

A low-angle, black and white photograph of several skyscrapers reaching towards a cloudy sky. The perspective is from the ground looking up, creating a sense of height and scale. The buildings are dark, and the sky is filled with soft, grey clouds.

CCAG

Climate Crisis
Advisory Group

Cities in a
climate crisis



The potential of cities

Cities are endlessly flexible. They have been reinvented over centuries, retaining and reusing core features.

As reservoirs of industry, innovation and culture, cities inspire civic pride, commitment and loyalty, and fuel human progress. Positive changes interact to amplify benefits, improving the lives of millions and setting standards in regulation, method and material.

At their best, cities thrive socially, economically and environmentally, offering excellent living conditions and the greatest opportunities for a collective mitigation response to the climate crisis. This response is defined by adaptivity and resilience; it can enable a swift and robust recovery from adverse events. At the same time, cities can enable resource efficiency and lower-carbon lifestyles.¹

Such is the potential of cities.

Yet most people in the world's cities breathe polluted air, which kills some seven million people annually. Many also do not have access to safe, affordable water and sanitation, and live in areas prone to disasters due to climate extremes. Most cities offer inadequate transport options. In absolute terms, energy use and consumption in cities is greater than in other areas.²

And in every city, climate-related risks are increasing – risks which will predominantly affect younger generations.

Age exposure to climate impacts is stark: people born before 2000 will experience relatively little upset; those born now or in the last 20 years will

suffer increasingly powerful effects.³

Further, these effects will fall disproportionately on the world's underprivileged. Oxfam reports that funding needed to meet its appeals in response to climate disaster has soared by 800% in the last two decades.⁴ These are largely disasters in locations where people emit almost nothing into the atmosphere.

The IPCC forecasts 'climate change risks to cities, settlements and key infrastructure will rise rapidly in the mid- and long-term with further global warming, especially in places already exposed to high temperatures, along coastlines, or with high vulnerabilities'.⁵ Flooding, coastal storm damage, damage to infrastructure and to key economic sectors are risk areas across all cities. The IPCC also confirms the increasing pressures of water and heat stress, food shortages, infectious diseases and migration.

Even so, these great conurbations are home to concentrations of wealth, skills, education, and influence. They can often move faster than governments, with massive effect. In Australian Capital Territory, for example, electricity prices will fall as elsewhere they rise precipitously, due to determined and unflagging investment in renewables. This shows the strength of a region, led by one strong city, acting ahead of national policies. It is now a demonstrator of what is possible.

Cities are where we will win or lose the fight against the climate crisis.



Sir David King
Founder and
Chair of CCAG

FIGURE 1

OBSERVED IMPACTS OF CLIMATE CHANGE ON HUMAN SYSTEMS⁶

Human Systems	Impacts on water scarcity and food production				Impacts on health and wellbeing				Impacts on cities, settlements and infrastructure			
	water scarcity	Agriculture/crop production	Animal and livestock health and productivity	Fisheries yields and aquaculture production	Infectious diseases	Heat, malnutrition and other	Mental health	Displacement	Inland flooding and associated damages	Flood/storm induced damages in coastal areas	Damages to infrastructure	Damages to key economic sectors
Global	±	-	○	-	-	-	-	-	-	-	-	-
Africa	-	-	-	-	-	-	○	-	-	-	-	-
Asia	±	±	-	-	-	-	-	-	-	-	-	-
Australasia	±	-	±	-	-	-	-	not assessed	-	-	-	-
Central and South America	±	-	±	-	-	-	not assessed	-	-	-	-	-
Europe	±	±	-	±	-	-	-	-	-	-	-	-
North America	±	±	-	±	-	-	-	-	-	-	-	-
Small Islands	-	-	-	-	-	-	○	-	-	-	-	-
Arctic	±	±	-	-	-	-	-	-	-	-	-	±
Cities by the sea	○	○	○	-	○	-	not assessed	-	○	-	-	-
Mediterranean region	-	-	-	-	-	-	not assessed	-	±	-	○	-
Mountain regions	±	±	-	○	-	-	○	-	-	na	-	-

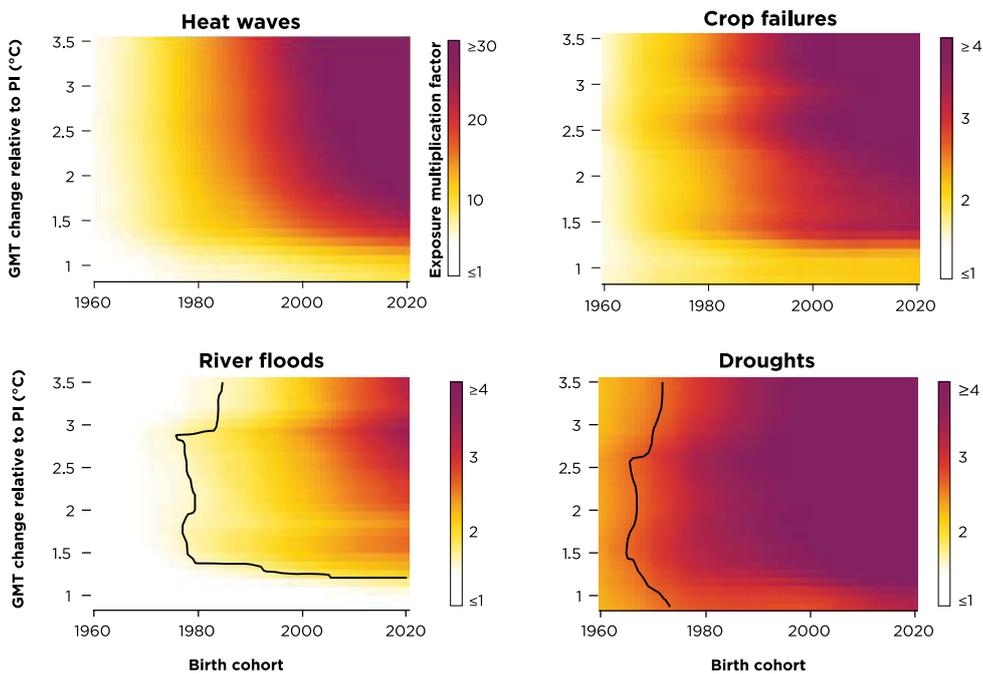
Confidence in attribution to climate change

Impacts to human systems

● High or very high
 ● Medium
 ● Low
 ○ Evidence limited, insufficient
 na Not applicable
 - Increasing adverse impacts
 ± Increasing adverse and positive impacts

FIGURE 2

LIFETIME EXPOSURE TO EXTREME EVENTS ON THE RISE





RIVER IN FLOOD, GUANGXI, CHINA. IMAGE: JÉAN BÉLLER

Four universal steps for better cities

Almost every city can take four steps to improve life, enhance its economy, and reduce emissions.⁷



1

Develop and expand inclusive, low emissions mass transport and active travel



2

Provide infrastructure and systems for waste management



3

Decarbonise the electricity grid



4

Radically improve the energy efficiency of buildings

Each of these four steps improves air quality, health prospects, economic possibilities, leisure opportunities and the quality of the built environment. Up to 90% of a city's GHG emissions can be removed.⁸

If measures are properly coordinated they address climate justice and provide effective adaptations to climate changes. For example, energy-efficient, affordable and safe

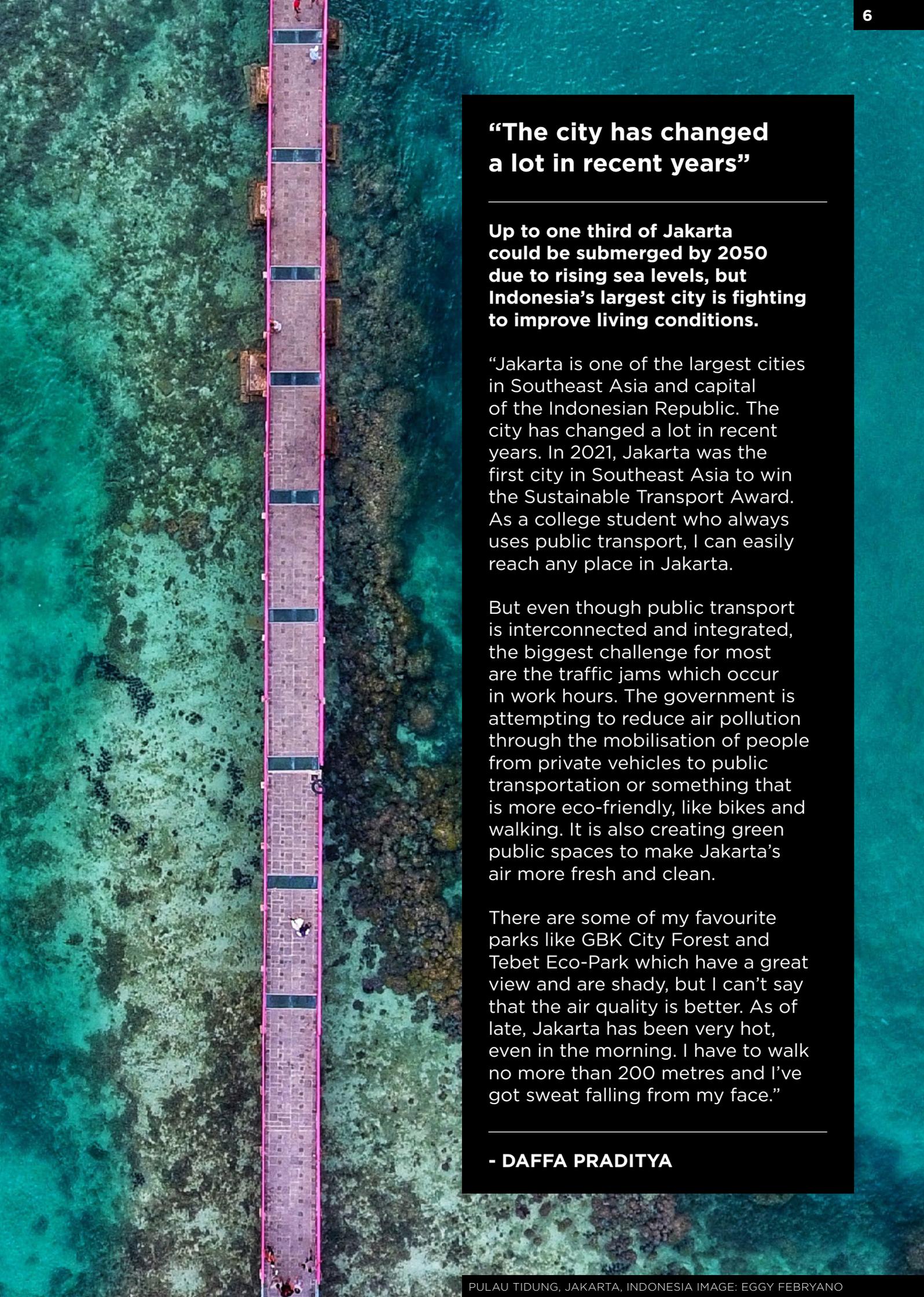
housing linked with low emissions mass transport provides inclusive community development and resilience.

This systematic approach will strengthen cities' ability to cope with climate change and improve the quality of life of all city dwellers, especially those who are most often excluded from social, economic and environmental wellbeing.

A green recovery for cities

According to modelling by C40 Cities, under a 'Green Recovery' scenario in which cities reduced emissions according to their 'fair shares,' emissions of C40 member cities could be more than halved in 5 years compared to a BAU scenario. This would save 2.3 GtCO₂e in 2030, with the reduction highest in high-income countries. In addition, investment in a green recovery could create over 50 million good, sustainable jobs, reduce air pollution as much as 29% in 10 years and prevent over 270,000 premature deaths in C40 cities.⁹

To remain on a 1.5°C trajectory, the average per capita emissions of residents of cities in the C40 group must decrease by 50% by 2030.¹⁰



“The city has changed a lot in recent years”

Up to one third of Jakarta could be submerged by 2050 due to rising sea levels, but Indonesia’s largest city is fighting to improve living conditions.

“Jakarta is one of the largest cities in Southeast Asia and capital of the Indonesian Republic. The city has changed a lot in recent years. In 2021, Jakarta was the first city in Southeast Asia to win the Sustainable Transport Award. As a college student who always uses public transport, I can easily reach any place in Jakarta.

But even though public transport is interconnected and integrated, the biggest challenge for most are the traffic jams which occur in work hours. The government is attempting to reduce air pollution through the mobilisation of people from private vehicles to public transportation or something that is more eco-friendly, like bikes and walking. It is also creating green public spaces to make Jakarta’s air more fresh and clean.

There are some of my favourite parks like GBK City Forest and Tebet Eco-Park which have a great view and are shady, but I can’t say that the air quality is better. As of late, Jakarta has been very hot, even in the morning. I have to walk no more than 200 metres and I’ve got sweat falling from my face.”

- DAFFA PRADITYA

New York, a large, high income, densely populated city, is adopting a diversity of city-based approaches in response to the climate crisis.

- The city's building regulations have been updated to approve low-carbon mass timber as a construction material for buildings up to six storeys high, reducing the need for carbon-intensive construction materials.¹¹
- Investment in sewage treatment has reduced nitrogen discharge from human waste by 60%, improving the ecology of the city's waterways.¹²
- Oyster reefs which once covered up to 89,000 hectares of New York coastline are being restored to create resilience against tidal and storm surges. It will take many decades to return them to previous levels, but with human intervention to start the process, there is hope that oysters will help to protect the New York of the future.¹³



City symptoms

WHAT ARE THE SIGNS OF A SUBOPTIMAL CITY?



A lack of green spaces, nature and parks. Cars dominate while pedestrians and cyclists are marginalised – although they are the majority.



Urban sprawl, wide roads, tenuous connections between neighbourhoods, and congestion on sidewalks and roadsides. Commuters often suffer poor mental and physical health.



Mass transportation is viewed as a marginal, even undesirable option, its value unrecognised.



Poor air quality caused by vast numbers of vehicles.



Poor implementation of waste management, leading to massive land-fill sites at city margins where people live amongst the rubbish.



Poor provision of water and sanitation; open sewers blight the cityscape.



Growth is wholly market-led, unplanned or unsupported, with no public engagement or agenda.



The frequent failure of upgrade efforts, imposed piecemeal by planners, rather than developed in consultation with communities. Infrastructural mistakes endure for decades.



Out of date regulation which fails to support climate-friendly progress. Climate resilient development is blocked by city-zoning, out-moded building regulations, development without provision for public transport, and more.



A high degree of separation between wealthy and poor neighborhoods. The wealthiest often leave disconnecting from the life of the city and increasing the number of private cars on roads.



Poor people tend to live in the most vulnerable areas, exposed to higher levels of economic, social and environmental harm. Such threats tend to compound: economic hardship undermines physical safety and good health; environmental degradation accelerates economic hardship, and so on.

“I can’t change the story”

In Kampala, Uganda, the traffic and dust are relentless.

“I am married with three children aged 6, 2, and 1. My wife and I both have a car. We live about 20km from the city centre. We usually allow two hours for this drive, but at busier times this is not enough.

The children’s school and nursery hours are 8.00am to 3pm, but I drop them off at 6.00am, before traffic becomes unmanageable. The children either eat their breakfast in the car, or sleep in the car until they are dropped off.

The stress of getting children to school – and then to work – is one of the main topics of conversation. Parents discuss how they feel as they see their children spend half of every day wasted in a car. They see the time as lost, unhappy.

Dust is everywhere. In the house you can take a suit out of the cupboard and find it is too dirty to wear. Every month or so one of the children will be sick with a bad cough. If there has been no rain for a week or two

we expect them to become ill.

In my travels abroad I have seen other cities. I feel sad to see how people are riding, walking and driving more easily. It is hard to achieve the ideal city in Uganda because the streets are too narrow for pavements.

I worry that, as an individual, I can’t have much impact. I don’t understand why planners can’t benchmark and implement changes. Our leaders could pick one lesson and bring it home. I can’t change the story.

Some people give up and move out of the city. They leave their friends, their network and become lonely. But my livelihood depends on the city. We are forced to live it. You adapt, though it’s not nice; you think you deserve better.

As individuals, should we fold our hands and accept what is happening? Where do we go to get where we should be? Is it government? Or is it collaborative? In the end we focus on getting through the day.”

- RICHARD MUNYANGABO



CASE STUDY

UPGRADING VULNERABLE HOUSING IN CITIES

Economically vulnerable households, often in informal settlements, typically live in poorly constructed houses isolated from services and infrastructure. However, community-partnering approaches can lead to significant improvements.

In Kitale, Kenya, in the 2000s, three informal settlements participated in upgrading programmes, each choosing different priorities and approaches. In the Kipsongo area, the community choice was safe water and latrines, maintained and managed economically by local women. In Shimo La Tewa, the most important development was a bridge across a ravine. In the Tuwan area, community priority was on sanitation, provided in a two-storey block, with flexible community space as well as showers and latrines – all built with sustainable materials, sustainable water-usage and local labour.

A critical success factor for these initiatives was strong, ongoing institutional support and expertise

provided to community teams.

By contrast, ‘slum clearances’ in Delhi, which rehoused communities without consultation in modern high-rise flats, introduced new stresses, such as social isolation from accessible shared space; unaffordable cooking that relied solely on costly electricity; and huge heat stress because cooling fans also depend on electricity. Here, slums were not so much cleared as extended vertically.¹⁴

Simple dialogue can make such transitions happier and more secure. In the Indian example, ‘after the event’ consultation exposed the problems, and at least some communal outdoor space was created between the walls of the crowded high-rise towers where women could cook and find company and shade during the heat of the day.



HOUSING, OLD DELHI, DELHI INDIA. IMAGE: ANNIE SPRATT

CLIMATE RISKS FACING CITIES

Heat stress

Urban areas are heat islands. Their populations suffer disproportionately from heat stress.

The trend for heat related deaths is increasing everywhere.¹⁵

In 2003, heat stress killed over 70,000 people in Europe¹⁶ with a peak temperature in France of around 44°C (see figure 3). By 2050, this temperature is set to become the average for the summer.¹⁷ A new record temperature in France of 45.9°C was set in 2019. The 'extreme' summer of 2003 now looks average.

Across India and Pakistan, the 2022 heatwave has stressed every aspect of human existence for months

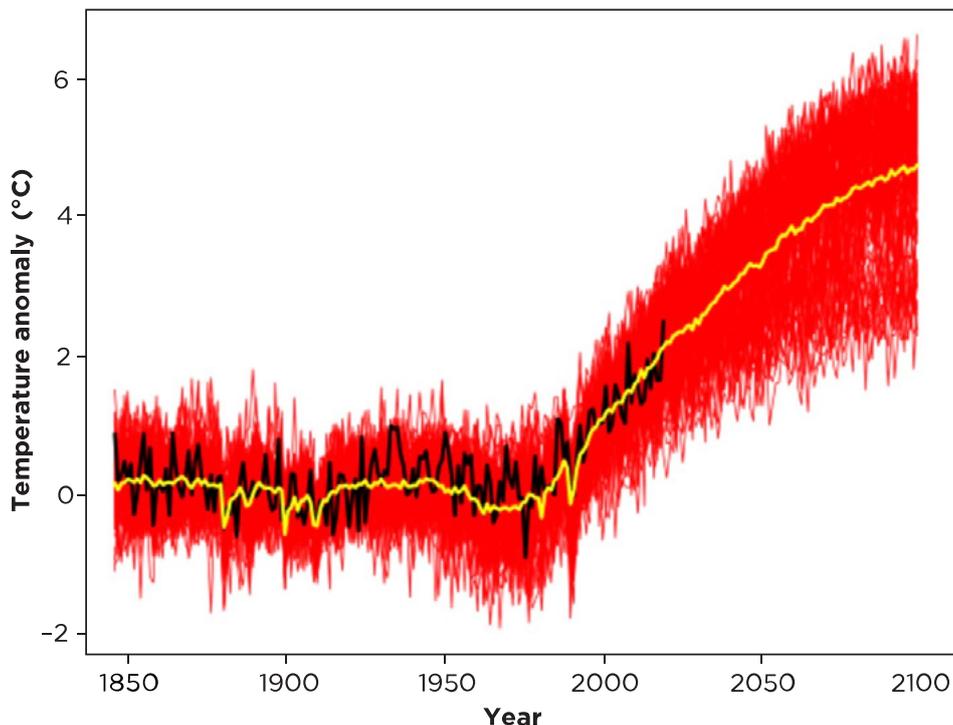
on end. Delhi, Jaipur, Shimla and other cities have seen 120% to 180% increases in days with extreme heat in April alone compared with 2021. "This is not a blip," says Chandhi Singh, IPCC author.¹⁸

Most of the emissions-rise to date has occurred since 2014, and it is accelerating. Extreme temperature rises, driven in part by urban heating effects, will add to heat stress for city occupants, leading to low productivity, poor quality of life, and premature deaths.

FIGURE 3

EUROPE: SUMMER MEAN TEMPERATURE

EUROPE: Summer Mean Temperature



Predicted and observed data on summer mean temperature across Europe by the Met Office Hadley Centre (2022). The red curves are individual runs of the model, the yellow curve is the average of these, and the black line is the observed summer temperatures in central Europe up to 2021.



LESSONS FROM PARIS

In the 2003 heatwave, many of the 20,000 excess deaths in France occurred in Paris.

Typical victims were elderly, living alone in small attic apartments of old buildings, without air conditioning or adequate cooling.

In the heatwave aftermath, air-conditioning in nursing homes was made obligatory. 'Cooling rooms' were established in vulnerable neighbourhoods, and meteorological and health agencies worked together to support those affected by heat.

When temperatures rise, public information campaigns warn communities of the dangers and advise about local services. In the heatwaves of 2005, 2015 and 2019, deaths in Paris were prevented; vulnerable people still live in dangerous, overheating apartments, but they are more likely to be monitored and to use life-saving cooling facilities. In the longer term, Paris has programmes to retrofit homes to greatly increase energy efficiency. This could also make them safer in hot weather if heating and cooling systems are part of the retrofit.

Paris shows the dangers of legacy housing stock, but also the importance of institutional and community learning from critical events. Community resilience can be strengthened with good planning, monitoring, and relatively modest interventions.

However, there are limits to adaptation, and deep emissions cuts remain the utmost priority.



CLIMATE RISKS FACING CITIES

Air quality

In 2020, 90% of the world's population breathed dangerous air.

As cities grow, their air quality tends to get worse.¹⁹ Urban air pollution from nitrogen dioxide (NO₂) and fine particulate matter 2.5 (PM 2.5) cause severe health problems. Both NO₂ and PM 2.5 are largely caused by motor vehicles, including both emissions and tyre particulate.²⁰

Air quality can be rapidly improved by managing vehicles, such as limiting their access to city centres in favour of other forms of transport.

Some cities have achieved striking reductions in car use and increased use of public transport, cycling and walking. In their different ways, Bogota in Colombia and Oslo in Norway are notable. Bogota re-imagined how roads should be used – systematically removing private vehicles from certain areas, thereby creating space for mass transportation on buses (which run like

a metro system), bicycles, and wider sidewalks along key urban highways. Transit times are reduced for most of the population.

Oslo introduced a Bicycle Strategy in 2015, and active travel has increased rapidly since then. The strategy has encouraged and supported cycling, creating safety standards, limiting car access with congestion charges, and specifically aiming to eliminate fatalities on the roads of Oslo. The target is for 25% of all journeys in Oslo to be carried out on bicycles.²¹

The quality of life in Bogota's communities was improved as parking on pavements was banished, allowing family and community life to flourish at street level. The leisure opportunities are better when cars are reduced, and for local communities, cycling and walking can be part of a normal day.

The battle to clean up city air

In 2020, Singapore, Beijing and Bangkok achieved between 20% and 25% reductions in PM_{2.5} pollution, showing serious efforts can get results. Across China, South Korea and India the trend was towards cleaner air from 2018 – 2020.

However, many cities such as Sao Paulo, Los Angeles and Melbourne, saw worse air quality. Severe wildfires made city air worse, showing how rural environmental issues can affect city dwellers.

Air quality is strongly linked to the burning of fossil fuels – whether in cars, industry or domestic settings. A switch to cleaner fuels – especially electric – will allow a transition to renewable energy sources and make a major contribution to emissions reductions. The bonus of massive improvements in air quality cannot be overstated. In the 2021 inquest of a nine-year-old girl who died in 2013 from asthma, air pollution in London was recognised as a material factor in her death.²²



A person is riding a bicycle away from the camera on a city street during sunset. The person is wearing a light-colored jacket, dark pants, and a backpack. The street is lined with buildings and other people in the distance. The sun is low in the sky, creating a warm, golden glow. The overall scene is a busy urban environment.

“WE WANT A REVOLUTION IN THE WAY WE MOVE AROUND OUR CITIES”

**Mums for Lungs campaigner
Roxanne Board describes the
impact of air pollution in London.**

“We live in north London. The level of air pollution here is very high. My son started having asthma attacks at 18 months old. That summer he had seven attacks; two were life threatening. Our local hospital told us to avoid traffic-filled roads because air pollution causes lung inflammation, increasing the likelihood and severity of asthma attacks. In addition, our specialist at Royal Brompton hospital described air pollution as a ‘significant contributory factor’ in the development of breathing issues in children in the UK. Air pollution is increasingly linked to almost every non-communicable disease.

We want to see the government treating this crisis with the urgency that it deserves. We need a significant reduction in car use on our roads, phasing out of domestic wood-burning, and increased active travel. There have been many positive changes, such as expansion of the Ultra-Low Emission Zone in London, but we need to go further and much faster. We need clean air zones in every city, real investment in active travel and a complete phase out of diesel vehicles. Mums for Lungs wants a revolution in the way we move around our cities. This requires genuine government support, and commitment to protecting children’s health from the risks of air pollution.”

CLIMATE RISKS FACING CITIES

Flood and storm damage

According to the IPCC, approximately one billion people are currently projected to be at risk from coastal specific climate hazards.

This number drastically increases as the global mean sea level rises compared with 2020 levels; people at risk double at 0.75m rise, and triple at 1.4m.²³

However, damage to cities and critical infrastructure has already begun, and for some there is no escape. Jakarta's key functions as a capital city are to be moved because much of the city is sinking too severely to be protected.²⁴ Similarly, Kolkata, which is already expected to suffer extreme temperature rises, faces severe and protracted flooding due to accelerating sea-level rise, threatening the city's viability.

In Australia, floods have caused major

infrastructure disruption, including landslip damages to Southeast Queensland's rail network, closures of public transportation services in Brisbane, and the closure of major highways. Fuel, food and water shortages have ensued in Northern New South Wales. The Insurance Council of Australia has estimated the cost of flood claims so far as US \$963 million.²⁵

In the US, repairs to flood-damaged infrastructure cost FEMA an estimated \$48.6 billion between 1998 and 2014.²⁶ The IPCC projects that by 2100 the value of global assets within coastal floodplains, at risk of 1-in-100 year flooding events, will be between US \$7.9 trillion and US\$ 14.2 trillion.²⁷



TABLE 1

RANKED: TWENTY GLOBAL COASTAL CITIES AT RISK OF GREATEST LOSS FROM FLOODING²⁸

CITY AND RANKING NUMBER FOR HIGHEST PROJECTED ANNUAL LOSSES BY 2050	POPULATION
1. Guangzhou, China	14 million
2. Mumbai, India	21 million
3. Kolkata, India	15 million
4. Guayaquil, Ecuador	3 million
5. Shenzhen, China	13 million
6. Miami, USA	0.5 million
7. Tianjin, China	14 million
8. New York, US	19 million
9. Ho Chi Minh City, Vietnam	9 million
10. New Orleans, USA	1 million
11. Jakarta, Indonesia	11 million
12. Abidjan*, Côte d'Ivoire	5 million
13. Chennai, India	12 million
14. Surat, India	8 million
15. Zhanjiang*, China	7 million
16. Tampa-St Petersburg, USA	1 million
17. Boston, USA	0.5 million
18. Bangkok, Thailand	11 million
19. Xiamen*, China	4 million
20. Nagoya*, Japan	2 million

Sources: Hallegatte et al., 2013; World Population Review/World Cities, 2022; Cities marked * are not included in the World Population Review, and estimated populations are taken from various sources.

CLIMATE RISKS

FACING CITIES

Flooding

Major floods are happening so frequently and widely that no country is safe. Many recent floods are unprecedented, indicating that they are part of the intensification of extreme weather events across the world.

No cities are immune from flooding, whether coastal or inland. Often founded on the banks of rivers and canals, and increasingly extending onto flood plains, cities are also vulnerable due to their high volume of impermeable surfaces, such as concrete and asphalt, which channel flood water into fast-flowing run-off that can overwhelm flood defences.

Elsewhere, as in many South American cities, unplanned urbanisation sprawls across steep hillsides. Heavy rain can cause landslides that inflict huge loss of lives and property, usually amongst the most vulnerable communities.

In the first quarter of 2022, severe inland flooding took place in at least eleven different countries:

- In February, Storm Franklin led to record river highs in the UK and flash flooding in France, Belgium, and the Netherlands.²⁹
- In March, days of heavy rainfall in Malaysia and Southern Thailand forced thousands to evacuate their homes,³⁰ with similar floods in parts of Bolivia.³¹
- The same month, Australia,³² Colombia,³³ Haiti and the Dominican Republic³⁴ also experienced devastating floods, causing scores of deaths, emergency evacuations and widespread damage to infrastructure.

The pattern of widespread floods around the globe has continued since.

TABLE 2

COUNTRIES AFFECTED BY MAJOR FLOODS SINCE JULY 2021

July 2021	China, Germany
August 2021	China, Japan, Turkey
September 2021	India, Pakistan, South Sudan, Thailand, USA
October 2021	Italy, Mexico, Sicily
November 2021	Canada, Indonesia
December 2021	Brazil, Iraq, Malaysia, Spain
January 2022	Dominican Republic, Haiti
February 2022	Belgium, Bolivia, France, Malaysia, Netherlands, Thailand, UK
March 2022	Australia, Colombia, Dominican Republic, Haiti
April 2022	South Africa, Philippines, Colombia, Thailand
May 2022	Brazil, Guatemala, Guyana
June 2022	Sri Lanka, Cuba, France
August 2022	Pakistan, India, DRC, Philippines, Indonesia, USA, Yemen, China, Afghanistan
September 2022* (*up to 6 Sep 2022 only)	India, Uganda, Bulgaria

An aerial photograph of a mangrove forest. A wide, light-colored river or canal winds through the center of the image, separating a large, dense island of green mangrove trees from the surrounding forest. The trees are vibrant green, and the water in the river is a pale, milky color. The overall scene is a lush, natural landscape.

THE POWER AND BEAUTY OF MANGROVES

By providing sturdy natural coastal defences as well as highly efficient carbon sequestration, mangrove forests have a vital role to play in the protection of cities.

A study shows there are global as well as local economic and social benefits to preserving and re-foresting mangrove in support of flood mitigation, protection against coastal erosion and abatement of economic loss.³³

In the face of storms, mangrove forests can absorb up to two thirds of wave energy within a width of 100 metres of forest. The trees can also adapt to sea level rise, keeping pace with rising water by 'vertical accretion'.

Despite historic losses of mangrove around the world, current mangrove forests reduce annual property damage by some \$US65 billion per year. These economic benefits are greatest in USA and China, despite degraded mangroves arising from coastal development.

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3. See 'Footing the Bill: Fair finance for loss and damage in an era of escalating climate impacts' <https://policy-practice.oxfam.org/resources/footing-the-bill-fair-finance-for-loss-and-damage-in-an-era-of-escalating-clima-621382/>
4. IPCC Working Group ii Sixth Assessment Report (2022) page 15 <https://www.ipcc.ch/report/ar6/wg2/>
5. IPCC Working Group ii Sixth Assessment Report (2022) <https://www.ipcc.ch/report/ar6/wg2/>
6. These focus areas are taken from a report of C40 Cities on 'Focused Acceleration - A strategic approach to climate action in cities to 2030' (2017). On page 21 the report shows how mobility and waste management improvements alone can tackle 40% of a city's GHG emissions, whilst clearly improving life for its citizens. https://www.c40knowledgehub.org/s/article/Focused-Acceleration-A-strategic-approach-to-climate-action-in-cities-to-2030?language=en_US
7. Again, this is shown in C40 Cities on 'Focused Acceleration - A strategic approach to climate action in cities to 2030' (2017). Ibid.
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12. See <https://www.bloomberg.com/news/features/2021-11-19/to-fight-floods-new-york-city-rebuilds-a-wall-of-oysters>
13. Debnath et al (2019) 'Discomfort and distress in slum rehabilitation: Investigating a rebound phenomenon using a backcasting approach' Habitat International <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6559131/>

14. A study, published in 2021, found that more than half of excessive deaths occurred especially in low-lying and crowded coastal cities of South and East Asia. This 'highlights how arduous the task will be for Asian countries to reduce the adverse effect of temperature on local population health and the substantial challenge to their health-care systems.' 'Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study' Zhao et al. (2021) [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(21\)00081-4/fulltext](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00081-4/fulltext)
15. The peer reviewed paper in ScienceDirect, 'Death toll exceeded 70,000 in Europe during the summer of 2003' covers a large part of Europe, but notes that no evaluation has been made of all of the excess deaths in every European country affected by the heatwave. The figure of 70,000 is likely to be an underestimate (Robine et al 2008, page 177) <https://www.sciencedirect.com/science/article/pii/S1631069107003770>.
16. The Washington Post article on the topic shows how the 'highest ever' 2003 temperatures in Europe are already becoming the 'new norm', as predicted by climate change models. 'Europe's killer heat waves are a new norm. The death rates shouldn't be.' (2019) Keller
17. Singh's quote appears in a recent Bloomberg article: <https://www.bloomberg.com/news/features/2022-08-18/india-heat-wave-forces-climate-adaptation-in-south-asia?leadSource=verify%20wall>. See also <https://www.irb.co.uk/blog/2022/july/the-heat-wave-in-northern-india>
18. Rankings are given by IQAir reports on their website. Daily rankings are given for cities across the world. All regions suffer from poor air quality in their cities. <https://www.iqair.com/world-air-quality-report>
19. A recent study shows heavier battery cars are causing greater wear and more tyre particle pollution than from car exhausts. See <https://earth.org/tyre-pollution/>
20. The second inquest, eight years after the death of Ella Adoo-Kissi-Debra, was granted after the expert evidence gathered by her mother showed that Ella's asthma attacks correlated with levels of high pollution – especially PM 2.5 – in the area where she lived and travelled to school. This was the first time a death certificate in the UK mentioned pollution as a cause of death. See the BBC report for further details. <https://www.bbc.co.uk/news/uk-england-london-56801794>
21. In 'How Oslo Achieved Zero Pedestrian and Bicycle Fatalities, and How Others can Apply What Worked' Haartmann et al (2020) show how the strategy for bike use has been implemented. <https://thecityfix.com/blog/how-oslo-achieved-zero-pedestrian-and-bicycle-fatalities-and-how-others-can-apply-what-worked/> In 'The city of Oslo joins the Cities & Regions for Cyclists network' Bashford (2021) explains what the changes have meant to cyclists. There is a strong focus on cargo bikes, bike sharing and bike parking as well as road safety and creating safe routes for cyclists. <https://ecf.com/news-and-events/news/city-oslo-joins-cities-regions-cyclists-network#:~:text=Cycling%20in%20Oslo&text=There%20has%20been%20high%20growth,28%25%20in%20the%20same%20period.>
22. IPCC Working Group ii Sixth Assessment Report, 2022, available from: <https://www.ipcc.ch/report/ar6/wg2/>
23. At a projected cost of \$32 billion, the relocation of the capital of Indonesia has been approved by parliament. <https://www.weforum.org/agenda/2022/01/indonesia-relocate-capital-borneo-jungle-cities-island-asia/>
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25. <https://www.nrdc.org/stories/flooding-and-climate-change-everything-you-need-know>
26. IPCC Working Group ii Sixth Assessment Report, 2022, available from: <https://www.ipcc.ch/report/ar6/wg2/>
27. This ranking of cities is taken from Table 2 'The 20 cities with the highest loss in 2050, assuming scenario SLR-1 and adaptation option that maintains flood probability'. Other ranking orders, also based on projections to 2050, emerge from the same paper, depending on different assumed scenarios, such as relative increase in loss (Figure 1), highest losses in optimistic sea-level rise scenario (Figure 2). Hallegatte, S., Green, C., Nicholls, R. et al. (2013) Future flood losses in major coastal cities. *Nature Climate Change* 3, 802-806. Available from: <https://doi.org/10.1038/nclimate1979>
28. <https://floodlist.com/europe/united-kingdom/floods-storm-franklin-february-2022>
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34. Menendez et al (2020) 'The Global Flood Protection Benefits of Mangrove' *Nature* <https://www.nature.com/articles/s41598-020-61136-6>



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