network, United Nations Environment Programme. Retrieved from https://www.asiapacificadapt.net/wp-content/uploads/2022/11/7th-APAN-Forum-summary-report.pdf

[23] Wang, T. Y., & Liu, H (2018). An emerging Asian model of governance and transnational knowledge transfer: an introduction, Journal of Asian Public Policy. Retrieved from https://www.tandfonline.com/doi/full/10.1080/17516234.2018.1477030

[24] Gray, C., & Varbanov, L (2021). The Economics of Climate Change: Impacts for Asia, Swiss Re. Retrieved from https://www.swissre.com/risk-knowledge/mitigating-climate-risk/economics-of-climate-change-impacts-for-asia.html

[25] International Energy Agency (2019). Southeast Asia Energy Outlook 2019. International Energy Agency. Retrieved from https://www.iea.org/reports/southeast-asia-energy-outlook-2019

[26] Okutsu, A (2018). Asia leads the charge in growth of renewable energy. Nikkei Asia. Retrieved from https://asia.nikkei.com/Economy/Asia-leads-the-charge-in-growth-of-renewable-energy

[27] World Bank (2022). Urban Development. World Bank. Retrieved from https://www.worldbank.org/en/topic/urbandevelopment/overview

[28] UN-Habitat (2022). The World Cities Report 2022: Envisaging the Future of Cities. United Nations Human Settlements Programme. Retrieved from https://unhabitat.org/sites/default/files/2022/06/wcr_2022.pdf

[29] UNEP, UNEP DTU Partnership, World Adaptation Science Programme (2021). Adaptation Gap Report 2020. United Nations Environment Programme. Retrieved from https://www.unep.org/resources/adaptation-gap-report-2020

[30] Global Commission on Adaptation (2019). Adapt Now: A Global Call for Leadership on Climate Resilience. Global Commission on Adaptation. Retrieved from https://files.wri.org/s3fs-public/uploads/GlobalCommission_Report_FINAL.pdf

[31] UN Climate Change (2021). António Guterres: 50% of All Climate Finance Needed for Adaptation. UNFCCC. Retrieved from https://unfccc.int/news/antonio-guterres-50-of-all-climate-finance-needed-for-adaptation

Image Credits

Cover	© Gettyimages
p 3	© Gettyimages
p 5	© Arup
p 6	© Gettyimages
p 8	© Gettyimages
p 11	© Arup
p 13	© Hooijer, A., Vernimmen, R.
p 14	© Arup
p 17	©Arup
p 19	© Arup
p 20	© Arup
p 24	© Gettyimages
p 27	©Arup
p 28	© Gettyimages
p 29	© Gettyimages
p 31	© Gettyimages
p 32	© Gettyimages
p 35	©Arup
p 31	© Arup
p 36	© Gettyimages
p 39	© Gettyimages
p 40	© Gettyimages
p 43	© Arup
p 44	© Gettyimages
p 47	© Gettyimages
p 48	© Gettyimages
p 51	© Gettyimages
p 52	© Gettyimages

About Arup

Dedicated to sustainable development, Arup is a collective of over 18,000 designers, advisors and experts working across 140 countries. Founded to be both humane and excellent, we collaborate with our clients and partners using imagination, technology and rigour to shape a better world.

About Civic Exchange

Civic Exchange is an independent Hong Kong public-policy think tank established in 2000. It uses in-depth research and dialogue to inform policy and engage stakeholders on societal and environmental challenges in Hong Kong. Its research focuses on four areas that are integral to a liveable city: environment, economy, society and governance. Civic Exchange is ranked among the top 50 environmental think tanks in the world by the Lauder Institute at the University of Pennsylvania.

About Institution of Civil Engineers, Hong Kong

ICE is one of the world's most respected professional engineering associations. Established in 1818, it has 95,000 members across the globe. Hong Kong has the highest membership amongst the regions outside of the UK. ICE's vision is to place civil engineering at the heart of society, delivering sustainable development through knowledge, skills and professional expertise.

About Resilient Cities Network

The Resilient Cities Network legacy is built on the 100 Resilient Cities (100RC) initiative, pioneered by The Rockefeller Foundation in 2013, as part of its Global Centennial Initiative. With strong support from member cities, the network was officially launched in 2020, with a mission to reduce vulnerability and improve the well-being of over 220 million urban dwellers around the world. We have a presence in nearly 100 cities and over 40 countries around the world.

About World Resources Institute

World Resources Institute is a global research organisation that works with governments, businesses, multilateral institutions and civil society groups to develop practical solutions that improve people's lives and ensure nature can thrive. We organise our work around seven global challenges: Food, Forests, Water, Energy, Climate, the Ocean and Cities. We analyse these issues through the lenses of our four Centres of Excellence: Business, Economics, Finance and Equity.

ARUP

Contact us

Arup
Jasper Hilkhuijsen
East Asia Sustainable Development Manager
e: jasper.hilkhuijsen@arup.com

Civic Exchange
Lawrence Iu
Executive Director
e: liu@civic-exchange.org

Instutition of Civil Engineers, Hong Kong
Wan Kai Hong
Regional Director
e: kaihong.wan@ice.org.uk

Resilient Cities Network
Lynette Lim
Global Director, Communications
e: llim@resilientcitiesnetwork.org

World Resources Institute
Wenyi Xi
Research Associate, Climate and Energy Program
e: wenyi.xi@wri.org

Published: June 2023