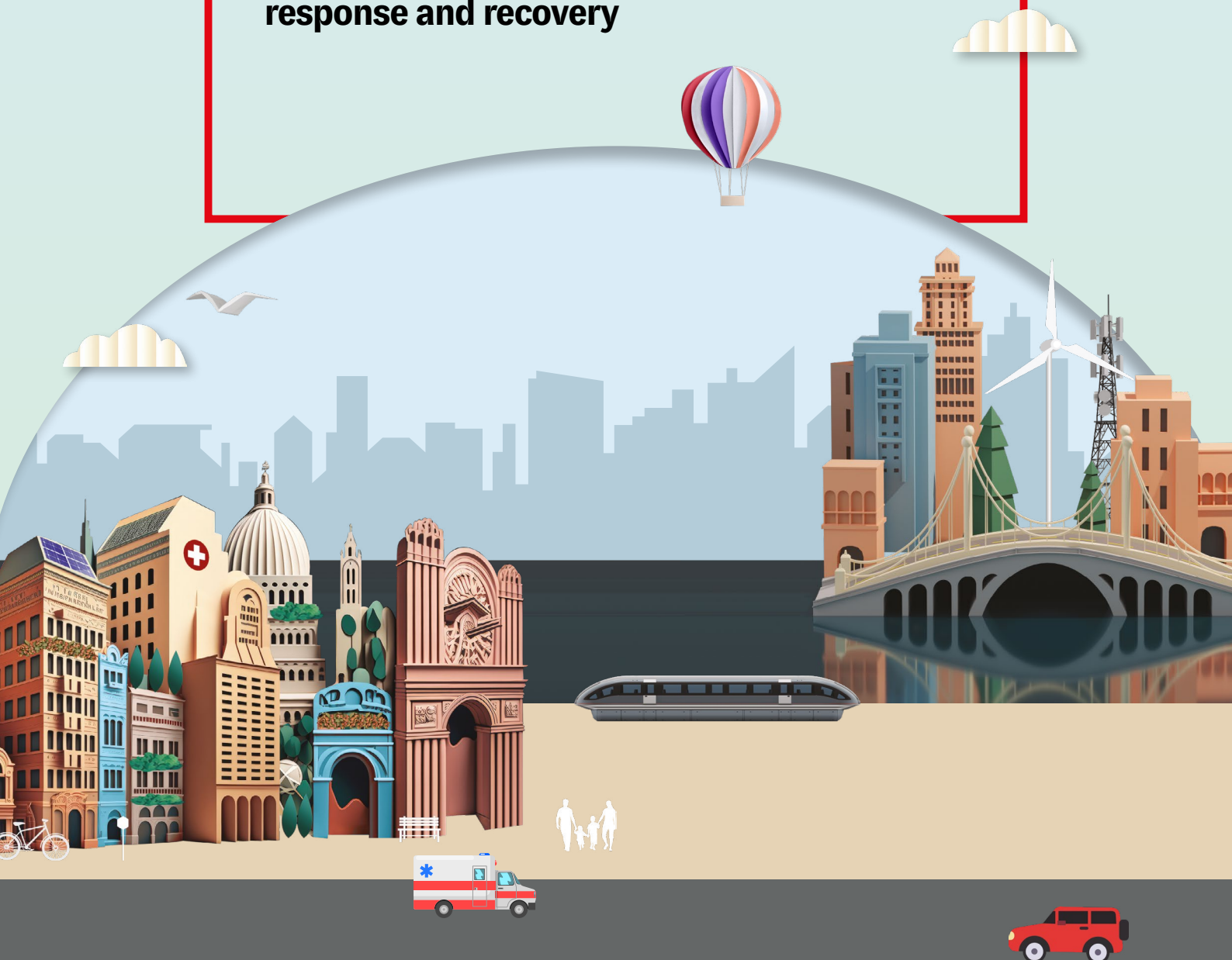


**ECONOMIST
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Resilient Cities Index

A global benchmark of urban risk,
response and recovery



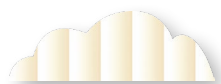
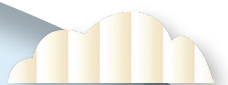
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About the report

The *Resilient Cities Index* was developed by Economist Impact and supported by Tokio Marine Group. To help policymakers and stakeholders understand risk and design effective policies for urban resilience, Economist Impact developed a benchmark of 25 cities. To gauge the resilience of these cities, we took measurements across four pillars: critical infrastructure, environment, socio-institutional and economic. This white paper combines index analysis with expert commentary to identify patterns, common strengths, deficits and best practices across index cities.

The index draws on work by institutions, scientists and researchers. Specifically, the project has benefited from counsel provided by a panel of experts who are prominent authorities on urban resilience. These include the following (listed alphabetically by surname):

- **Sachin Bhoite**, director, climate resilience, C40 Cities
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- **Gareth Morgan**, executive director of future planning and resilience, City of Cape Town
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- **Lavan Thiru**, executive director, Infrastructure Asia
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Our thanks and gratitude go to these individuals for their time and insights.

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Foreword

The world is facing unprecedented challenges. Extreme weather events, from hurricanes and wildfires to flooding and heatwaves, are becoming more frequent and their effects more devastating. Emerging risks like cyber-attacks loom larger as technology dependence deepens. Our cities are exposed to all of these risks and more. Lives and livelihoods depend on our ability to understand and mitigate the evolving threats to our urban centres.

There are three phases to resilience. Preparation and mitigation come first. Understanding the risks, how they are evolving and taking steps to minimise their impact is essential if cities are to avoid the worst. The second phase is response, necessitating swift reactions and timely assistance to save lives and diminish the impact when disasters occur. Last is recovery, emphasising the need to learn from tragedies and rebuild stronger, better-equipped communities for future shocks and stresses.

The *Resilient Cities Index* 2023 was sponsored by Tokio Marine Group to establish a research programme that will measure the resilience of societies and cities, identify the gaps and challenges and give insights into the opportunities and the way forward. We believe the Index will help to advance thinking on the topic of resilience while facilitating a constructive dialogue on what we can do to create a better tomorrow for all.

While the research provides a comparative analysis of 25 cities, it is all too easy to focus on the individual rankings and miss its true value. Cities face different challenges, due to their economic positions and geographic locations, and are at different stages on their resilience journey. It is therefore important to understand where gaps exist and how growth can be secured.

Tokio Marine Group is one of the largest and longest standing insurance groups in the world. Founded in 1879, it comprises a strategic collection of leading insurance businesses. We, at Tokio Marine Group, believe that dealing with emerging risks will require greater collaboration between industries, governments, academia, the non-profit sector and society as a whole. It is incumbent on our industry to work with commercial and governmental partners to strengthen cities both now and in the future.

We know the risks and will continue to work with our clients and partners to mitigate and overcome the unexpected to build a better society and a better tomorrow.



Executive summary

By 2050, cities will be home to more than two-thirds of the world’s population, placing them at the crux of humanity’s ability to adapt to the risks and uncertainties of the 21st century. Natural disasters from extreme weather to pandemics, and human catastrophes such as industrial accidents, terrorism and cyber-attacks, take their gravest toll on citizens in densely populated urban centres. Cities can also be flashpoints for instability and conflict due to poverty and inequality.

For the purpose of this research, Economist Impact defines urban resilience as a city’s ability to avoid, withstand and recover from shocks, such as natural disasters; and from long-term stresses such as poverty, decrepit infrastructure or migration. A resilient city should be able to self-organise following a shock event, adapt to unfolding risks and plan ahead rather than react.¹ “With the reality of climate change, resilience is not just about the ability to withstand or absorb disturbances but [is also about] being sustainable. It must not add to any future potential problems while serving its basic functions,” says Lavan Thiru, executive director at Infrastructure Asia.

Index scores: overall resilience

Score 0-100 where 100 = most resilient

1	New York	84.9
2	Los Angeles	84.4
3	London	83.2
4	Singapore	82.0
5	Paris	81.3
6	Melbourne	80.9
7	Amsterdam	79.9
8	Tokyo	79.6
9	Barcelona	79.0
10	Munich	78.6
11	Hong Kong	77.0
12	Warsaw	75.4
13	Dubai	69.5
14	Shanghai	69.4
15	Santiago	66.1
16	Istanbul	65.9
17	Mexico City	62.7
17	São Paulo	62.7
19	Cape Town	62.1
20	Bangkok	58.0
21	New Delhi	53.3
22	Jakarta	51.6
23	Cairo	44.7
24	Dhaka	43.0
25	Lagos	39.6

Key findings from the inaugural edition of the *Resilient Cities Index* include the following.

- **Cities performed well in the critical infrastructure pillar of the index, but there are some weak points that require strategic focus.** The cities with the highest scores were Dubai, Shanghai, New York and Singapore. These capital-rich market locations have greater opportunities to develop new infrastructure, compared with European cities constrained by decades- or centuries-old systems. Within this pillar, digital infrastructure and transportation were a drag on cities' resilience.
- **Cities that use data and technology to create operational efficiencies and share information with their citizens—i.e., smart cities—are better at dealing with shocks.** Patchy internet quality, which can impede access to digital services, pulled down the overall resilience score in the critical infrastructure pillar. Digital technologies and advanced data analytics can help to predict risks, optimise existing systems and keep the public informed. Greater digitalisation comes with risks, especially to critical infrastructure, but most cities in the index have built safeguards against this.
- **Most emerging economy cities lack adequate regulatory frameworks, strategies and incentives for future-proofing infrastructure.** Only a few cities in the index achieved high scores for future-proofing, which involves ensuring infrastructure preparedness for shocks while managing current and future emissions. One way cities can future-proof is by incentivising sustainable designs for buildings, such as installing green roofs, incorporating modularity and retrofitting for energy efficiency—a practice only found in high-income cities in the index.
- **Efforts to achieve environmental resilience are led by innovative solutions.** Cities are employing a variety of nature-based solutions to adapt to flooding and heat stress, from planting rooftop vegetation and mangrove forests (green infrastructure) to rehabilitating wetlands (blue infrastructure). Cities are also decarbonising by adopting renewable energy and negative emission technologies, such as carbon capture, storage and removal. However, the scalability of these technologies is likely to be challenging for resource-constrained emerging market cities.
- **Cities demonstrated poorer performance in the socio-institutional pillar, mostly due to income inequality and poor health and well-being metrics.** Only nine cities have a single, comprehensive plan to support vulnerable groups. However, one bright spot is that cities are promoting a culture of readiness to act in the event of a disaster. The majority of cities scored highly on this or are working to improve their readiness.
- **Cities had the lowest average scores in the economic pillar, dragging down some cities that performed well in other areas.** The low penetration of financial safety nets hinders safeguards against threats and undermines a city's ability to recover from shocks. Another aspect of economic resilience is a city's ability to incubate innovation, which can foster solutions to a range of problems, from congestion to water stress. Unfortunately, most cities scored poorly on the indicator for start-up ecosystems.

Introduction: The century of the city

Cities have long been celebrated as symbols of resilience, endurance and adaptability. They are often regarded as dynamic and progressive powerhouses, brimming with innovation and vitality. The promise of opportunity, in particular, continues to pull people towards urban centres. By 2050, the world's cities will be home to more than two-thirds of the global population.² With this in mind, it is critical for societies and governments to evaluate their risk management practices and build resilient cities that can withstand an uncertain future.

In 2023, the planet experienced the hottest three-month period on record,³ with unprecedented sea surface temperatures and extreme weather. Repeated heat waves hit urban tourist hotspots, harming people's health and disrupting their daily lives.⁴ China's temperature record was shattered, driving people to seek relief in bomb shelters. Elsewhere, the heavens opened. Exceptional monsoon rains washed away bridges and homes in northern India, shortly after New Delhi recorded its heaviest day of rainfall in more than 40 years. Hilary, the first tropical storm to strike California in 84 years, brought nearly a year's worth of rain to Los Angeles in a single day, causing widespread flooding.⁵ In September, Hong Kong was drenched by the heaviest rain since records began 140 years ago. Unrelated to climate change, cities were also battered by natural

disasters. Syria and Turkey are still reeling from the effects of an earthquake in February that killed nearly 60,000 people, prompting questions about urban resilience and the governance of building construction.⁶ The Russia-Ukraine war also continues to rage, with resulting increases in energy prices making households more vulnerable to energy poverty.⁷

The human toll of disasters in cities can be devastating, reflecting both their high population densities and their interdependent infrastructure. Poverty, inequality and urban sprawl also make cities potential flashpoints for social unrest and riots. "In every major metropolitan area in the world, the risk profile is just rapidly increasing, particularly in cities in developing countries," says Gareth Morgan, executive director of future planning and resilience for the City of Cape Town.

The *Resilient Cities Index* is a comprehensive evaluation of urban resilience that explores cities' preparedness to tackle shocks by examining their critical infrastructure, environment, socio-institutional dynamics and economy. Economist Impact's research captures the beginning of a move from theory to practice as cities start to implement plans to improve their preparedness and resilience. It also captures a growing focus on the relationship between resilience and sustainability. The research is not exhaustive, reflecting both the complexity and dynamics



of the urban system and the complex causal chain of indicators. Where possible, however, we have incorporated subsystems with close causal relationships into the same framework. For example, urban climate resilience is considered alongside carbon neutrality goals, infrastructure future-proofing and the electrification of transportation. We also recognise that aspects of the socio-institutional pillar play significant supporting roles for other indicators. For example, effective disaster management, which is an indicator in the environmental pillar, is co-dependent on the digitalisation of a municipality, a city's inclusiveness and its culture of readiness.

In the realm of urban planning and governance, the gap between policy and implementation will remain a significant challenge to cities' resilience. While cities around the world are recognising the need to build resilience in the face of growing environmental, social and economic uncertainties, translating intentions into action remains a formidable hurdle.

Chapter 1:

Critical infrastructure

A city's critical infrastructure—interpreted in this index as electricity, water, transportation, buildings and digital connectivity—needs to meet residents' everyday needs, withstand extreme events and support cities to bounce back after disasters.

Back-up or blackout

In the *Resilient Cities Index*, high-income Gulf and Asian cities were the top performers in the critical infrastructure pillar, with Dubai, Shanghai and Singapore taking three of the top four slots. This reflects several advantages, including the ability of capital-rich emerging economies to develop greenfield infrastructure, unlike European cities hobbled by decades- or centuries-old infrastructure. It also, in the case of Dubai and Singapore, reflects the benefits of a smaller geographic footprint.

The populous emerging economy cities of Lagos, Dhaka and Jakarta face the most significant challenges as they seek to deliver critical infrastructure for huge metropolitan populations across sprawling geographies. In some cases, efforts are further complicated by poor governance. Cities with high levels of corruption scored poorly on most aspects of critical infrastructure.

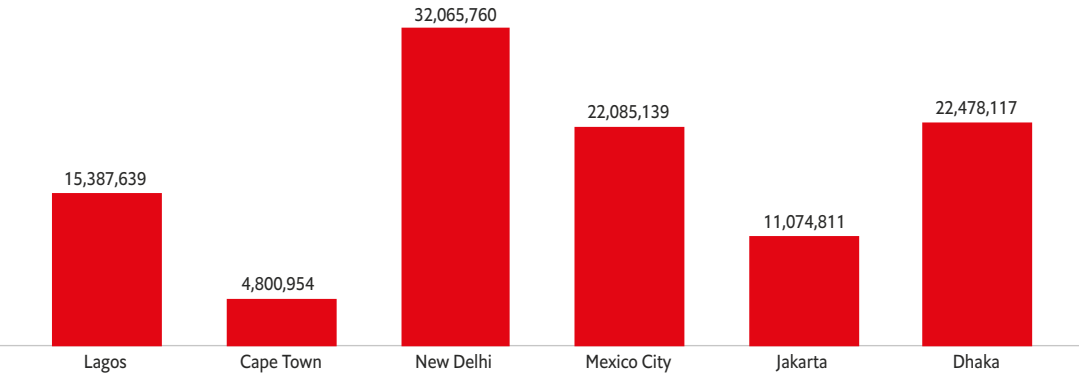
Decrepit grid infrastructure is exacerbating energy poverty in cities. Nearly 775m people in the world live without electricity, according to the International Energy Agency.⁸ Lower- and upper-middle-income cities, concentrated in Asia-Pacific, the Middle East and Africa, need to improve their electricity provision (see Figure 1). When responding to a crisis, outdated and fragile infrastructure can amplify the impacts of a disaster, as was evident in Puerto Rico in 2022. “The hurricane destroyed the electricity system and all the critical infrastructure it powered. There was no way to communicate or to provide energy, even the hospitals didn’t have backup generators,” notes Katrin Bruebach, global director of programmes and delivery at the Resilient Cities Network. Failure to modernise the electrical grid following the 2017 hurricane worsened the disaster’s outcomes.

Such events are not isolated to developing cities. Critical infrastructure has also failed in high-income cities, such as during Hurricane Sandy in New York, when power blackouts affected several hospitals, leading to the evacuation of 200 patients.⁹ Power providers do not sufficiently factor climate change into future planning, often failing to use materials that are temperature-resistant or to locate facilities in areas that are less likely to flood.¹⁰



Figure 1: Inadequate electricity provision brings cities to a halt

More than 107m people live in index cities with inadequate electricity provision, risking interruptions to their daily lives.



Note: The graph shows the population of cities that experience frequent to severe power outages and have relatively poor maintenance of the grid. Source: World Population Review, 2022, Economist Intelligence Unit (EIU) Liveability Index 2023 and Economist Impact, 2023

Another important aspect of resilience is the ability to learn from shock events and adapt accordingly. Some cities have become world leaders in preparedness and public communication following tragic experiences with natural hazards. The city of Christchurch in New Zealand, for example, learned painful lessons from an earthquake that destroyed its main water-supply pipeline. “They put a system in place that is able to keep the water supply running for six months if another earthquake hits,” says Ms Bruebach.

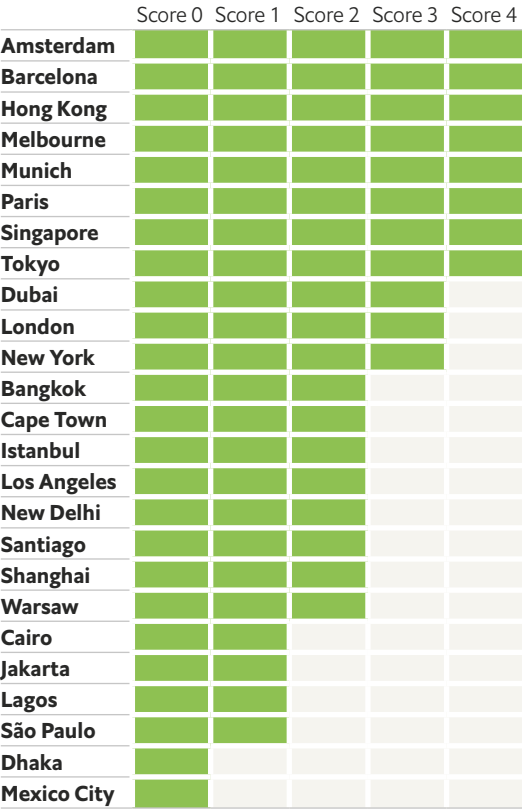
Connecting in a crisis

Urban mobility goes hand in hand with quality of life in cities. City governments across the world are investing in smart mobility solutions that will reduce journey times and congestion and improve air quality. The global smart mobility market is expected to grow annually at a rate of 20% from 2020 to 2027, reaching a value of US\$70.5bn by 2027.¹¹

During crises, transportation infrastructure is the most vital intermediary between victims and first responders. It facilitates response and recovery efforts, from the evacuation of victims to the delivery of supplies. However, most global cities are plagued by traffic congestion and only six of the 25 cities in the index have emergency services that can respond in under ten minutes.

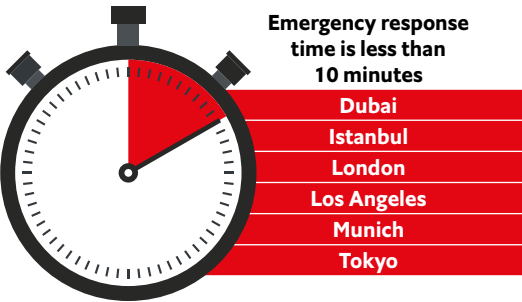
Figure 2: Good public transport eases everyday mobility for city-dwellers

High-income cities in Europe and Asia-Pacific lead the way in public transport quality.



Note: Scores from 0 to 4, where 4 is the highest quality of public transport. Source: EIU Liveability Index 2023 and Economist Impact, 2023

Figure 3: Only six index cities have emergency services which can respond in under ten minutes



Source: Economist Impact, 2023

Forty percent of cities in the index have not leveraged intelligent traffic management technologies to help manage congestion and optimise transportation infrastructure—for example, ensuring the efficient passage of emergency vehicles by synchronising traffic lights. There is also room to improve the efficiency of public transport, which would reduce emissions and provide an opportunity to lessen social inequality. More than half of the cities in the index (56%) have inefficient public transport systems, with outdated networks, irregular services and regular overcrowding. In New York, passengers wait a cumulative average of 64 minutes on platforms each month due to train delays.¹²

Digital infrastructure is another important aspect of critical infrastructure (as well as socio-institutional resilience) as local authorities increasingly rely on digital technology to deliver essential services. Most cities in the index performed well overall on the indicator for e-government services, such as applying online for identification cards, filing taxes online and finding information online about government schemes for residents, with an average score of 68.8 (where 100 denotes most resilient). The flow of information must run both ways though, with the public providing real-time updates during a crisis. Cities are racing to expand their 5G connections to improve internet speed, which will support digital infrastructure resilience.

As the world becomes increasingly connected, however, the number and severity of cyber-threats continue to grow.¹³ Cyberattacks on government agencies increased by 95% over the course of a single year (2021-22)¹⁴ and major security flaws could affect flood defences, radiation detection and traffic monitoring.¹⁵ Cities in the index scored well for cybersecurity preparedness, with 19 scoring 75 or above, indicating high levels of preparedness and awareness. Top performers (Dubai, Los Angeles, New York and Singapore) have advanced technical barriers, such as tools to monitor network security, detect intrusions and identify

Figure 4: Cybersecurity preparedness for a future-ready digital city

Cairo's relatively strong performance presents opportunities for other low-income cities to improve their preparedness against cyber-attacks.

	Score 1	Score 2	Score 3	Score 4
Dubai				
Los Angeles				
New York				
Singapore				
Amsterdam				
Barcelona				
Cairo				
Cape Town				
Istanbul				
Jakarta				
London				
Melbourne				
Munich				
Paris				
Santiago				
São Paulo				
Shanghai				
Tokyo				
Warsaw				
Bangkok				
Dhaka				
Hong Kong				
Lagos				
Mexico City				
New Delhi				

Note: Scores from 0 to 4, where 4 is the highest level of cybersecurity preparedness.
Source: EIU Risk Tool and Economist Impact, 2023

security vulnerabilities, on top of efforts to protect key infrastructure. Some lower- and upper-middle-income cities such as Cairo, Jakarta and São Paulo have taken the lead in building cybersecurity capabilities (see Figure 4). Cairo’s preparedness is driven by a national level task force that protects specific sectors such as telecommunications from cyber threats. This national task force also collaborates with educational institutions to provide cybersecurity training and certify talent.¹⁶

Cities must adapt to what they can’t avoid

Infrastructure accounts for 79% of all greenhouse gas emissions and is central to decarbonisation strategies.¹⁷ Future-proofing infrastructure—which involves developing regulatory frameworks, policies and strategies for flexible, adaptable and sustainable infrastructure—can reduce emissions while preparing for the impacts of climate change. To date, cities have deployed a range of innovative solutions (see Figure 5).^{18,19}

Future-proofing and retrofitting legacy structures with climate-friendly technology can be expensive and requires significant planning to support efficient operation for years to come.²⁰ For instance, switching to more efficient heat pumps is proving difficult in cities with older housing and gas boilers, as installation needs to be supported with extra insulation and

requires outdoor space.²¹ For older houses, this would mean lifting floorboards to line walls with insulation or investing in thicker external insulation.

City decision-makers can take steps to help embed resilience in both existing and new buildings. New York City provides a one-year tax abatement for the construction of a green roof that covers 50% of eligible space on residential and commercial buildings in the city. A recent mapping exercise revealed that green roofs cover less than 1% of New York City’s one million buildings, however, leaving a substantial opportunity for expansion.²²

Building designs should also be functional, enduring and easy to replace to limit costs, waste and emissions. Valued at US\$91bn in 2022, the global modular construction market is expected to grow to US\$120.4bn by 2027.²³ Some cities are developing policies to support the future-proofing of buildings. For example, Melbourne’s Design and Construction Standards require all designs to consider long-term life-cycle implications and future renewal opportunities.²⁴

Cities must also future-proof their transport infrastructure—for example, through rapid electrification. Tough emissions regulations have helped spur electric vehicle adoption, and cities will need to scramble to build supporting

Figure 5: Climate-resilient designs for buildings

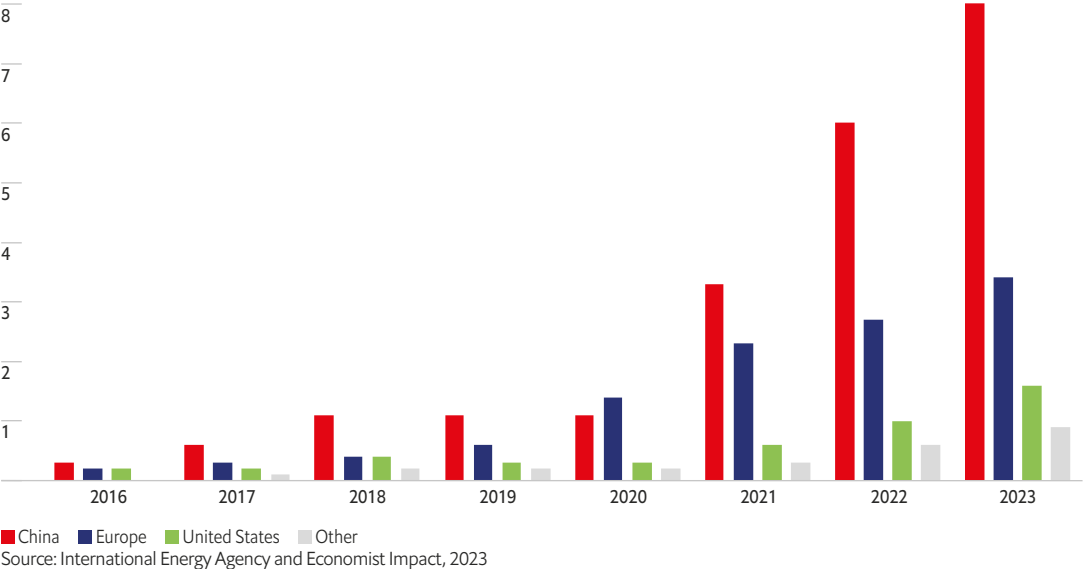
Risk	Design
Heat stress	<div>1. Incorporate green roofs and green corridor networks to cool buildings and provide shade (e.g., Singapore)</div> <div>2. Use reflective surfaces to reduce the temperature of buildings (e.g., Ahmedabad)</div> <div>3. Use insulation in the walls and double-glazed windows to prevent heat transfer (e.g., London)</div> <div>4. Control the height of buildings in key places to enhance ventilation (e.g., Shanghai)</div> <div>5. Replace vegetation with plants suited to warm climates (e.g., Barcelona)</div>
Coastal flooding and sea-level rise	<div>1. Use mangrove forests to protect against coastal flooding (e.g., Ho Chi Minh)</div> <div>2. Enhance natural drainage corridors that convey, store and filter runoff precipitation and stormwater, including streams, ponds and wetlands (e.g., New York)</div> <div>3. Use artificial barriers to help protect against flooding (e.g., Rotterdam’s Maeslant barrier)</div>

Source: United Nations Environment Programme, C40 Cities Knowledge Hub and Economist Impact, 2023

infrastructure. Worldwide, new policies are supporting this shift too. A draft law approved by the EU in February could see a total ban on new internal combustion engine (ICE) cars by 2035, and China is demanding that new energy vehicles account for 20% of cars by 2025, with a full switch from ICE vehicles by 2035.

China is already home to 13 of the top 25 “electric vehicle capitals”, as described by the International Council on Clean Transportation.²⁵ Some of our index cities are also in this category, including Tokyo, Paris, London, Amsterdam, Los Angeles and New York. Dhaka is the only city in the index that does not have a plan to promote transport electrification.

Figure 6: Electric take-off
Electric car sales 2016-2023, m



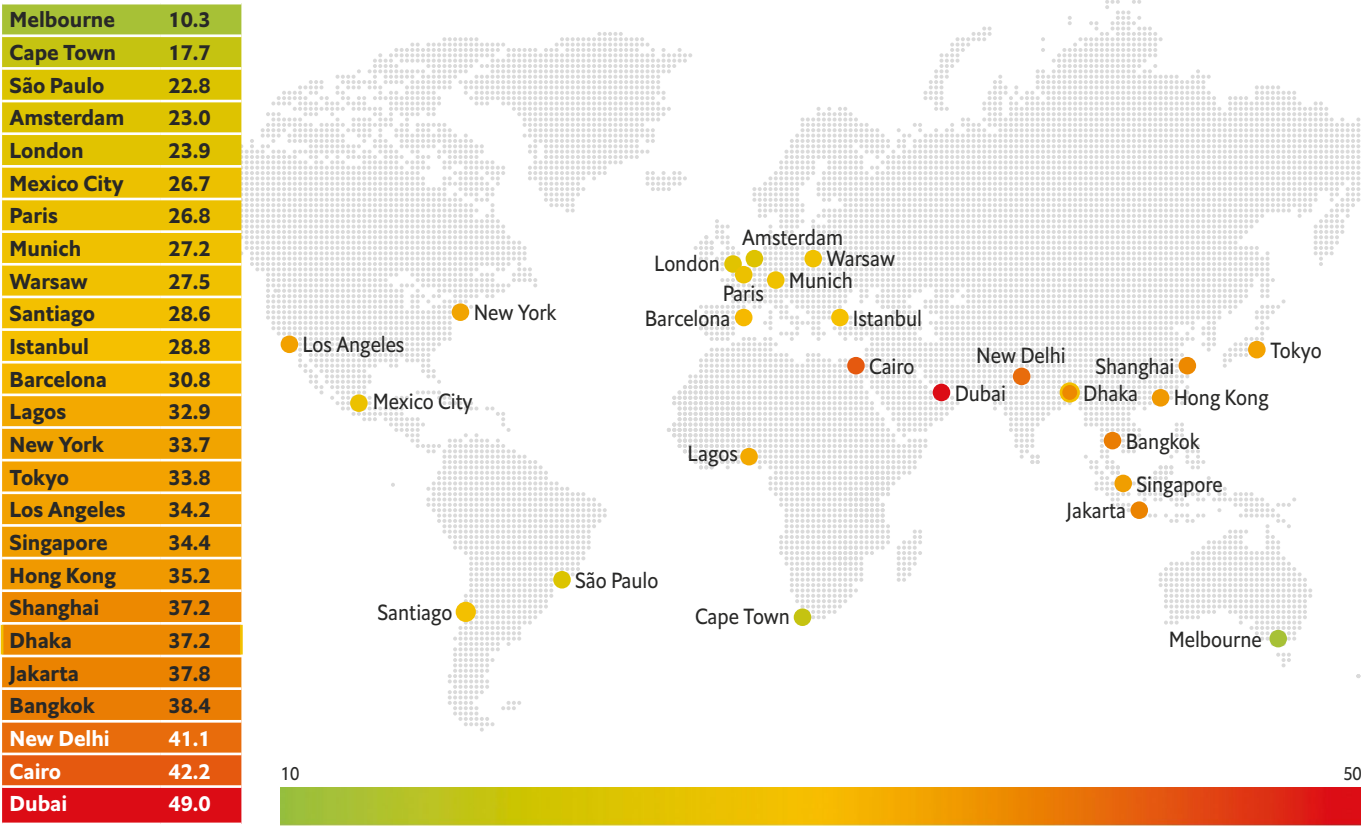
Chapter 2: Environment

Cities are at the mercy of natural forces. The index measures urban environment resilience across six indicators: flooding, heat stress, air pollution, disaster management, decarbonisation and waste management. These reflect the degree of risk that cities are exposed to and the extent to which they are readying themselves for future changes.

Responding to extreme heat

Cities must prepare and be redesigned for a future of deadly heat. Between June and September this year, nearly half of the global population experienced at least 30 days of higher temperatures, made three times more likely by human-caused climate change.²⁶ Very

Figure 7: Heat stress projection for 2030



Note: The Universal Thermal Climate Index (UTCI), measured in °C, is a bioclimatic index describing physiological comfort for the human body under specific meteorological conditions. Heat stress is measured based on the UTCI magnitude, which represents the average daily maximum UTCI values during the hottest month of the year (July for cities in the northern hemisphere and January for cities in the southern hemisphere). UTCI values are divided into 5 classes of heat stress: no thermal stress (9°C-26°C), moderate heat stress (26°C-32°C), strong heat stress (32°C-38°C), very strong heat stress (38°C-46°C) and extreme heat stress (>46°C). The projection for the 2030 period corresponds to the average value between the years 2021 and 2040.

Source: Lobelia Earth and Economist Impact, 2023

few cities are safe from heat waves in a warming world. Much of the Mediterranean sweltered in temperatures exceeding 40°C, extending from Madrid to Cairo, where the government was forced to schedule power cuts as heatwaves strained the national grid. “This is a completely new experience to think about going forward because it’s going to happen a lot more,” says Professor Christine Loh, chief development strategist at the Institute for Environment at Hong Kong University of Science and Technology.

Rising temperatures drive frequent and longer heat waves, heightened in cities due to the heat island effect, where man-made structures and materials absorb and re-emit solar radiation, making day-time temperatures several degrees higher.²⁷ Hotter, more humid conditions can have dire health consequences, including heat stroke, heat exhaustion, dehydration and respiratory problems. Children, pregnant women, the elderly and outdoor workers are the most vulnerable to these effects.²⁸

Cities appear to be responding to this risk. The majority of cities in the index (20) have a detailed heat plan or have aligned their planning with expected heat stress challenges. Cities that do not have heat plans are in emerging markets.

Heat stress strategies range from adapting infrastructure to appointing personnel, such as chief heat officers. From Miami to Melbourne, Dhaka to Athens, a growing number of cities have chief heat officers²⁹ who co-ordinate the emergency response to heatwaves (such as establishing cooling centres and distributing water) and plan adaptive measures.³⁰

Structural interventions to lower urban temperatures include maximising green space and building artificial shade. Cooling Singapore, a research project supported by local research institutions and the Prime Minister’s Office, has developed a roadmap to tackle urban heat by incorporating more vegetation, adding water features that act as cool sinks, and building permanent and movable shade structures.³¹

Successful solutions should start by identifying who is most vulnerable to and at the highest risk of extreme heat. This is particularly the case in developing cities, which are often resource constrained and where a lack of cooling makes heat all the more deadly. “In the last couple of years, we are seeing more conversations, especially from cities in the developing world, in terms of which are the communities that are most impacted by risks,” says Ms Bruebach.

Cooling Melbourne: Open data for citizen support

According to Tiffany Crawford, co-director of the City of Melbourne’s Climate Change and City Resilience Branch, the annual average number of days where Melbourne experiences temperatures higher than 35°C is expected to increase from 11 days to 16 days by 2050.

Melbourne, one of three cities to attain maximum scores for its social protection measures, is focusing on the intersection between resilience, risk and social inequality with the use of open data. Its heatwave and homelessness programme provides vulnerable people with access to climate shelters and services that offer respite from extreme heat.³²

The programme uses publicly available data and relies on coordination between government agencies to ensure data sets are collected and analysed effectively. The benefits of robust mapping are clear. According to a recent survey, just 19% of Melbourne residents leave their home during periods of extreme heat, rising to 45% for those living in public housing.

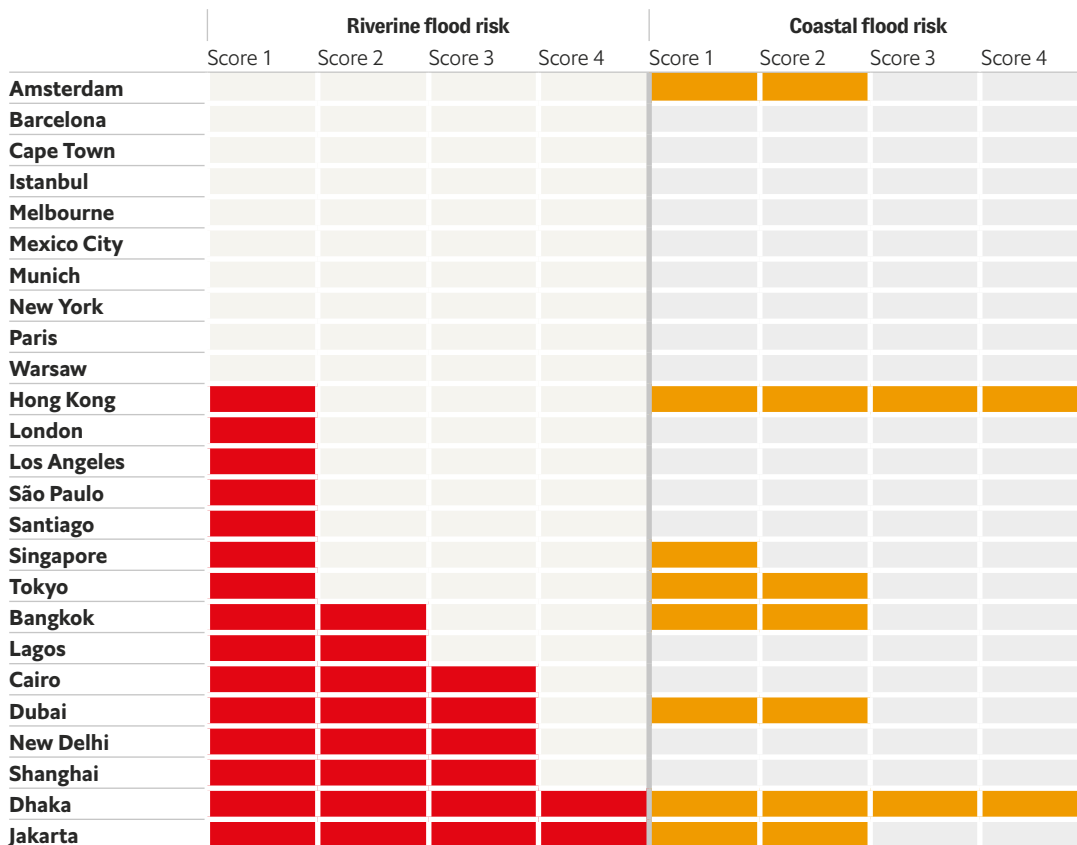
Managing and mitigating

Globally, 1.81bn people—one in every four—live in high-risk flood zones.³³ Exposure is severe in densely populated and quickly urbanising river plains and coastlines in developing countries, where 89% of the world's flood-exposed people live.³⁴ The damage wrought by flooding directly affects assets and lives. Flooding also poses longer-term public health risks. Stagnant bodies of water, for example, can provide breeding grounds for waterborne and vector-borne diseases.³⁵ In the index, most lower-income cities performed poorly for riverine flood risk, especially Dhaka and Jakarta.

“Today, infrastructure projects must incorporate nature-based solutions, such as green roofs and natural drainage systems that can enhance resilience and sustainability by improving water management, reducing flooding and providing additional ecosystem services,” says Mr Thiru. Blue interventions that capture and store rainwater, such as wetlands, rivers and canals, are also critical.³⁶ Policies and initiatives across index cities include permeable and green roofing to improve water retention (Amsterdam and Barcelona), wetlands rehabilitation and sewer network upgrades (Cape Town) and the promotion and use of stormwater storage tanks (Hong Kong).

Figure 8: High riverine and coastal flood risk threatens to erode middle-income cities

The majority of the most flood-vulnerable cities are lower- and upper-middle-income cities in Asia-Pacific, such as Bangkok, Dhaka and Jakarta.



Note: Riverine and coastal flood risk is measured by the percentage of the population expected to be affected by riverine flooding in an average year; 4 is the highest risk level.

Source: Aqueduct Water Risk Atlas and Economist Impact, 2023

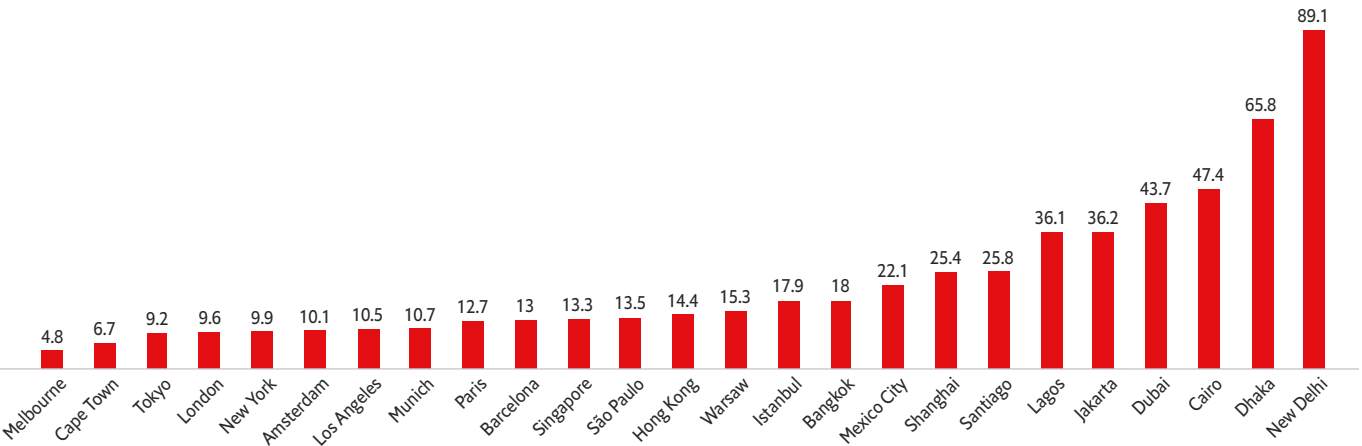
The cost of clean air

Poor air quality damages people’s health, causing issues like cardiovascular and respiratory disease, dementia and cancer. Nine in ten people in urban areas breathe polluted air.³⁷ Dhaka and New Delhi prove to be the least resilient to air pollution in the index, which kills 7m people globally each year.³⁸

Measuring air pollution has become easier thanks to low-cost sensors that track trends over time, enabling decision-makers to identify hotspots. These are now in use in cities as diverse as Addis Ababa, Denver, Paris, Portland and Quezon City.³⁹ Cities are increasingly partnering with technology firms, universities and research institutes to help monitor air pollution.^{40,41}

Figure 9: Poor air quality continues to clog cities

Even the top-performing cities continue to face unhealthy air quality levels in specific regions or at certain times of the year.



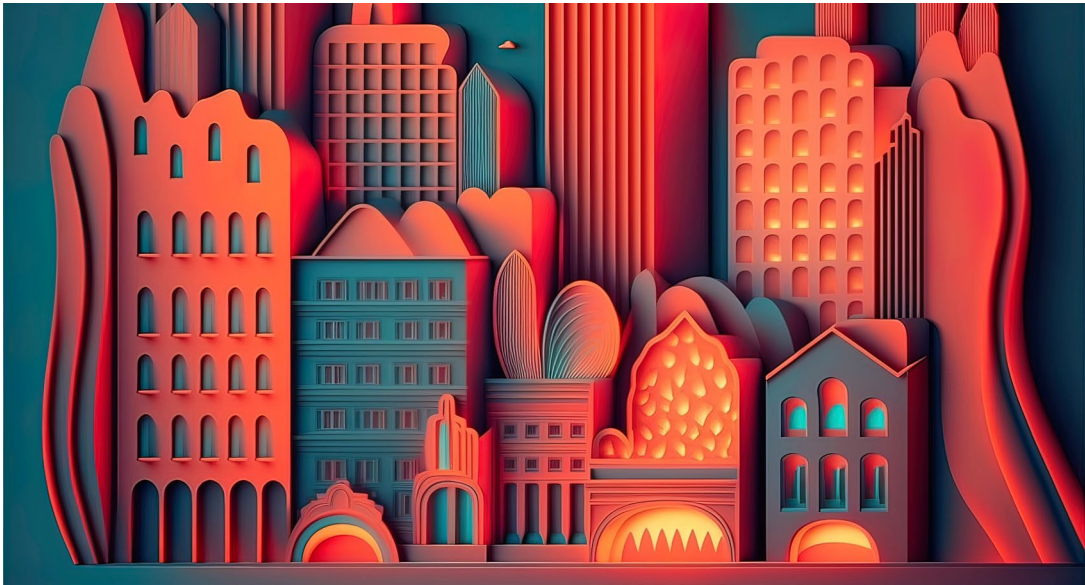
Note: Air quality is the average PM2.5 concentration, measured in µg/m³. A higher number denotes greater air pollution.
Source: IQAir, 2022 and Economist Impact, 2023

Breathe London: pulling in pollution

London has come a long way since the Great Smog shrouded the capital in 1952, killing thousands.⁴² However, it is still badly polluted. Cancer, asthma and lung disease associated with high concentrations of nitrogen oxide and small particulates kill an estimated 4,000 Londoners every year, according to a study conducted by Imperial College in 2021.⁴³ In response, the capital has employed different tactics to clean its air.

Breathe London is an air quality community-sensing network that observes air quality in nearly 350 locations across the city, with priority given to schools, hospitals, museums, cultural institutions and locations chosen by communities. The network is expected to support cutting-edge research and raise public awareness.⁴⁴

Other efforts are more punitive, such as the pollution charge targeting older diesel vehicles, which tend to create more harmful concentrations of nitrogen dioxide than petrol-fuelled cars. The pollution charge helped to cut the concentration of nitrogen oxide in central London by over a quarter between 2019 and 2021.⁴⁵



Fair warning

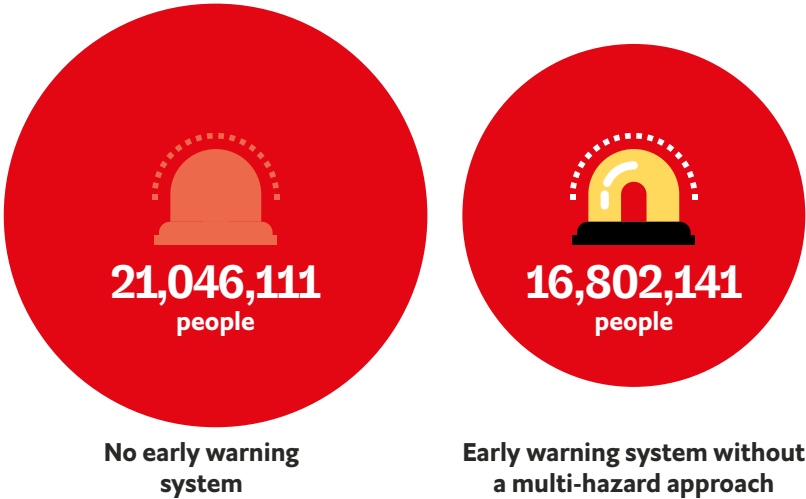
Over the past 50 years (1970-2019), a weather-, climate- or water-related disaster has occurred every day, on average, taking the lives of 115 people and causing US\$202m in losses each day.⁴⁶ Cities need to provide advance notice

of impending disasters like storms, floods and earthquakes through early warning systems (EWS), giving residents sufficient time to act.

Early warning works. Providing 24 hours' warning of a coming storm or heatwave can cut the ensuing damage by a third. Spending US\$800m on such systems in developing countries could avoid losses of US\$3bn to US\$16bn a year, according to the Global Commission on Adaptation.⁴⁷ Despite the clear need for EWS, one in three people globally are not covered by such a system, with the most vulnerable disproportionately affected. Furthermore, half of countries worldwide do not have an operational multi-hazard EWS, and even fewer have the necessary legislation to connect these systems to emergency and response plans.⁴⁸ However, the value of such systems lies not just in building them, but also in their maintenance; failed warnings led to large numbers of fatalities during western Europe's floods in 2021.⁴⁹ In 2022, United Nations secretary-general António Guterres called for a global effort to ensure that EWS protect everyone on Earth by 2027.

EWS can take various forms, but social media, telephone hotlines, smartphone apps, radio, TV and text messages are the most obvious and

Figure 10: Alarming absence of early warning systems
One in three people globally are not covered by an early warning system. More than 20m people live in index cities (representing a population the size of Sri Lanka) that are not covered by any early warning system, heightening exposure to increasingly common disaster risks.



Source: World Population Review, 2022 and Economist Impact, 2023

effective means. Connectivity and coverage vary wildly, however, particularly in rural areas in developing countries, where church bells, loudspeakers and sirens are used as backup methods of communication.⁵⁰ Among cities in the index, only Amsterdam, Barcelona, Istanbul and Lagos do not have EWS with multi-hazard approaches. Common hazard-monitoring deficits in the index group include hazard-monitoring systems that are limited to a specific risk, rather than multiple hazards.

One of the top performers, Tokyo, is leveraging the latest technology to improve its early warning capabilities. J-Alert, Japan's EWS, relies on satellite technology to transmit critical information in seconds to all municipalities before and after a disaster.^{51,52} The country has also been experimenting with drones to provide early

warning and disaster relief through enhanced monitoring.^{53,54} As an example, solar-powered smart sensors in rivers help to detect flood risk.⁵⁵ During the Kumamoto earthquake in 2016, local response teams were able to act immediately thanks to damage estimates, including population exposure, shared by a real-time earthquake estimation system.⁵⁶ To understand future earthquake risk, the Japan Meteorological Agency also has an earthquake EWS that uses artificial intelligence (AI) to assess seismic data patterns. Hong Kong has also adopted best practices. Its EWS consists of signals that give a ranking based on a storm's distance, using scientific criteria, says Professor Loh. "If you're living in Hong Kong, everybody understands the system ... we're so acculturated to this long-standing system that is backed by science," she adds.

Decarbonisation pathways: from net-zero targets to real action

The race to net zero is picking up momentum as countries aim to reach carbon neutrality by mid-century. However, real action is lacking. Most index cities (76%) have a net-zero target, but many lack detailed action plans that are critical to developing net-zero pathways. Furthermore, most continue to rely heavily on fossil fuels to meet electricity demands. Indeed, all but two cities in the index (São Paulo and Santiago) are in countries that generate less than half of their electricity from renewables. While significant drops in the price of producing renewables provide the opportunity to transition, weak governance, poorly targeted subsidies and high capital costs are hindering progress.⁵⁷

Cities are also exploring ways to remove carbon from the atmosphere in their net-zero plans. This can be done through nature-based solutions, such as afforestation and reforestation, or through technology-driven solutions. Sixteen cities in our index are considering carbon removal—a technology-driven solution. However, nature-based solutions are more scalable, given that carbon capture, utilisation and storage technologies are relatively nascent and will require significant research and development (R&D) and feasibility assessments before being implemented at scale.

Chapter 3:

Socio-institutional

Urban resilience is strongly influenced by social and institutional dynamics, including the inclusivity of, access to and trust in government information, as well as broader health and well-being factors. The index’s socio-institutional pillar measures indicators including digital government platforms, crime and safety, income inequality and social protection. Together, these can affect the degree to which a society can withstand disaster and bounce back.

Social cohesion under strain

Inequality is a significant consideration when assessing a city’s resilience. The unequal distribution of income and resources undermines the well-being of marginalised groups and limits a city’s capacity to respond to and recover from a disaster. More vulnerable urban residents, particularly in developing countries, tend to be clustered in neighbourhoods with the least mobility, work and educational opportunities, the poorest access to health services and below average health outcomes.⁵⁸ During the covid-19 pandemic, structural inequalities accelerated the spread of the virus and, in some cases, overwhelmed health facilities due to a highly uneven distribution of risk.

The elderly are particularly vulnerable to extreme weather events and heat waves, partly due to susceptibility, but also as a result of low incomes, social isolation, ill health, lower personal mobility and poor living conditions. Some of our index cities, such as Tokyo, Munich, Paris, Hong Kong, Amsterdam and Barcelona, have older populations, with more than 20% aged 65 and above. Their plight is a concern, given that the number of people over the age of 65 is expected to double to 1.6bn by 2050.⁵⁹

“People with fewer resources, or who have underlying health conditions, or who live and work in any number of adverse circumstances will see worse outcomes from any shock or disruption,” says Fiona Twycross, the Mayor of London’s deputy mayor for fire and resilience. “If you’re poor, you

Figure 11: Integrating the vulnerable for collective well-being

Cities that performed well on this indicator have schemes that clearly identify and target vulnerable populations, regardless of income levels.

	Score 0	Score 1	Score 2
Amsterdam			
Barcelona			
Cape Town			
Dhaka			
Istanbul			
London			
Melbourne			
Paris			
Warsaw			
Bangkok			
Dubai			
Hong Kong			
Los Angeles			
Mexico City			
Munich			
New Delhi			
New York			
São Paulo			
Singapore			
Tokyo			
Cairo			
Jakarta			
Lagos			
Santiago			
Shanghai			

Note: Scores from 0 to 2, where 2 is the highest level of vulnerable group integration.
Source: Economist Impact, 2023

can't move away from flood risk. If you rent, you can't necessarily make changes to your home to make it safer. If you're isolated, you are less likely to survive a heatwave. That is why the Greater London Authority targets local funding and other support towards people who need it the most – building a better, fairer and safer London for all.”

Cities that performed well on the inclusion indicator have specific schemes and city-level plans to support vulnerable groups, including the young, the elderly and refugees. This can strengthen the social fabric, networks and institutional architecture needed to ensure an effective response during and after emergencies.

Under my umbrella: navigating the challenges of social safety nets

Social safety nets encompass a range of policies and initiatives that protect individuals, households and businesses from exposure to risks, shocks and disasters. These include unemployment benefits, food assistance programmes, pensions for old age, healthcare, housing aid and insurance.

Protecting everyone, particularly the vulnerable, remains a daunting task for many cities, however. A big challenge in emerging cities is identifying those who need protection. This challenge is exacerbated in places with a substantial informal sector, due to a lack of income documentation.⁶⁰ In some cities, governments have collaborated with non-governmental organisations and local community groups to fill these data gaps.

Lack of awareness is another challenge. In developing countries such as India, limited awareness of social safety nets, such as health insurance, may result in low uptake, even when offered at subsidised rates by the government.⁶¹ Our index revealed that in emerging economies like Dhaka, Jakarta, New Delhi and Lagos, over 70% of the population lack coverage by even a single social protection benefit.

Other optional safety nets, such as insurance, are a harder sell, particularly in low-income markets. The decade preceding 2020 was the costliest for natural, weather-related disasters, but the protection gap is widening with an underinvestment in climate-risk protection.⁶² Insurance can help to transfer and mitigate risk, but it also plays a role in risk awareness. The index suggests that cities are underusing this financial mechanism, which has been identified as a cornerstone of recovery.

Developing comprehensive social safety nets requires inter-departmental collaboration to ensure a co-ordinated approach to service delivery and adequate outreach, especially to vulnerable communities. Countries like Kazakhstan are taking steps to improve accessibility. During the pandemic, informal workers in the country were provided with online access to a one-time cash grant application, which received 5m applications.⁶³

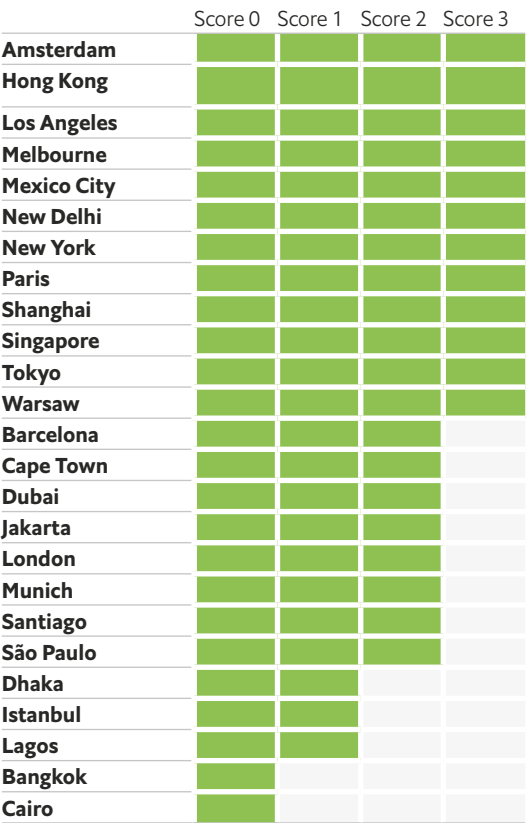
Be prepared

Experts argue that resilience requires broad consensus and public buy-in to create a strong culture of preparedness—a crucial aspect of risk management. In the majority of cities, readiness is nurtured through educational awareness and media campaigns, with high performers including comprehensive and detailed information. “A big part of resilience readiness involves education and dealing with risk reduction, which starts from kindergarten,” explains Professor Rajib Shaw from Graduate School of Media and Governance, Keio University. “[It’s about] how you bring risk reduction into the mindset of people from a very early age in a way that is replicable in other parts of the world.”

A culture of preparedness is critical to Japan’s success in disaster resilience. “Japan’s strength to tackle a disaster is not only its technology but also its people. The culture of preparedness, rooted in Japanese society, is the reason behind Japan’s success in tackling many disasters,” says Mr Shaw. New Delhi is also proactive in preparing its residents. The Delhi Disaster Management Authority conducts awareness campaigns across media channels, runs mock drills, and provides measures for safe action before, during and after events such as fires, floods and earthquakes.⁶⁴

Figure 12: A culture of readiness prepares a population to act

The culture of readiness in lower-middle-income cities varies. New Delhi demonstrates that progress is possible for these cities.



Note: Scores from 0 to 3, where 3 is the highest level of readiness. Source: Economist Impact, 2023

Community-powered: how inclusion strengthens resilience

Cities can only achieve “deep resilience”—a foundation of preparedness that applies to multiple risk scenarios—through an inclusive approach. “A resilience strategy is not something developed at a desk by a city official,” says Katrin Bruebach, global director of programmes and delivery at the Resilient Cities Network. “Cities need to bring a variety of stakeholders together around the table, including community representation and the poor and vulnerable. Depending on the kind of shock and stress, listening to the voices of the people most affected is important.”

If an early warning is issued in the Japanese city of Kobe for a disaster such as an earthquake or typhoon, schools become resilience hubs for residents living within 2 km. There are 191 elementary schools that function as evacuation centres, storage facilities for emergency goods (such as blankets and food) and sites for community drills and practices. The city formalised this approach with elementary schools through committees, grants from local government and engagement with emergency services.

Chapter 4:

Economic

Cities are engines for economic growth, and access to opportunity has been the dominant driver of growing urban migration over the last half century. But urban economies face a number of risks, such as overreliance on a small number of economic sectors, which can lead to precipitous declines and/or inequality, leaving cities unable to bounce back from disasters. The index assesses economic resilience across four indicators: economic robustness, exposure and risk, innovation and entrepreneurship, and human capital.

No economy is an island

There has been no shortage of macroeconomic shocks in recent years, including an economic slowdown led by the pandemic, disruption to the spread of new technologies due to geopolitical tensions between the United States and China, and rising energy prices worsened by war in Ukraine. Economies everywhere have felt the brunt of these shocks, but some have recovered faster than others. Our index measures economic exposure through fluctuations in a city's GDP.

A city's ability to recover depends on the extent to which its economy is exposed to global markets and the stability of its local economy to redirect financing to rebuilding.⁶⁵ Since the late 19th century, globalisation has created intricate dependencies on external goods and services, with global trade reaching a record US\$28.5trn in 2021.⁶⁶ Without the diversification of supplier bases, these dependencies translate into greater exposure to macroeconomic shocks that can hinder access to necessities such as food and energy. For Singapore, which imports 90% of its food, diversification proved crucial in ensuring food security during the pandemic.⁶⁷

Innovating a pathway to long-term resilience

Turning cities' climate and resilience goals into action will require significant innovation, which in turn requires stable business environments. Markers of a favourable business environment include streamlined bureaucratic processes, efficient regulations and clear property rights. The index found a generally conducive business environment across the group, with countries averaging a score of 66.3 (out of a score of 100). However, significant progress needs to be made in terms of climate innovation, with almost half of the emission reductions required by mid-century dependent on innovations that are not yet in the market.⁶⁸ The rise in cyber-threats also reveals a US\$2trn opportunity for cybersecurity technologies and services.

Cities with innovative ecosystems provide opportunities to close these gaps. In our index, New York, London and Los Angeles received the top scores for the indicator measuring innovative business ecosystems (which looks at patents filed and R&D expenditure). In 2022, climate start-ups in the United States raised US\$20bn, and enthusiasm for the sector remains intact despite a tough market.⁶⁹ New York has prioritised entrepreneurship and innovation in its latest sustainability plan. For instance, the city plans to connect industry with existing grants to explore low-carbon construction materials and methods.⁷⁰

Emerging economy cities like Shanghai and New Delhi outperformed the majority of high-income Western cities on this indicator. Shanghai has become a global innovation epicentre in domains such as AI, robotics, chips and medicine as part of a strategic push in China's 13th Five Year Plan.⁷¹

New Delhi is also expected to be at the forefront of innovation, with AI and machine learning (ML) forecast to contribute up to US\$1trn to the economy by 2035.⁷²

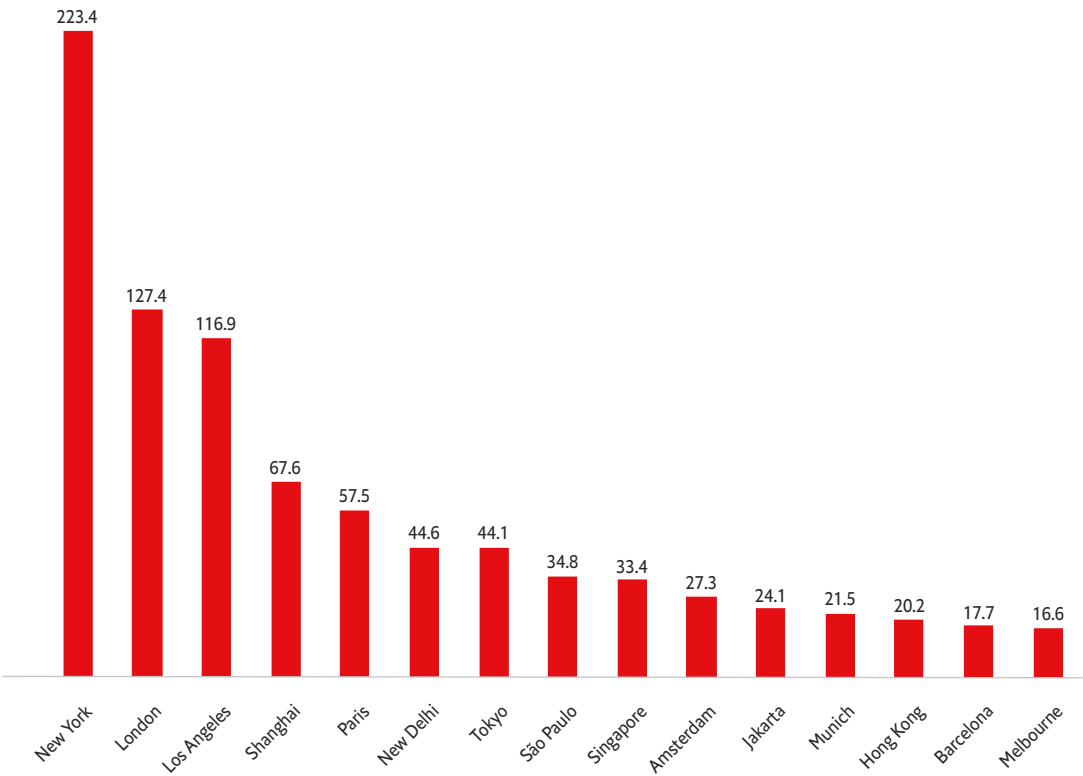
In addition to supporting business innovation, governments need to adopt new technologies to achieve resilience. For example, cities can use advanced data analytics and ML to model and predict the impact of natural disasters or other disruptions. This helps with planning evacuation routes, resource allocation and emergency response strategies, according to Mr Thiru. Ultimately, however, these analytics need to serve a clear purpose. “Flooding is easy [to predict], you know where water goes when a river floods. But how do we define communities at higher risk like the elderly?” says Ms Bruebach.

Resilient workforce, resilient economy

Human capital encompasses a population’s knowledge, skills and health. It is critical to economic productivity, integral to driving inclusive urban growth and a crucial resource for cities as they recover from shocks. A highly skilled and educated workforce fosters innovation and productivity, enabling better economic navigation. Human capital also fuels entrepreneurship, attracts investment and supports institutions in shaping effective policies. A healthy workforce adds an extra layer of resilience, ensuring productivity during economically challenging times.

Figure 13: Incentivising innovation

There is a need to bridge the wide gap between the top three cities and other cities to level the playing field in creating an innovation ecosystem.



Note: This graph presents scores of the top 15 cities. Scores range from 0 to 250, where 250 is the highest score for an innovation ecosystem.
Source: Startup Ecosystem Report 2023 and Economist Impact, 2023

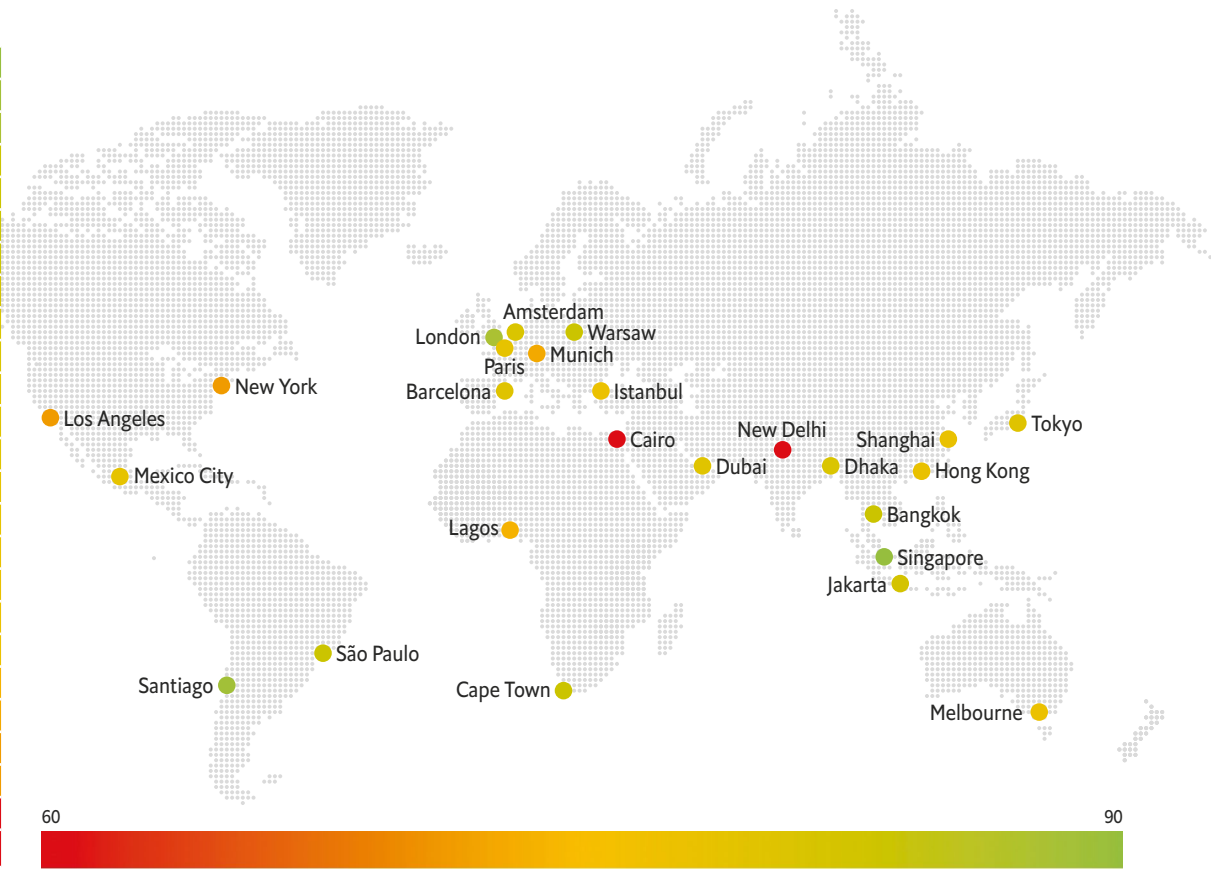
The index measures human capital by looking at levels of advanced education among a city’s workforce. James Simmie, professor of innovation studies at Oxford Brookes University, says, “When we talk about human capital and its link to economic resilience, the key variable is the quality of this human capital and this can be measured in terms of the proportion of graduates in the workforce or the level of education of the workforce.”

The top performer on this indicator was Singapore, where close to 90% of the population possess an advanced education. The city-state has also prioritised reskilling and upskilling based on industry needs. Through close collaboration with businesses, the government has gained valuable insights into the skills and qualifications in demand, enabling the creation of a highly skilled talent pool and further enhancing its attractiveness to new companies.⁷³

Figure 14: Educated workforce—a resilience booster

Three South-East Asian cities (Singapore, Bangkok and Jakarta) are in the top ten for this indicator, driven by advanced education of their populations.

Singapore	86.2
Santiago	85.1
London	84.5
São Paulo	81.9
Cape Town	81.4
Warsaw	81.1
Bangkok	81.1
Jakarta	80.4
Dhaka	79.6
Amsterdam	79.4
Barcelona	78.7
Tokyo	78.6
Dubai	78.4
Mexico City	77.4
Paris	77.4
Hong Kong	77.1
Shanghai	77.0
Melbourne	76.6
Istanbul	76.5
Lagos	73.6
Munich	72.9
Los Angeles	71.9
New York	71.9
Cairo	63.7
New Delhi	63.5



Note: Percentage of total working-age population with advanced education in a country.
Source: World Bank, World Development Indicators, 2022 and Economist Impact, 2023

Conclusion: Resilience in motion

A resilient city is not only prepared for shocks but has the ability to bounce back and thrive. Recognising both existing and looming threats will help cities better understand their vulnerabilities and design targeted actions. However, building such cities requires stakeholders from government, businesses and communities, as well as individual city-dwellers, to engage in holistic resilience thinking at community and municipality levels.

Cities that consistently topped the index across all four pillars have lessons for other cities to consider, but they also have vulnerabilities that can undermine urban resilience. The report provides examples of how cities of all income levels and sizes have leveraged a variety of methods and interventions to improve resilience.

While resilience needs to be tackled in myriad ways, a number of critical strategies have been identified in the course of this research and are summarised below.

- Empower the community to be active participants.** This is contingent on the democratisation of information. All city-dwellers should have equal access to government information, including what to do in an emergency. Some cities, like Singapore, do this very well, using digital channels to disseminate information to everyone simultaneously. Fostering a culture of readiness and the ability to manage hazards will require investment to train and educate people at governing and grassroots levels to be stewards of their city. Recognising that information is key, municipalities could consider partnering with a digital platform to minimise misinformation and ensure the city moves in one direction, despite disruption.
- Social cohesion efforts need greater advancement across the board.** Cities are nothing without the people who inhabit them. Greater attention to social cohesion will help to ensure cities are less fragmented, adaptive and better prepared for shocks. City governments should overlay resilience efforts with initiatives that aim to improve the lives of urban residents. This process should be driven by city leadership and engage civil society. The majority of cities in the index have some way to go to strengthen social cohesion through integration programmes for society's most vulnerable.
- Early warnings are vital for safe cities but investment is needed to hit the 2027 target.** National governments and municipality leaders will have to collaborate to ensure universal early warning systems coverage by 2027. There are two challenges that need to be met. First, capital is needed to bridge the investment gap for technologies with a greater push for the development and adoption of frontier and horizon tech—from drones to AI. Second, governments need to facilitate the necessary legislation to connect these EWS to emergency and response plans to ensure there are protocols and resources in place to deal with climate extremes and hazards. Community acceptance and responsiveness to early warnings are essential in the effectiveness of EWS. This can be achieved through systematic training and education and awareness programmes.

- **Incentivise preparedness.** Building resilience is a long-term process and should focus on future risks rather than current disruptions. However, the near-termism that often influences investment can undermine the long-term thinking needed for building resilience. It can also stop businesses and homeowners from forging their own safety nets through insurance. Providing clear incentives for businesses and individuals to prepare for future risks can help to build the necessary defences. These could take the form of financial benefits to retrofit legacy infrastructure or rewards for meeting benchmarks on the use of renewable materials.
- **Identify and track the progress of resilience interventions.** This will allow cities to adapt and refine their resilience strategies over time. An iterative process ensures that interventions remain effective in the face of evolving challenges such as climate change and urbanisation. Cities can also identify the gaps and make data-driven decisions. Despite having spent years planning to deal with climate change, the index's top ranking city, New York, scrambled to deal with wildfire smoke in June leaving more than eight million residents unprepared.⁷⁴

Tracking progress will also keep city officials accountable and help ensure that public funds are used efficiently and transparently, maintaining the trust among citizens.

- **Support innovation to map risks and drive solutions.** Solving some of the most pressing issues, such as decarbonisation, will require innovation. Advances in technology have offered some remedies, but they are not scalable or affordable enough for all cities to adopt. This is pushing out climate targets despite the existence of city-level net-zero plans, as in Cape Town. Cities that provide an enabling environment where start-ups, businesses and research centres can develop cutting-edge solutions will be better able to tackle complex problems. Technology will also help to identify, predict and monitor risks, which is critical to building resilience.

Cities are places of movement, flow and energy; they are rarely static. They can also be sites of debilitating natural and human shocks and stresses, which can have an outsized impact on critical infrastructure, livelihoods and the social fabric. Cities need to become more resilient in order to absorb adverse shocks, whether they are natural, economic or social.



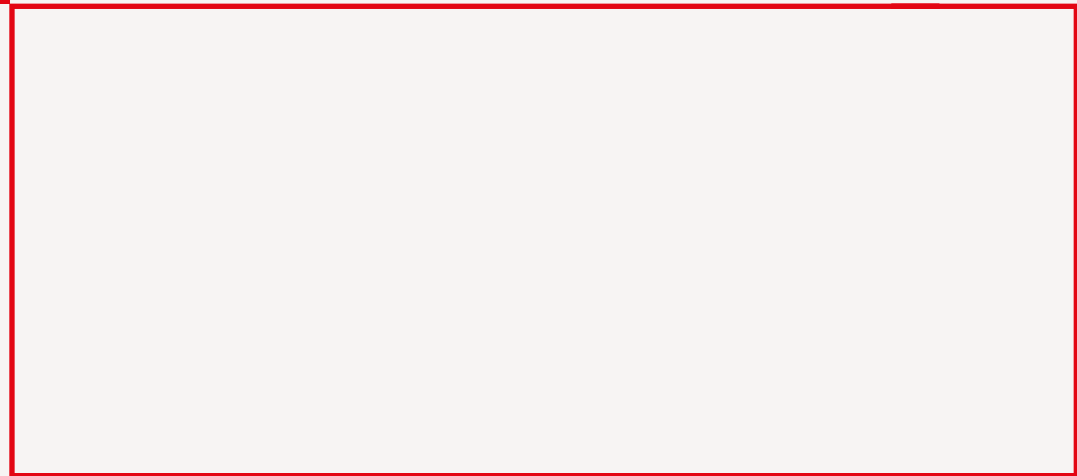
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