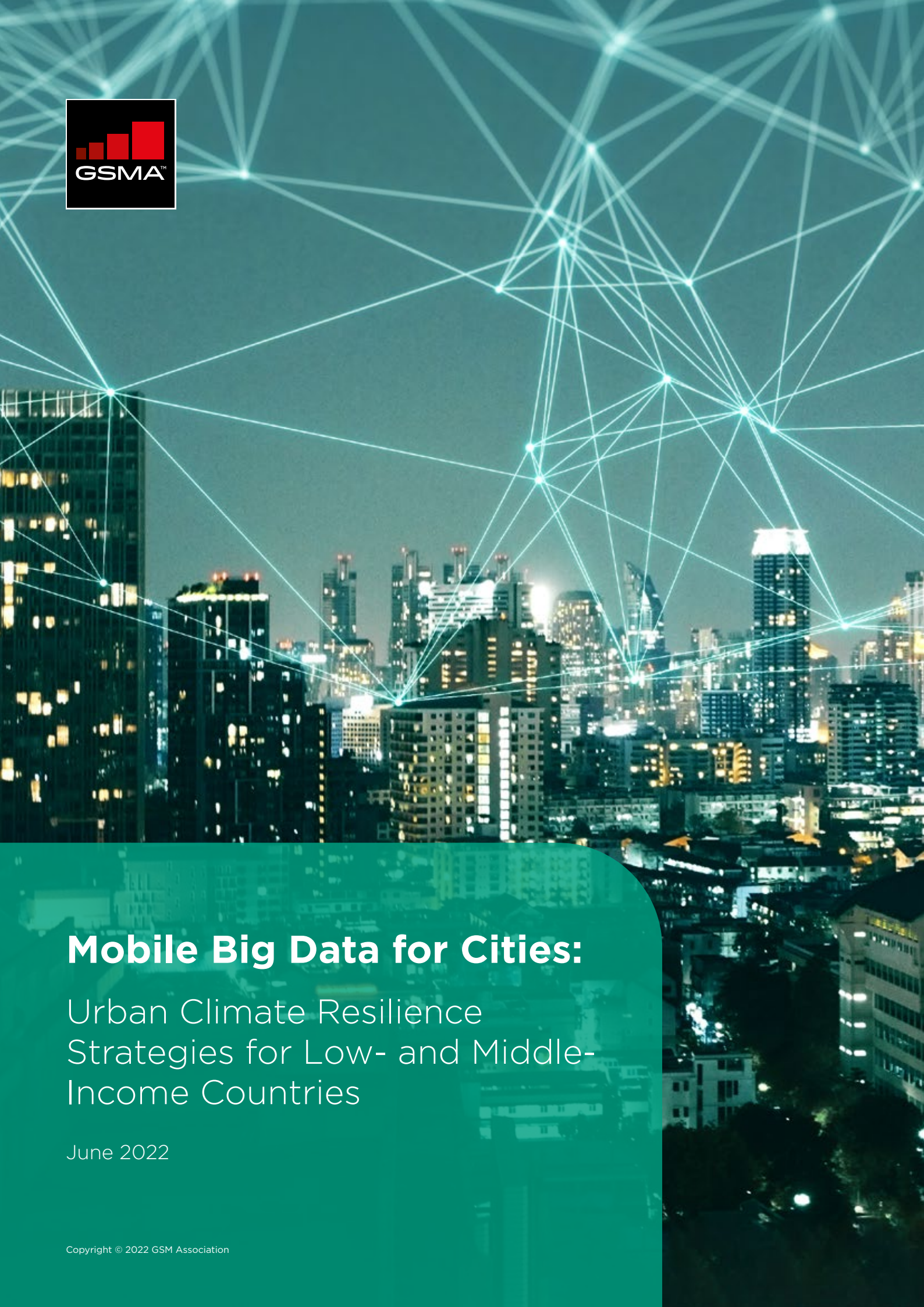

Mobile Big Data for Cities:

Urban Climate Resilience Strategies for Low- and Middle-Income Countries

June 2022

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Executive summary

Cities in low- and middle-income countries (LMICs) are increasingly vulnerable to the impacts of climate change, including rising sea levels and storm surges, heat stress, extreme precipitation, inland and coastal flooding and landslides.

In a time of unprecedented urbanisation and greater global uncertainty, it has become more challenging for cities in low- and middle-income countries (LMICs) to configure themselves more sustainably. Traditional planning strategies have led to urban sprawl and produced negative impacts ranging from habitat fragmentation and water and air pollution to higher infrastructure costs, inequality and social homogeneity.[1]

The compact city model,[2] based on density, diversity, mixed land use, sustainable transportation and green space, offers a sustainable response to these challenges and an opportunity to design and develop cities for long-term resilience and viability. Given these trends, the integration of digital technology in the environmental and physical development of urban areas is urgently needed across LMICs.

1 For more on the challenges of urban sprawl, see: Ewing, R. (1997). "Is Los Angeles-Style Sprawl Desirable?" *Journal of the American Planning Association*, 63:1, 107–126; Squires, G.D. (2002). "Urban Sprawl and the Uneven Development of Metropolitan America". In Squires, G.D., Ed., *Urban Sprawl: Causes, Consequences, and Policy Responses*, Urban Institute Press, Washington DC, pp. 1–22.

2 For the definition of a compact city, see: https://www.sciencedirect.com/science/article/pii/S266616592030017X#bib39.

Summary of findings

This study highlights the potential value of using mobile big data (MBD) in preparing for and responding to climate-related disasters in cities. In line with the "3As" of urban climate resilience, a framework adopted by the GSMA Mobile for Development programme, this study examines how MBD could help cities and their populations **adapt** to multiple long-term challenges brought about by climate change, **anticipate** climate hazards or events and/or **absorb** (face, manage and recover from) adverse conditions, emergencies or disasters.[3]

Building on insights from recent GSMA publications, this study maps best practices in the transport, land, service delivery, finance and early warning sectors, and the potential benefits of integrating MBD in plans and frameworks to respond to the impacts of climate change in urban settings. Best practices in these sectors show that MBD can reveal the daily mobility patterns of a city's population and generate insights on population distribution, the intensity of human activity and shifting population density. All these are crucial in the coordination, communication and allocation of resources to respond to climate change and build resilience. In some instances, combining MBD with other data sets, such as climate, population census, GIS and traffic, provide more comprehensive and accurate results that are instrumental in decarbonisation strategies, land use classifications and real-time urban disaster response and financing plans.

Barriers and recommendations

Despite best practices, interviews for this study revealed that MBD is still underused in planning, monitoring and response strategies for urban climate resilience in LMICs. The primary barriers to using MBD include low capacity of national and local government to apply MBD in practice; weak data-sharing culture; underdeveloped data privacy and security laws; lack of coordination; limited gender disaggregation (for example, women, those living in rural areas, those with lower incomes); and the costs of supplying MBD for MNOs. However, these constraints can be overcome if governments, MNOs and development partners pursue well-informed initiatives that have determined the value of MBD for urban climate resilience. It is important to acknowledge the limitations of MBD to serve the most underserved. Certain demographics, such as women, are less likely to be digitally included (e.g. own a mobile phone or use mobile money and mobile internet) and are therefore less likely to be represented in the data. This means that using MBD to design new disaster warning systems and optimised public transport routes, for example, risks further excluding these groups.

This report proposes next steps for national and local governments, MNOs and development partners to use MBD to strengthen urban climate resilience. Our call to action includes building the capacity of the public sector and MNOs to use MBD for urban climate resilience; combining MBD with other data sources to have a more effective impact on urban climate resilience; developing partnerships and commercial models to ensure social inclusion and transparency; and lobbying for effective and efficient data infrastructure and data security measures to apply MBD insights at scale.

3 Bahadur, A. et al. (2018). *The 3As: Tracking Resilience Across BRACED*. BRACED Knowledge Manager.

01 Introduction

1.1 Defining urban climate resilience in LMICs

There are numerous definitions of urban resilience. Some argue that "a resilient city is one that can adapt to... changing conditions and withstand shocks while still providing essential services to its residents."[4] Others argue for a vision of resilience that seizes opportunities and allows cities to "bounce back better".[5] In short, urban resilience can be understood as the capacity of cities to function so that those who live and work in them, particularly poor and vulnerable groups, survive and thrive no matter what stresses or shocks they encounter. By extension, urban climate resilience can be defined as embracing climate change adaptation, mitigation and disaster risk management while recognising the complexity of rapidly growing urban areas and the uncertainty associated with climate change.[6]

Cities and human settlements are local, national and global drivers of economic prosperity and development, generating up to 80 per cent of global GDP and contributing more than 70 per cent of global carbon emissions.[7] Most of the world's population live in cities, where innovation and opportunity are cultivated and government, commerce, culture and society converge. The rapid pace of urban change driven by rural-to-urban migration and population growth is placing stress on city services and resources and increasing carbon emissions in cities are exacerbating persistent challenges, such as vulnerability to climate-related events and pollution.

All this has made cities, especially those in low- and middle-income countries (LMICs), climate change hotspots with rising sea levels and storm surges, heat stress, extreme precipitation, inland and coastal flooding, landslides, drought, increased aridity and water scarcity. The physical effects of climate change have disrupted supply chains, led to lost productivity from health issues and incurred costs associated with rebuilding or repairing physical assets, such as buildings and transport infrastructure. However, municipal governments and systems often lack the adaptive capacity or resources to keep up with growing populations and economic pressures, let alone threats from climate change.[8]

As cities identify their specific climate resilience challenges, there are unique opportunities for technology to address them. Over the past 30 years, technology has advanced greatly while the organisational structure of cities has remained largely the same.[9] The "smart city" concept has been widely accepted by city leaders due to the need to strengthen resilience on all fronts. The goal of a smart city is to use data and digital technology to make better decisions and improve quality of life.[10] More comprehensive and real-time data gives municipal agencies the ability to watch events as they unfold, understand how demand patterns are changing and respond with faster and lower-cost solutions. This provides a solid basis for innovative data sources, such as mobile big data (MBD), to help strengthen urban climate resilience.[11]

4 World Bank. (2014). *Can Tho, Vietnam: Enhancing Urban Resilience*.
5 Satterthwaite, D. et al. (2007). *Adapting to Climate Change in Urban Areas: the Possibilities and Constraints in Low- and Middle-Income Nations*.
6 Bahadur, A., Tanner, T. and Pichon, F. (November 2016). *Enhancing Urban Climate Change Resilience: Seven Entry Points for Action*. ADB Sustainable Development Working Paper Series, No. 47.
7 UNDP. (2 November 2020). *Issues Brief: Urban Climate Resilience*.
8 Ibid.
9 Arafah, Y. and Winarso, H. (2017). "Redefining Smart City concept with resilience approach". *IOP Conference Series: Earth and Environmental Science,* 70.
10 Ibid.
11 Ospina, A.V. (2018). *Big Data for Resilience Storybook: Experiences integrating Big Data into resilience programming*. International Institute for Sustainable Development (IISD).

1.2 Research objectives and methodology

This research sought to understand the role of mobile network operators (MNOs) and MBD – in combination with remote-sensing data and other innovative data sets – in strengthening urban climate resilience in LMICs. The research builds on insights from recent GSMA publications, such as "Utilising Mobile Big Data and AI to Benefit Society", "Insights from the COVID-19 Response" and "Innovative Data for Urban Planning: The Opportunities and Challenges of Public-Private Data Partnerships", while also generating new and original insights that will drive climate action, support sustainable development and foster public-private collaboration.

The research combined comprehensive desk research and key informant interviews with stakeholders from government, the private sector, MNOs and civil society in Indonesia, Kenya and Mozambique to produce tailored recommendations for each of the three countries.

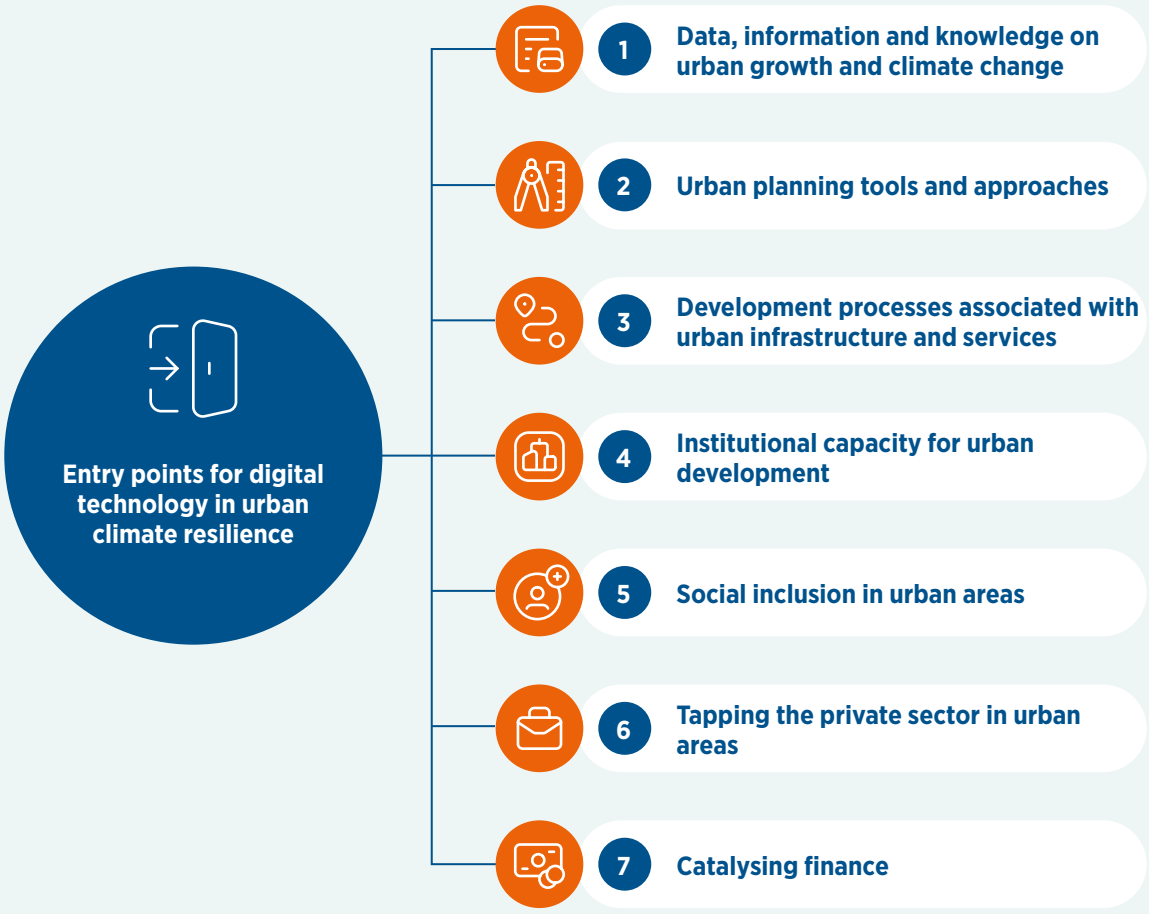
Specifically, the study was designed to:

- Capture and document global trends, demand-side needs, barriers, benefits, gaps and examples of best practice in using mobile data to strengthen urban climate resilience.
- Contextualise the findings through deep dives into climate resilience in Indonesia and Kenya, with additional insights from Mozambique.
- Focus on the role of MBD in improving the resilience of populations that are most vulnerable, including women and the poor.
- Develop tailored recommendations for development partners, MNOs and governments to establish, manage and strengthen the sustainability of new data-sharing private-public partnerships (PPPs).
- Develop practical and engaging workshop materials to help local stakeholders understand the potential value of MBD, work together to identify high-impact use cases and take the first steps in developing a data-sharing methodology and framework.

1.3 Entry points for digital technology in urban climate resilience

Every city has its own DNA – the geographic, demographic, economic and institutional characteristics that distinguish it from other places. These same characteristics provide unique blueprints and entry points for digital technology, including big data. A comprehensive approach to urban climate resilience might begin with collecting the right information and knowledge, and then moving on to planning and policy processes, strengthening capacity, engaging with a variety of stakeholders and accessing finance. Recognising the diverse pathways to urban climate resilience shows how some actions may be more important than others in certain contexts.

Figure 1:
Entry points for digital technology in urban climate resilience



Entry point 1:
Data, information and knowledge on urban growth and climate change

Climate change affects the assets and performance of a range of interdependent urban sectors (water and sanitation, electricity, housing, natural resource management and transportation), the delivery of basic urban services and the emergency management functions of a city government. Effective urban climate resilience requires data, information and knowledge on both environmental and physical exposure to climate change-related shocks and stresses, as well as the social and economic vulnerability of people and assets. This data cuts across administrative boundaries, sectors and timescales to include information on past events and performance, current trends and future projections on climate change and urban growth. Technological advancements not only provide new and cost-effective opportunities to collect and update data, but also to analyse and extract actionable insights that can inform decisions. Advances in technology, such as mobile technologies that have high usage in urban areas, offer new opportunities to gather local perspectives on climate change resilience in an efficient, cost-effective and participatory manner.[12]

Entry point 2:
Urban planning tools and approaches

Urban planning aims to provide a comprehensive and longer-term approach to development and guide the spatial, social, economic and cultural development of a city. Integrating the principles of urban climate resilience[13] within urban planning regimes has potential to ensure that different approaches to urban development are considered and help build climate resilience. The ability of a city to assimilate new technologies in urban planning has been shown to not only strengthen democratic values, security and social inclusion, but also reduce or limit exposure and vulnerability.[14]

Entry point 3:
Development processes associated with urban infrastructure and services

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) identifies six critical urban sectors: water and sanitation, energy supply, transport and telecommunications, built environment, ecosystems and health and social services.[15] The impact of climate change is projected to have adverse effects on urban infrastructure and service delivery, but integrating technology in infrastructure and services guarantees good-quality, functioning infrastructure and service delivery that reduces vulnerability.

Entry point 4:
Institutional capacity for urban development

Urban climate resilience will be strengthened only when the individuals and institutions charged with managing cities have the proper capacity. There is a need to build the capacity of city government and other key stakeholders to understand climate risks and deploy responses, including with digital technology. With the right individual and institutional capacities, relevant programmes will be developed, the right investments made and valuable partnerships established. All this will ensure that digital technology is at the core of urban climate resilience and supports urban development.

12 Quaggiotto, G. (9 April 2014). "Combining "Big" and "Small" Data to Build Urban Resilience in Jakarta". *United Nations Global Pulse*.
13 Arup's City Resilience Framework: https://www.arup.com/projects/city-resilience-index
14 Ramos, J. (12 July 2021). "Technology for Smart Cities: The Pillars of Urban Planning for the Future". *Tomorrow.City*.
15 Revi, A. et al. (2014). "Urban Areas". In *AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability*. IPCC.

Entry point 5:
Social inclusion in urban areas

There are two major steps that urban communities can take to make their cities more resilient to climate change:

- Enhance their understanding of what is driving climate-related shocks and stresses; and
- Identify and prioritise pathways to urban climate resilience through community-level planning, implementation and operations.

Cities across LMICs have seen informal settlements expand. Built in areas susceptible to extreme weather conditions, such as flooding, these communities are vulnerable to disasters and climate change impacts.[16] As a long-standing urbanisation challenge, informal settlements were expected to be tackled with urban planning, but rapid population growth has made it difficult for municipalities to keep up with needs of these communities and deliver services effectively. At the same time, municipalities also face challenges collecting disaggregated data, which is vital for urban planning and especially fast and effective service delivery.

To become more climate resilient, cities require a better understanding of the needs of communities typically excluded from formal data sets, including the urban poor, urban migrants, women and people living in informal settlements. In the event of a disaster or climate-related impacts, poor urban planning has left informal settlements without evacuation routes or a way to be reached with assistance. Municipal planning for service delivery therefore provides an entry point to integrate technology – and the voices of communities in informal settlements – in planning processes that identify climate risks and resilience.

Entry point 6:
Tapping the private sector in urban areas

There are huge potential gains from involving the private sector in urban climate resilience, not only for business profitability but also the resilience of urban areas. Municipal governments can influence investment-related decisions through planning, incentives, policy and knowledge sharing, but contend with significant resource and capacity constraints. The private sector can play a key role in enhancing urban climate resilience, especially by engaging the informal economy where enforcement and compliance with formal planning and regulations are usually much weaker.[17]

Entry point 7:
Catalysing finance

Enhancing the ability of urban areas to access and absorb funding streams for climate resilience is the final entry point. Cities have the fiduciary infrastructure to generate local funds, receive funds from provincial and national governments, distribute funds (e.g. by allocating them to different departments) and account for receipts and expenditures. It is also important to tap local sources of finance to support urban climate resilience. Finance from the private sector can play a key role, including through investments in the provision of risk-transfer mechanisms or insurance, climate-proofing supply chains and business continuity, all of which can ensure that urban economies continue to flourish amid disruptions.

16 Sakijege, T. (February 2019). "Mainstreaming Disaster Risk Reduction into Housing Development in Keko Machungwa". *Journal of Environmental Protection.* 10(2).
17 Bahadur, A., Tanner, T. and Pichon, F. (November 2016). *Enhancing Urban Climate Change Resilience: Seven Entry Points for Action*. ADB Sustainable Development Working Paper Series, No. 47.

02

Emerging insights: mobile big data for urban climate resilience

2.1 Defining mobile big data

Big data can be defined as "high-volume, high-velocity and high-variety datasets that can be analysed to identify and understand previously unknown patterns, trends and associations."[18] The scope of this study is on the role of data created by everyday usage of mobile services, such as:

- **Event data:** Logs recorded by an MNO when users connect to their network for calls, SMS, mobile internet, Unstructured Supplementary Service Data (USSD), mobile money transactions or other type of event data recorded by the MNO's system.
- **Network data:** Includes data on the telecom network itself, including the location of cell towers antennae and underground networks, infrastructure status and other logs of activities taking place on the network.
- **Customer data:** This is usually collected by an MNO during the registration process and includes socio-economic and demographic information, as well as information related to the sign-up, status and activity of the customer.

MBD can be used for several urban planning and disaster response activities. It has notable use in sectors like transportation and health, and the most prominent use case is transport network planning and management. Most current use cases have a strong focus on location-based activities, and therefore use MBD data subsets that indicate location, for example, call data records (CDR). MBD can also be combined with data sets such as climate, population census, GIS and traffic. Unlike a snapshot of the population obtained from a census or household survey, MBD can capture an almost continuous record of population location and movement that can be analysed by time of day, day of the week or seasonally.

The use cases in this section are aligned with the GSMA definition of urban climate resilience solutions: adaptive capacity, anticipatory capacity and absorptive capacity.[19] However, many solutions cut across more than one category.

18 World Bank. (2016). *Big Data and Thriving Cities*.
19 Bahadur, A. et al. (2018). *The 3As: Tracking Resilience Across BRACED*. BRACED Knowledge Manager.

2.2 Mobile big data for adaptive capacity: use cases and examples

Urban resilience can be strengthened with robust, data-driven urban planning that enables the design and implementation of climate-resilient infrastructure likely to withstand climate hazards, such as flooding. MBD can also be used to address the needs of urban populations that may not be identifiable from conventional data sources, such as census data. The following use cases are variations on this theme.

MOBILE BIG DATA FOR ADAPTIVE CAPACITY

Transport network management

MBD and climate data can be used to **plan safe alternate routes** and redirect public transport services.

Predictive analytics and MBD can **provide insights on weather conditions/city events** that are likely to increase infrastructure use, such as energy or transport.

Public services and infrastructure management

MBD and big datasets on vulnerable populations can be used for **planning and delivering public services**.

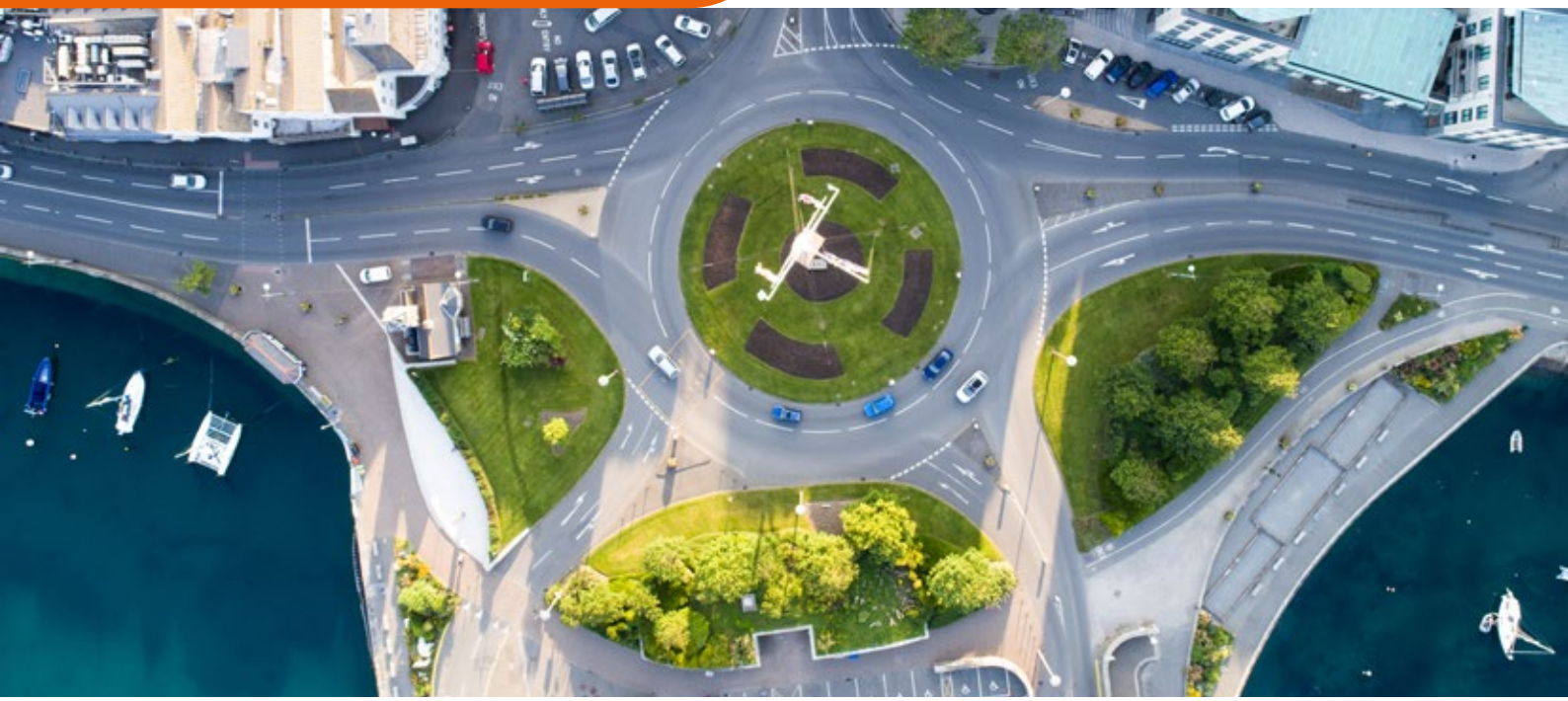
Predictive analytics and MBD can **provide insights on weather conditions/city events** that are likely to increase infrastructure use, such as energy or transport.

Climate-resilient land use

Predictive analytics and MBD can **provide insights on weather conditions/city events** that are likely to increase infrastructure use, such as energy or transport.

Long-term migration patterns

MBD can **provide crucial information about population clusters**, i.e. informal settlements.



Transport network management: MBD can be used to plan and manage various aspects of a city's transport network. This data can be used to understand the daily mobility patterns of a city's population, such as peak hours of transport and the level of traffic on various routes. This analysis can be used to plan for public transport, which may include how to distribute the public bus fleet, at what times of day or new routes to add, particularly to improve the connectivity of marginalised and vulnerable communities. MBD can also be combined with climate data, such as historical spatial impacts, to plan for safe alternate routes and redirect public transport services. City authorities and transport service providers can use MBD with climate data to plan transport infrastructure in safe areas and climate-informed maintenance. When combined with emissions data and insights about choices of transport mode, decision-makers can plan for a low-carbon transport system that reduces carbon emissions and the impact of climate change and the need for ever greater resilience measures.

Box 1.

Mobility insights support urban planning in Colombo, Sri Lanka

LIRNE Asia collaborated with a Sri Lankan MNO to pseudonymise call detail records (calls, SMS, internet access), airtime recharge records and visitor location records (VLR). The analysis showed clear mobility patterns and hotspots in a typical 24-hour period on weekdays and weekends. This provided a series of recommendations for the city authority, including adjusting administrative boundaries and accommodating transport demand. The analysis also found different mobility patterns around and during the festival of Avarudu, providing insights on population movement across the whole country. Machine learning techniques were used, via principal component analysis (PCA), to complement census data and shed light on population numbers and distribution in Colombo.[20]

20 Samarajiva, R. (17 January 2015). Video: "Using mobile-network big data for urban and transportation planning in Colombo". MESC Public Lecture.

Public services and infrastructure management: Other public services and general city management can also apply insights on population distribution and intensity of activities. When combined with other big datasets on vulnerable populations, public services can be tailored to meet their specific needs. Predictive analytics using MBD can provide insights on when certain weather conditions/city events are likely to lead to greater use of infrastructure, such as energy or transport. These insights can help to plan for expected increases in infrastructure load and avoid loss or disruption of critical services.

Box 2.
Vodafone's Smart Cities Platform harnesses MBD insights

Vodafone's Smart Cities Platform creates a single platform to monitor a wide range of their services. The platform builds on existing systems to develop smart 'vertical' services, using MBD capabilities enabled by ThingWorx Analytics.[21] The platform is designed to provide transparency for public agencies and, by combining analytical capabilities and the integration of multiple data sources, it can contribute to more efficient and higher quality municipal services. Sectors currently using the Smart Cities Platform include energy, mobility and environmental management.

Climate-resilient land use: Insights on the intensity of urban population activities can be used for land use classification, and insights on activities in locations at risk of climate-related hazards can be used to change how the space is used. For instance, new infrastructure and public venues can be planned in less at-risk locations. Over time, this data can capture the growth of classification areas and enable climate-resilient city management plans to be developed accordingly. These insights can also be used to make strategic planning decisions related to land use, future investments and business location strategies.

Box 3.
MBD transforms official statistics and aids planning in Ghana

Ghana Statistical Services (GSS) worked with Vodafone Ghana and Flowminder to produce official statistics using de-identified (anonymised) MNO data to strengthen humanitarian and development decision-making in the country. This collaboration is the first of its kind in Ghana, and one of the first in Africa, to use technology to transform the production of official statistics.[22] De-identified and aggregated telecommunications big data, provided by Vodafone Ghana, is used to generate population predictions that can support more sustainable development planning. The data, in combination with more traditional data sources such as household surveys, provides useful information on the mobility and characteristics of the Ghanaian population, which can be used for a range of humanitarian and development applications, including public health, disaster preparedness and transportation planning.

21 Vodafone. (n.d.). "Creating Smart Cities".
22 Flowminder.org. (n.d.). "Integrating mobile operator data into official statistics in Ghana".

Long-term migration patterns: Data on population movement and density over time can provide insights on shifting population density. This can be used for medium- and long-term planning for public services and infrastructure. MBD can provide crucial information about population clusters that may otherwise be difficult to capture or are not included in more official datasets, such as populations that live in informal settlements or those who are internally displaced or refugees. Migration can be triggered by several factors, including seeking education or jobs, displacement due to shocks like a major climatic event or degradation of one's home environment.

Box 4.
MBD measures internal displacement in Colombia

In partnership with the Food and Agriculture Organization (FAO) of the United Nations, Telefónica used MBD to measure the internal displacement of citizens from La Guajira region following a severe drought in 2018. LUCA, Telefónica's big data services unit, used their SmartSteps platform to analyse mobile network data from La Guajira and map population movements from rural to urban areas.[23] This provided the government with better data to plan and implement social protection measures, reduce climate-related displacement and build more resilient communities. MBD filled a critical gap since data on internally displaced people (IDP) is inherently difficult to collect. IDPs in LMICs can be practically invisible to national and international organisations, leaving their needs unaccounted for, unplanned and unaddressed. The World Bank estimates that in 2018 there were 3.7 million people in Colombia vulnerable to climate-related impacts, such as cyclones, landslides and floods.[24] Telefónica is also working with LUCA and UNICEF to map those affected by floods and landslides.[25]

23 GSMA. (2019). "Case Study: Building Communities Resilient to Climatic Extremes".
24 The World Bank. "Colombia Dashboard Overview".
25 LUCA and UNICEF. (28 February 2017). Video: "Big Data for Social Good in Colombia".

2.3 Mobile big data for anticipatory capacity: use cases and examples

The second category of resilience is the ability to anticipate and prepare for rapid onset disasters, such as typhoons, flooding and landslides. The following use cases show how MBD can enhance this capacity in urban areas.

MOBILE BIG DATA FOR ANTICIPATORY CAPACITY

Disaster risk reduction and management planning

MBD can **provide insights on population distribution** and mobile patterns that can inform a city's disaster risk reduction and management (DRRM) plans.

Public services and infrastructure management

MBD can help to **identify population groups** that are vulnerable to climate hazards.

Early warning systems (EWS)

MBD **provides insights on the growth of land classification areas** to support climate-resilient city management plans.

Disaster risk reduction and management planning: Insights on population distribution, mobility patterns and land use derived from MBD can inform a city's DRRM plans. Data can be used to prevent dangerous situations and plan emergency evacuations, and historic data on mobility at the time of a climate shock can help to understand how it triggers or affects population movements. These insights can aid in planning for similar future disasters.

Public services and infrastructure management: MBD can help to identify population groups that are vulnerable to climate hazards, when they are most at risk and where they are located within specific disaster risk-prone areas. This can be used to plan targeted interventions to reduce disaster risk based on a community's needs.

Box 5.
Understanding inequalities in disaster response in Houston, USA

Following Hurricane Harvey in 2017, academic researchers[26] analysed the mobility patterns of more than 800,000 anonymised mobile devices in Houston, Texas, which represented approximately 35 per cent of the local population. Based on changes in mobility behaviour before, during and after the disaster, they empirically defined community resilience capacity as a function of the magnitude of impact and time to recovery. Overall, they found clear socio-economic and racial disparities in resilience capacity and evacuation patterns. Their work provided new insights on behavioural response to disasters and a basis for data-driven public sector decisions that prioritise the equitable allocation of resources to vulnerable neighbourhoods.

Public communication/early warning systems (EWS): MBD can provide valuable insights for early warning agencies in LMICs. Through big data, it is possible to understand current population dynamics and their exposure or vulnerability to climate hazards. Combined with forecast information, MBD analysis can provide an accurate impact forecast of how a disaster or weather is likely to affect populations and infrastructure. Early warning alerts can then be designed and disseminated in a more targeted way to improve preparedness and decisions about the best course of action.

MBD analysis can also provide insights on the communication and connectivity behaviours of the population. This can be used to design an EWS public communication approach that ensures information reaches people in a timely and effective manner. For instance, an EWS that is internet-dependent may not be an effective way to reach low-income communities that can only afford to use mobile internet intermittently.

26 Hong, B. et al. (2021). "Measuring inequality in community resilience to natural disasters using large-scale mobility data". *Nature Communications*, 12, Article number: 1870.

2.4 Mobile big data for absorptive capacity: use cases and examples

The third category of resilience is the ability of urban areas and their populations to experience rapid onset shocks and quickly rebound to normal life without debilitating loss of life, property and economic output. The following use cases show how MBD can support this aspect of resilience.

MOBILE BIG DATA FOR ABSORPTIVE CAPACITY

Migration/ displacement

MBD can **provide migration patterns** of people affected by disasters.

MBD can **support operational planning and allocation of resources**.

Public services and infrastructure management

Integrating MBD and real-time data, such as crowdsourced data, can **provide insights on disaster response needs**.

Forecast-based financing and finance distribution

MBD can **provide insights on efficient mechanisms** for mobilising finances, such as cash transfers, to prepare for extreme weather events.

COVID-19 and future pandemics

MBD analytics has potential to help governments around the world better **prepare for future disease outbreaks**.

Migration/displacement triggered by disasters: Insights derived from MBD on the migration patterns of people affected by disasters can support better operational planning and allocation of resources. These insights can be used to improve support for host communities where displaced people congregate.

Box 6.
MBD tracks post-disaster population flows in Bangladesh

Bangladesh has crowded, low-lying coastal areas that are exposed to frequent flooding from tropical cyclones and rising sea levels. The country is at the frontline of climate vulnerability. Following Cyclone Mahasen in 2013, Flowminder used mobile big data to quantify post-disaster population flows.[27] Analysis found that while cyclone shelters were used by some, others left their homes late, or not at all, to safeguard their property and assets. Data on such high-risk behaviour can help target messages for future disaster preparation plans. Researchers found that the yearly migration patterns in Bangladesh were virtually unaffected by the cyclone but dominated by the seasonal migration accompanying the annual monsoon and religious festivities.

Real-time disaster response: Integrating MBD with other real-time data, such as crowdsourced data from social media, can provide insights on ongoing disaster response needs. It can inform decisions on logistics, rescue routes, resource mobilisation, redirecting public services and others. In cases of real-time disaster response, MBD has been instrumental in measuring the effectiveness of an EWS in terms of number of people evacuated and could enable learning about the real impact of disasters.

Forecast-based financing (FbF) and finance distribution: Rapidly evolving mobile payment systems in LMICs, such as M-Pesa, provide an opportunity to mobilise finances more efficiently before an impending extreme weather event. Financing is a key tool for recovery in the short term and for building climate resilience over time. It can also support the system of cash transfer to households affected by disasters. Digital solutions are well suited to the time-sensitive nature of mobilising finances and can serve as both an anticipatory and a relief tool.

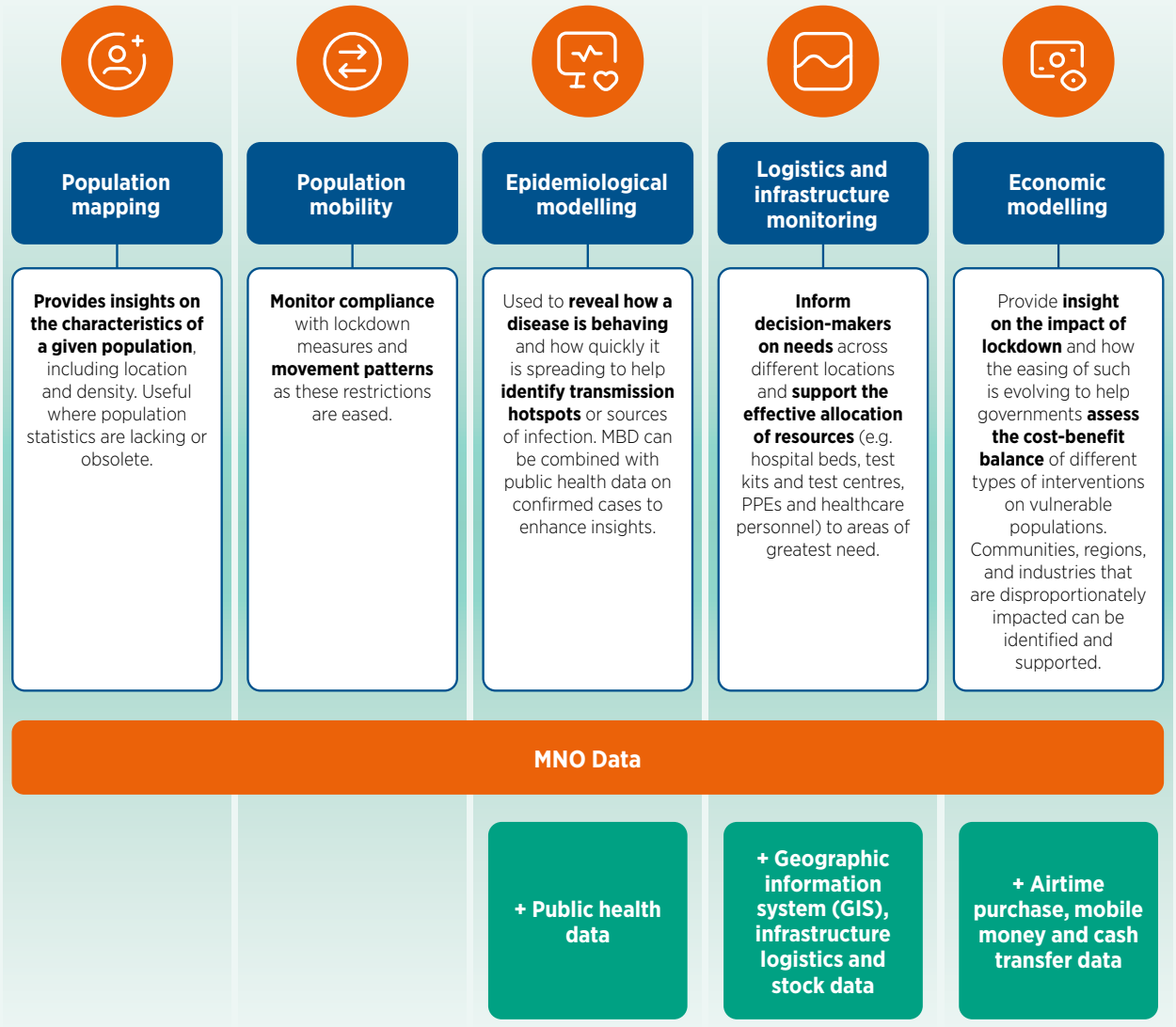
Box 7.
Mobile money transfers as a coping mechanism in Rwanda

A 2011 study in Rwanda used mobile phone activity to estimate money transfer patterns within social networks to cope with the 2008 Lake Kivu earthquake.[28] The research used a log of all mobile-based airtime transfers and estimated that, as of 2011, an earthquake would result in the transfer of between $22,000 and $30,000 to individuals living near the epicentre. Another aim of the research was to identify the types of individuals who are most likely to benefit from access to the mobile phone network. The research showed that those who did not own a mobile phone, who tended to be the poorest and most vulnerable, were not able to access and benefit from this coping mechanism.

27 Flowminder.org. (n.d.). "Mobile Phone Data to Understand Climate Change and Migration Patterns in Bangladesh".
28 Blumenstock, J. et al. (2011). *Risk and Reciprocity Over the Mobile Phone Network: Evidence from Rwanda*. CSAE Working Paper WPS/2011-19.

COVID-19: According to the GSMA report, "Utilising Mobile Big Data and AI to Benefit Society", MBD analytics hold promise for governments around the world to better prepare for future disease outbreaks and tackle local and global challenges in line with the United Nations Sustainable Development Goals (SDGs). The immediate and timely need to respond to disease outbreaks has similarities to the need to respond effectively to a climate disaster. In both instances, there is a need for timely and dependable data that can be used to make decisions rapidly and prevent further loss of life, suffering and economic harm. In response, the GSMA has mapped key MBD analytics use cases for various government COVID-19 response measures, which vary according to the stage of the pandemic outbreak, the unique needs of each country and the local capacity to develop and use MBD products and services.

Figure 2:
MBD analytics use cases for the COVID-19 response



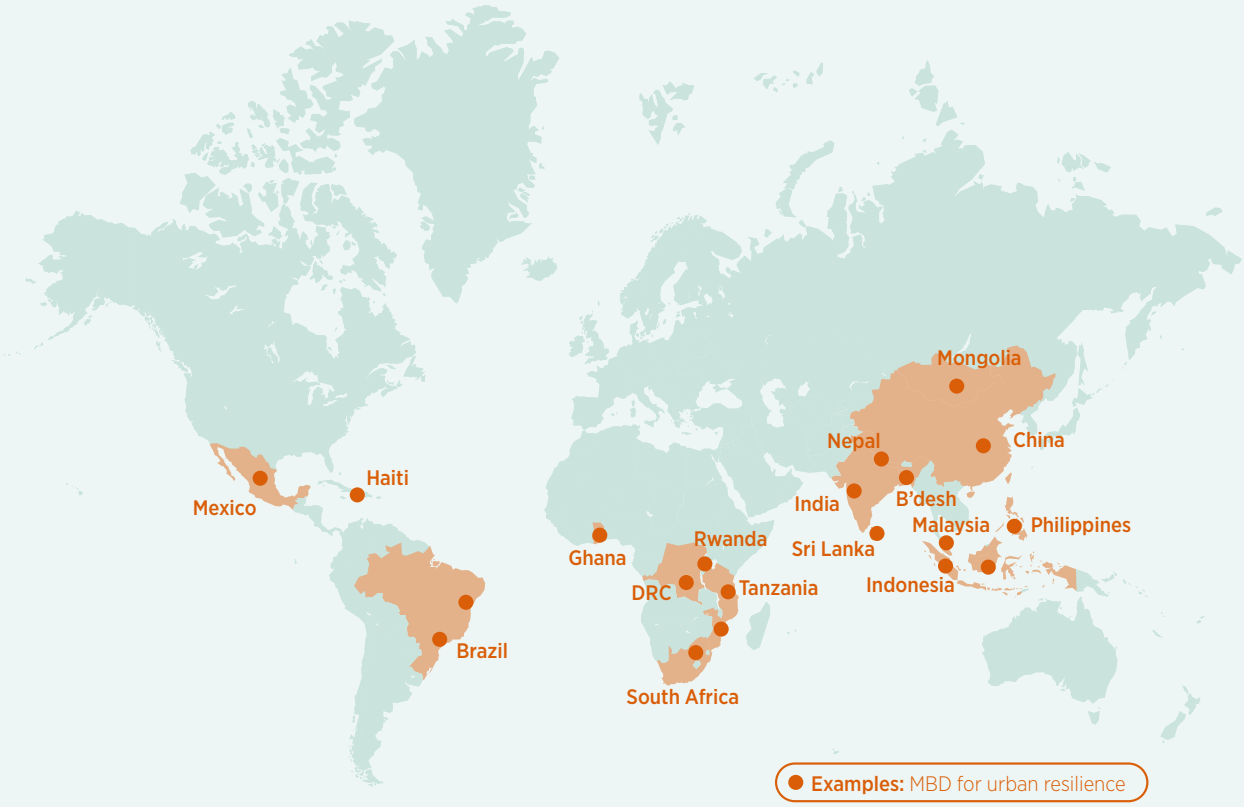
Source: GSMA. (2021). Utilising Mobile Big Data and AI to Benefit Society.

2.5 Mobile big data for urban climate resilience in practice

This research identified a rather limited number of practical examples of MBD being used for climate resilience. A total of 25 examples were found in LMICs, as shown in Figure 3. These were identified via a systematic internet search. Approximately five standardised key search terms were entered along with the name of a specific country. Some of the use cases described earlier have multiple real-world case studies, whereas some are supported purely by analytical research and do not yet have real-life application. The most common use cases that have been implemented are:

- Transport network management;
- Long-term migration patterns; and
- Migration/displacement triggered by disasters.

Figure 3:
Location of MBD for resilience case studies identified during the research



Source: Analysis by Urban Emerge

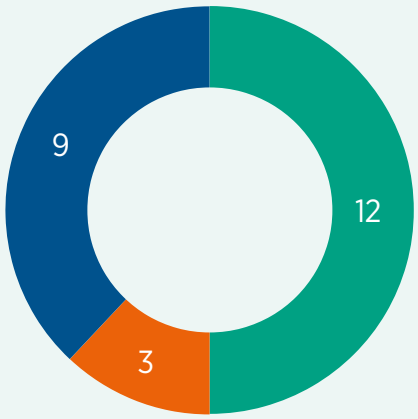
Figure 4 groups the 25 practical examples identified in the research by the 3As. Half were related to adaptive resilience and informed longer-term climate-resilient planning for urban areas. A few examples were anticipatory, feeding into initiatives to help cities anticipate and better prepare for and respond to disasters. The rest were absorptive resilience examples, allowing urban areas to cope with and bounce back quickly from climate-related disasters.

As shown in Figure 5, many of the use case examples fall into two main categories:

- The use of MBD to enhance urban planning, which can improve resilience to disasters; and
- The use of MBD to inform disaster preparedness and response.

Figure 4:

Use case examples by the 3As

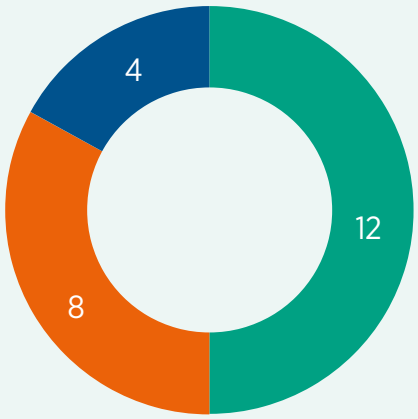


38%	Absorptive
13%	Anticipatory
50%	Adaptive

Source: Analysis by Urban Emerge

Figure 5:

Types of MBD use case examples



17%	Other aspects (heat, hailstorm etc.)
33%	Urban mobility/planning'
50%	Disaster response

Source: Analysis by Urban Emerge

2.6 Assessing the value of MBD for urban climate resilience

The attractiveness of using MBD for urban climate resilience depends on whether it can deliver new or better information; accelerate decision-making and action; and deploy more targeted interventions, all of which can have positive impacts on people's lives and livelihoods and enable governments and other decision-makers to stem economic losses. However, climate risk analytics in LMICs are still undeveloped, making it difficult to fully articulate the economic benefits of MBD for climate resilience. This is due mainly to the costs of providing data infrastructure, obtaining consent and investing in skills, which are much more visible to MNOs. Once these issues are resolved, some business models will eventually become sustainable for MNOs, governments and other actors.

The value of MBD in urban climate resilience for governments, business and society

The World Bank reports that natural hazards may cost cities worldwide $314 billion each year by 2030. Investing in climate-resilient infrastructure and solutions can provide a "net benefit in low-and middle-income countries of $4.2 trillion, with $4 in benefit for each $1 invested".[29]

For a municipal government, the attractiveness of using MBD for urban climate resilience has two broad components.

- First, governments often use a measure called value of a statistical life (VSL)[30] when setting budgets on safety and resilience spending. The VSL estimates the amount of money the public is willing to spend to save one life. Given that governments play a key role in the uptake of new technologies, the replication of innovations and providing incentives that attract MNOs and other private sector companies, the VSL is instrumental in evaluating the efficiency of the existing regulatory environment. In this context, using the VSL methodology to analyse the attractiveness of investing in MBD will include calculating the value of the lives potentially saved and whether this outweighs the cost of investing in MBD. The health, transportation and environment sectors attract the use of the VSL tool. However, it is not popular in most LMICs as the necessary infrastructure is underdeveloped.[31] Spending on MBD can be understood as a 'premium' that can 'pay out' like insurance for LMICs.
- It is therefore useful to consider the value proposition of certain use cases for MBD, as shown in Table 5. An important cost-benefit is the efficiency of using MBD for data collection compared to conventional surveys, which are labour intensive. Many of these could be quantified for a specific city or national context, helping to make the business case for the purchase and use of MBD.

> The VSL methodology would be instrumental in assisting local governments to design MBD solutions for scale. Specifically, the VSL methodology would quantify the additional lives saved by using MBD data analytics in urban climate resilience scenarios.
>
> Municipalities and organisations can move quickly from being inspired by examples of social impact, to achieving widespread scale through repeated implementation in different local environments and circumstances. This requires implementing agencies and MNOs to work with other stakeholders to develop sustainable solutions and scale up their impact.

29 World Bank. (17 June 2019). *Lifelines: The Resilient Infrastructure Opportunity*.
30 The VSL is an estimate of the amount of money the public is willing to spend to save one life.
31 Viscusi, W.K. and Masterman, C.J. (2017). *Income Elasticities and Global Values of a Statistical Life*. Vanderbilt Law School.

Table 1.

Value proposition and benefits of different MBD use cases

Use case	Type	Value proposition	Benefits	Timespan
Statistics support for post-disaster analysis of population movements	Adaptive	**Government:** Improving a future disaster response and resilience strategy to target areas where people will leave **Government and business:** Where economic recovery is most likely to occur where people will arrive and stay	High	Long
Participatory planning for resilient solutions	Anticipatory	**Government:** Save consultation time on resilience solutions	Medium	Long
Proxy for food security	Absorptive	**Government:** Target food subsidies and deliveries in a resilience event; measure poverty for general income assistance	High	Short
Informing transport planning	Anticipatory	**Government and business:** Understanding mobility patterns and travel demand before, during and after a disaster event	Medium	Long
Measuring government responses to disasters (e.g. stay-at-home orders)	Absorptive	**Business:** Where economic activity occurs: commuting, shopping, trade	Medium	Short

Source: Analysis by UrbanEmerge
* The benefits column is likely to be viewed differently by different countries and governments. In this regard, it is important to understand the context of the country and city priorities.

03

Insights and recommendations from country deep dives

Following the global overview of the potential use cases and actual examples of MBD to strengthen urban climate resilience, a deep-dive study was conducted in three selected countries: Indonesia, Kenya and Mozambique. The deep dives sought to understand the current uses and potential for MBD at a more granular level and to:

- Understand the nature of urban climate risk vulnerability;
- Identify and assess current or recent uses of MBD for urban climate resilience;
- Identify similar uses of MBD for non-climate-related disasters, such as earthquakes, which still provide valuable learning for climate-related disasters;
- Explore opportunities to use MBD to address specific data gaps that can strengthen urban resilience;
- Understand the constraints; and
- Assess other relevant factors, such as partnerships and commercial models, and provide country-specific recommendations to help guide subsequent initiatives.

3.1 Indonesia

Vulnerability to climate hazards in urban areas

Indonesia is extremely vulnerable to extreme climate hazards and disasters and is ranked in the top third of countries when it comes to climate risk.[32] Made up of more than 17,500 islands and 81,000 kilometres of coastline, Indonesia is the world's largest archipelagic state.[33] The country is also rapidly urbanising at an average rate of 4.4 per cent a year, the highest rate of urbanisation in Asia. Sixty-eight per cent of its population is expected to be living in cities by 2050[34] and it boasts the largest economy in Southeast Asia, playing an important role in the region.

How MBD is strengthening urban climate resilience in different sectors

Indonesia has a vibrant mobile ecosystem with seven MNOs serving an estimated 185 million unique subscribers. According to GSMA data from 2021, nearly 55 per cent of Indonesians subscribe to mobile internet, 69 per cent of SIMs are connected to 4G and 78 per cent of SIMs are installed in a smartphone, making the mobile ecosystem a key data provider.[35]

Disaster response

A partnership between UN Pulse Lab Jakarta (PLJ) and the International Organisation for Migration (IOM), Digicel and Telkomsel Indonesia used MBD to analyse population movements following an earthquake in Sulawesi in September 2018. The three most-affected districts were Palu, Sigi and Donggala, which had approximately 600,000 active mobile subscribers.[36]

The IOM used MNO data from Telkomsel Indonesia to establish a baseline for residents, which called for close cooperation, tight data-sharing and security agreements with PLJ on the analysis of population movements. PLJ worked to establish a baseline for resident subscribers and then compared changes in the number of subscribers who travelled outside the districts following the initial earthquake and several subsequent earthquakes (based on data from October 2018 to January 2019). An origin-destination matrix was created to identify popular destinations for IDPs and tailor disaster response plans to better meet the needs of the maximum number of people.

32 World Bank Group and Asian Development Bank. (2021). *Climate Risk Country Profile: Indonesia*.
33 World Bank. (2022). "The World Bank in Indonesia".
34 World Bank. (2016). *Indonesia's Urban Story.*
35 GSMA. (2021). *The Mobile Economy 2021*.
36 Pulse Lab Jakarta. (16 December 2019). "Understanding Population Movement After the 2018 Central Sulawesi Natural Disasters". *UN Global Pulse.*

Tourism

Since 2016, the Ministry of Tourism has been working with Telkomsel to analyse MBD as an additional source of statistics for a range of areas, including calculating inbound tourism in Indonesia and legal and illegal border crossings.

In 2019, Positium, a third-party data analysis company from Estonia, began working with BPS (Statistics Indonesia) and Telekomsel in Indonesia on MBD for disaster response, which was related to tracking and locating tourists in disaster areas. The dashboard they developed was instrumental in sharing information on the number and origin of tourists present in the vicinity of a crisis-affected area.

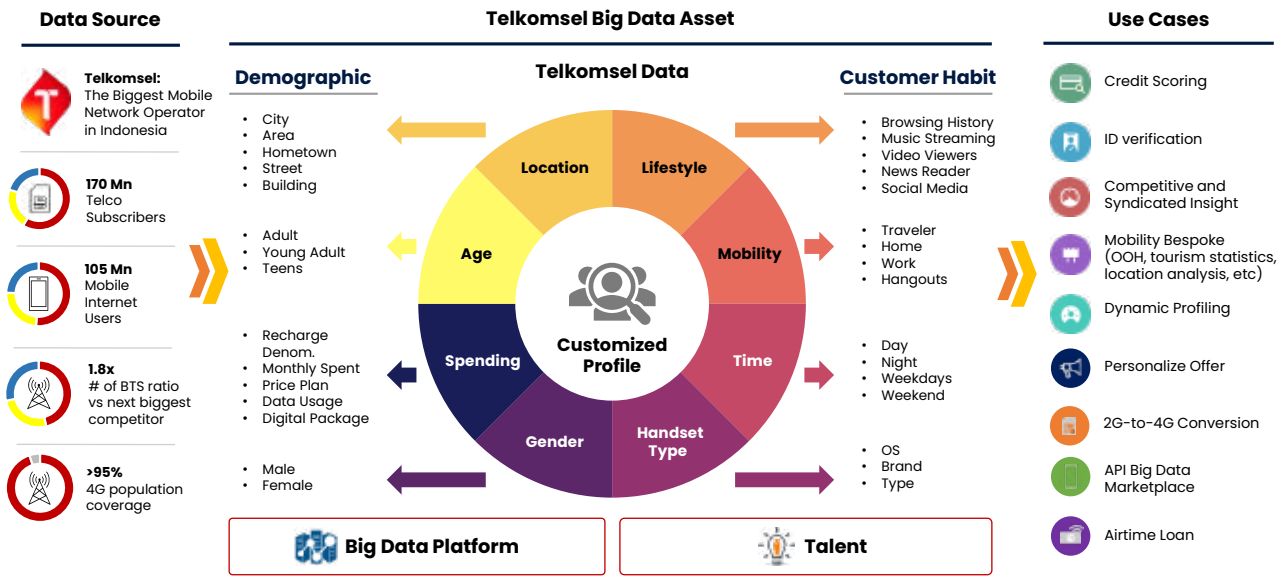
Statistics support

In 2019, Telkomsel signed a Memorandum of Understanding with BPS, which launched a programme of cooperation to use mobile positioning data (MPD) in the production of official statistics in Indonesia.

Positium was again involved as a subject matter expert in 2019 to develop the algorithms, guide the data analytics, provide quality assurance standards and review and check the work of BPS. Positium suggests that big data in general, and MPD in particular, is currently one of the best sources to understand the spatio-temporal behaviour of people.[37] This is part of a wider initiative by Telkomsel to commercialise their MBD assets through their M-SIGHT initiative. As shown in Figure 6, there are multiple sources of MBD and multiple use cases, including the support to BPS and the Ministry of Tourism.

Figure 6:

Telkomsel's M-SIGHT MBD ecosystem



Source: Telkomsel[38]

This kind of data was unknown to the Government of Indonesia before 2016. Due to this initiative, the use of MBD has become part of the government's statistics skill sets.

37 Positium. (30 January 2019). "Partnership with BPS - Statistics Indonesia: Using MPD for Official Statistics". *Positium Blog.*
38 Shared via the 2021 Expert Group on Mobile Big Data, hosted by ESCAP.

Mobilise Your City is a major programme funded by the EU to support sustainable transport and mobility in cities around the world. The programme is active in the city of Medan where a Sustainable Urban Mobility Plan (SUMP) is being prepared by Egis, an urban development consultancy. Through a commercial agreement between Egis and Telkomsel, mobile phone data was used to provide a comprehensive understanding of mobility patterns and travel demand. This contributed to evidence to support the development of a transport strategy for the city that will meet the needs of the maximum number of citizens.

Opportunities for MBD to strengthen urban climate resilience

Population location data

Indonesia's Village Potential Statistics (PODES) are updated every three years, which leaves gaps in population and household data in certain areas. PODES provides insights on the needs of vulnerable populations who are typically underrepresented, which is important for cities that do not have sufficiently granular data for robust urban planning.

Population movements

MBD provides a basis for displacement mapping, such as in Sulawesi following the 2018 earthquake. Cities can use baseline data provided by MBD to inform changes that occurred during and following a disaster. In the case of a disaster, necessary actors, including humanitarian agencies, would be able to follow population movements and mobility patterns.

Disaster management

Access and use of MBD would help to assess the impact of an incident or disaster, where people are located, as well as how to reroute people to manage flows in urban areas.

Early warning systems

MBD can provide more accurate impact forecasting for EWS using predictive analytics based on MBD trends correlated with past hazard events. Having a granular understanding of the risk of landslides, both for the population and where they might happen, would also be essential for climate resilience strategies

Social protection mechanisms

Mapping poverty using mobile phones can inform the deployment of social protection mechanisms after a disaster as an adaptative strategy to climate change. Outcomes can be used to inform sustainable livelihood strategies, as well as social assistance and labour market programmes to encourage inclusive growth.

Solid waste management

MBD could complement data on solid waste management with household location and their likely waste generation habits. This would be generated by correlating waste generation patterns with socio-economic factors that may also be available from MBD. This would have an impact on sanitation and drainage planning, the efficiency of waste management services and its relationship to other pollution issues.

Fire risk

MBD could help to anticipate the impact of fires in cities, particularly in informal settlements. This would rely on an analysis of population movements in past fire events, either in the same city or different cities, and would shed light on how to enable primary evacuation routes and keep them clear. This also has implications for city planning.

Other opportunities

With some of these MBD applications, there is an opportunity to collaborate with several ongoing urban resilience initiatives in Indonesia. This includes the Climate Resilient and Inclusive Cities project,[39] which is funded by the EU and being implemented by United Cities and Local Governments (UCLG).

Demand from national and city government: There is interest and demand from Bappenas, the national development planning agency and BNPB, the national disaster management agency, to explore how MBD can add value to urban climate resilience. However, it will be important to pinpoint the specific initiatives and uses that would truly meet the disaster resilience needs of government.

Barriers to strengthening MBD

Although there is a great deal of support for using MBD for urban climate resilience in Indonesia, there are several constraints, including:

Lack of awareness of MBD and how to use it: While Indonesia benefits from some MBD use cases in resilience and urban planning, as well as an advanced ecosystem developing between MNOs and commercial clients, one of the most frequent constraints cited in the research is lack of awareness of MBD and how it can be applied to climate resilience efforts. Among government agencies and civil society organisations working on urban planning and disaster resilience, there is little knowledge of the potential use cases and how to source MBD.

Limited understanding of the value proposition of MBD for resilience: The use cases for MBD in Indonesia offer entry points to build resilience to negative climate change impacts. However, inadequate information on the use of MBD in adaptive, absorptive and anticipatory capacities can often create a misalignment between the value of MBD, priority use cases and the right actors to convene. Difficulties can also arise if there is a mismatch between what the government needs and what is possible for suppliers.

Limited capacity of national and local government to apply MBD: There is low capacity in most small and large cities in Indonesia, particularly outside West Java, to apply MBD to city governance and operations. The research revealed high potential for regional and local governments to benefit from the insights of MBD. However, local capacity to turn data into insights is a significant barrier. Other barriers include data silos in government and hesitation by national and local governments to accept new research and data sources.

Recommendations: Help government and

MNOs to understand how MBD can create value and save costs compared with other data collection methods. A business case can be developed by illustrating the cost of inaction in the face of climate impacts.

Different actors can draw on lessons from the use of MBD for public good in Indonesia. This would include identifying an appropriate government champion for an initiative, such as BPS (a driver of MBD in Indonesia), and other relevant agencies, such as BNPB, to build capacity in using MBD and its applications.

Include conveners who understand how to forge these public-private collaborations and who understand the potential of MBD and artificial intelligence (AI).

Underdeveloped data privacy and security laws: With no specific cybersecurity regulations in Indonesia, data privacy is a challenge. Existing regulations do not recognise or value interactions with MBD. A General Data Protection Regulation (GDPR)-like data protection bill has been in parliament for several years but has not yet been put to a vote. It is expected to be enacted in 2022.

Recommendation: Develop frameworks and policies that would support data privacy and security laws at national and municipal levels. MNOs have an opportunity to lobby for the enactment of a data protection bill.

39 Climate Resilient and Inclusive Cities Project website.

3.2
Kenya

Vulnerability to climate hazards in urban areas

With the largest economy in East Africa and a population of 48.5 million, Kenya is extremely vulnerable to climate change. Rising temperatures and rainfall variability are affecting the lives and livelihoods of millions,[40] and flooding and landslides have become common. The sectors most vulnerable to climate change include agriculture, water resources and health. The rapid growth of Kenyan cities has pushed their boundaries well beyond the territory of their municipal authorities and there has been a simultaneous rise in informal settlements. More than half (54.7 per cent) of Kenya's population live in informal settlements.[41] According to World Bank estimates, roughly 60 per cent of Kenya's urban families live in areas that would be defined as slums.

People living in informal settlements like Kibera are disproportionately vulnerable to flooding, landslides and extreme heat. Informal settlements are often located in areas with high exposure to hazards, for example, low-lying flood-prone areas near rivers where it can be cheaper to live. Other risk factors in these areas are population density, housing design (e.g. limited ventilation, improper building materials) and inadequate public infrastructure (e.g. sanitation, waste management). For example, people who must cross rivers to go to work face a dangerous journey in the rainy seasons. When the river overflows, bridges become unusable, limiting safe travel options. This exposure to climate hazards is compounded by other vulnerabilities, such as low-income levels and limited access to critical services, such as health services, clean and affordable housing and weather information. This affects the adaptive capacity of communities and the city at large.

40 USAID. (2018). Fact sheet: "Climate Risk Profile: Kenya".
41 UN-Habitat. (2016). *UN-Habitat Support to Sustainable Urban Development in Kenya: Addressing Urban Informality*.

Opportunities to use MBD for urban climate resilience in different sectors

This research did not identify any existing use cases for MBD on urban development or climate resilience in Kenya. However, several opportunities for MBD emerged in the health, transportation, agriculture, urban planning and resilience sectors. As a technologically savvy country, the following are potential entry points for MBD to strengthen urban resilience in Kenya.

Mobile phone use: High mobile phone penetration in Kenya provides an excellent opportunity for various sectors to integrate MBD insights in their work. The GSMA's 2021 Gender Gap report shows remarkable data on mobile ownership in Kenya. 94% of the population own mobile phone are male while 88% are of the female gender. In addition, the GSMA estimates that smartphone connections in Kenya will reach 52 million by 2025.[42] Growing demand for telecommunication services is fostering new businesses, such as mobile app development, mHealth, e-commerce and gaming, and is making mobile technology a platform for innovations across different sectors, including health, agriculture and financial services. As mobile phone use increases across population groups, more data should become available. This could be beneficial in providing data on underserved population groups (e.g. informal settlements) that may not be included in official data or other datasets.

Technological skills: Home-grown platforms like Ushahidi[43]and Digital Matatus[44] showcase the demand for technology that meets local needs. Cities like Nairobi, Mombasa and Kisumu have been the cradle of technological innovations and the centres of Kenya's thriving technology ecosystem. A key contributing factor is the abundance of technological skills, especially among youth. However, specialised training that improves skills and builds capacity in data analytics can enable the use of MBD in various sectors.

Existing case studies on the use of mobile technology in public services: There are many examples of using mobile devices and mobile-enabled solutions in fields such as disaster risk management, urban planning, health, transport and mobility and water management. Mobile phones are an important part of early warning communication and hazard reporting in Kenya.[45] Mobile devices have been used as key data collection tools for citizen reporting (e.g. Digital Matatus), which has enabled public participation, multistakeholder approaches and direct collaboration with targeted communities. For data that does not exist or is difficult to access, organisations collect primary data using mobile-based data collection tools.

Interest in MBD: This research indicates there is strong interest in using MBD for urban climate resilience initiatives. Given the early stage of MBD use in Kenya, this research introduced different actors to the potential uses of MBD in their respective areas of work. One of the primary benefits of having access to MBD they highlighted was lower survey costs for organisations, as it eliminates respondent fatigue with multiple data collection exercises. However, it is important to note that MBD should not be considered a replacement for traditional methods, but a complementary tool to combine with other data where possible.

42 GSMA. (2020). *The Mobile Economy: Sub-Saharan Africa 2020*.
43 Ushahidi: https://www.ushahidi.com
44 Digital Matatus: http://digitalmatatus.com/intro_lite.html
45 See, for example, the M-Salama SMS alert service in partnership with the Red Cross.

Barriers to strengthening MBD

Technological capacity and access issues: Organisations we interviewed in the urban climate resilience sector lack the appropriate technical tools (e.g. servers) to access, store and process MBD, especially government institutions and NGOs. This makes it difficult to use this data.

> **Recommendation:** While using and applying MBD requires a medium-to-high skill level, organisations would benefit from training. It would also be interesting to connect MBD-related investments and initiatives with Kenya's strong tech and community innovation clusters.

Data access and partnerships: Kenya lacks a standardised framework and infrastructure for data-sharing partnerships or the co-creation of data-related products and services. Notably, the development of an open data portal that would provide solutions stirred interest among various stakeholders and actors.

> **Recommendation:** Design MBD for resilience initiatives in ways that help to alleviate the constraints in Kenya's data infrastructure and data innovation environment. A useful starting point is the humanitarian and development communities, which have expertise in collecting and using data for resilience initiatives in Kenya.

Limited capacity in analytical tools: There is a gap in the ability to use analytical tools and perform analytics to process data at this scale, which is often curtailed by low knowledge and skills in the analysis and application of MBD.

> **Recommendation:** It is important to build the capacity of government and MNOs to develop regulatory, fiscal and innovation frameworks in this area. In the interim, municipalities may need to consider engaging existing private-sector innovators or third parties to perform data analytics, while ensuring robust data security and privacy measures.

Data privacy and trust: Due to a lack of firm data regulation policies and frameworks, stakeholders we interviewed are of the general view that their data is not yet appropriately protected and is used for other purposes. In 2019, Kenya enacted a data protection law after widespread concern about data privacy and the rise of massive data collection programmes in various sectors.

> **Recommendation:** Digital systems should respect and uphold an individual's right to privacy and ensure that personal data is protected and secure. Organisations using MBD should pay special attention to any additional privacy and security risks arising from MBD systems.

3.3 Mozambique

Vulnerability to climate hazards in urban areas

Mozambique's geography and tropical to subtropical climate make it extremely vulnerable to climate risks. The impacts of climate change add additional stress to the development context make Mozambique one of Africa's most vulnerable countries to climate change while also undermining progress in poverty reduction.[46] In addition, more than 60 percent of the population live in low-lying coastal areas and 45 per cent live below the poverty line.

Coastal cities in Mozambique such as Maputo, Beira and Quelimane are therefore highly vulnerable to climate change-related shocks and stresses.

Inland cities such as Nampula and Chimoio are also vulnerable to cyclones, flooding and extreme heat. The high vulnerability of Mozambique's cities is the result of three decades of unplanned human settlements that have gradually expanded to lowlands and marshy areas. Population rise is also expected to be higher than the national average of many other Sub-Saharan African countries in the next decade and result in rapid urbanisation. The aftermath of floods in Mozambique's urban settlements often leads to lack of shelter, water stagnation and the onset of disease.[47]

46 Irish Aid, Resilience and Economic Inclusion Team, Policy Unit. (2018). *Mozambique Country Climate Risk Assessment Report*.
47 UN-Habitat (n.d). *Climate Change Assessment for Maputo, Mozambique: A Summary.*

The potential role of MBD in strengthening urban climate resilience

Using MBD to understand disaster-driven displacement and support recovery: The Government of Mozambique and the National Institute of Disaster Management (INGC) is being supported by Flowminder to strengthen their disaster response and preparedness capability. Using de-identified mobile data,[48] the partnership has developed a system to monitor disaster-driven displacement and recovery related to cyclone and flooding. Working closely with INGC, Flowminder has designed a solution tailored to support INGC's decision-making processes before, during and after cyclone events. The system will detect both population displacements and returns by identifying changes in the main residence location of phone users that coincide with the time and location of a sudden onset disaster.[49] The system can be informed by live estimates of where displaced people are and how many people remain displaced over time.

To enable INGC to conduct better operational planning and resource allocation before, during and after cyclones or other rapid onset disasters, host communities have been supported during recovery to manage resources. Reconstruction planning has also been informed by data on displacement, contributing to hazard vulnerability assessments.

Opportunities to combine MBD with other data sources and platforms for urban climate resilience

MBD for urban planning: MBD has the potential to address data gaps related to urban populations, planning and resilience. The country has also documented a few programmes and initiatives that use big data analytics from other sources, such as satellite data or drone footage to strengthen the evidence base for planning. In this regard, the World Bank is working with the National Institute of Statistics to use map and satellite images to understand vulnerability to and the impact of cyclones, to support a programme to build back better with more resilient housing.[50]

Tech innovations for development: There is a nascent but growing tech innovation scene in Mozambique, particularly in Maputo. Many data points are collected from conventional surveys, sometimes using sophisticated mobile-enabled tools, that can be paired with insights from MBD for more in-depth analysis. For example, from 2017 to 2019, UN-Habitat developed a project with City of Maputo on data for urban diagnostics using their city resilience profiling tool, which relies on many data points related to population, infrastructure and economic and environmental factors.

48 Funded by the Digital Impact Alliance (DIAL) and supported by Mcel, Vodacom and Movitel and hosted by mobile regulator ARECOM.
49 Flowminder.org. (n.d.). "Strengthening disaster response and preparedness in Mozambique".
50 Data from key informant interviews in Mozambique.

Barriers to strengthening MBD

Access to internet and mobile phone penetration rate: Mozambique has one of the lowest mobile phone penetration rates in Africa and a significant gender gap. GSMA's research from 2021 shows that 64% of men and 47% of women are mobile phone owners, compared to 92% and 86% respectively in Kenya.[51] There is also much discrepancy within the national figure. For example, mobile ownership rates are higher in Mozambique's urban centres,[52] and in Mozambique, the mobile internet gender gap among those who are literate is 18 per cent, but rises to 62 per cent among those who are illiterate.[53] Young women have very little access to smartphones in the country due to socio-cultural constraints.[54]

Recommendations: Municipalities should consider creating an enabling environment, including providing incentives for MNOs to develop products and provide services that would accelerate mobile penetration and make mobile phones more affordable.

The research highlighted that a better understanding of mobile phone ownership by population density will be crucial for the integration and use of MBD in urban climate resilience.

Low government capacity: The capacity of national and municipal governments in Mozambique in data collection and analytics for urban planning and resilience is generally low. Cities rarely have institutional data of their own, with most coming from outside government sources.

Recommendations: MBD insights would need to be integrated in government plans where possible, including the five-year government plan that is produced by the municipalities.

The GSMA could help convene relevant stakeholders and ensure that MBD insights reflect local issues and trends, particularly in vulnerable communities.

Draw on the lessons of the only MBD for resilience initiative identified in Mozambique: the partnership between INGC and Flowminder.

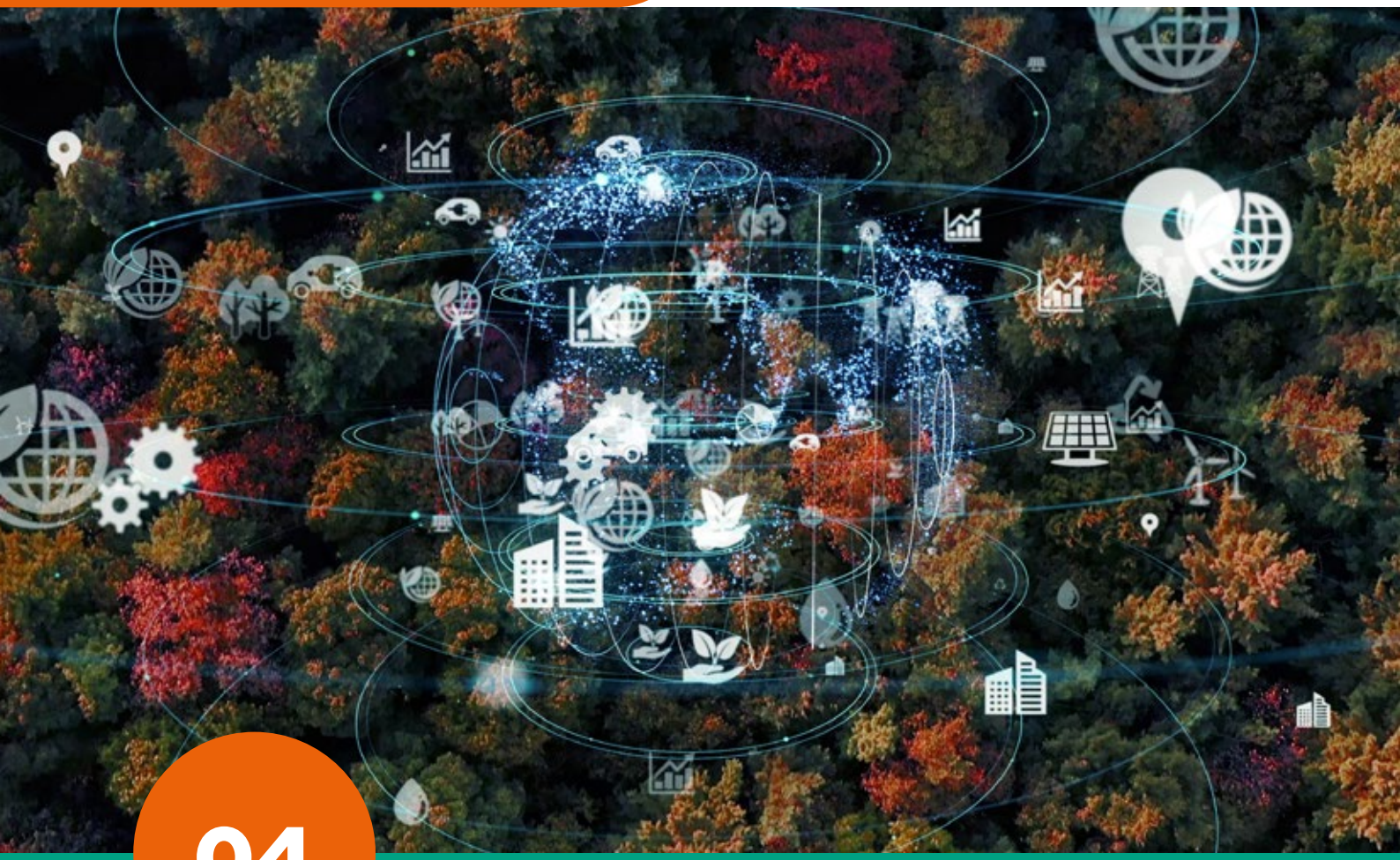
Weak data-sharing culture: Government and other stakeholders are also unwilling to share public data. The lack of an application programming interface (API) prevents organisations from sharing data.

Recommendation: It is important to collaborate and co-create the right technical solutions based on existing frameworks and policies on data sharing. These solutions would respond to the existing challenges, needs and capabilities in Mozambique, which would need to be identified.

Data regulation: Data privacy and protection regulations are weak in Mozambique, with little rigour, controls or formal regulation.

Recommendation: Develop frameworks and policies that would support data privacy and security laws at national and municipal levels. Digital systems should respect and uphold an individual's right to privacy and ensure that personal data is protected and secure. Organisations using MBD should pay special attention to additional privacy and security risks arising from MBD systems.

51 GSMA (2021) The Mobile Gender Gap Report 2021. Connected Women (Link)
52 Gillwald, A., Mothobi, O. and Rademan, B. (2019). *State of ICT in Mozambique*. Policy Paper No. 6. Research ICT Africa.
53 GSMA (2021) The Mobile Gender Gap Report 2021. Connected Women (Link)
54 Data from key informant interview with an international organisation in Mozambique.



04

Conclusion

The country deep dives in this report explore the intersection of MBD, urban climate risk and resilience, and identify the contributions of MBD in Indonesia, Kenya and Mozambique. Documented trends on past and continued use of MBD in these countries highlight its potential for sustainable development. Local governments confirm there is demand to use and integrate MBD in urban development plans and service delivery to strengthen climate resilience. The entry points highlighted in Chapter 1 provide a useful basis for integrating MBD in these efforts. To do so, the featured cities in these countries would require:

Data on climate change and resilience that can be derived from MBD

MBD not only provides new and cost-effective opportunities to collect and update data, but data analysis and disaggregation can also be used to extract actionable insights that can inform decisions.

Institutional capacity to enable urban development personnel to integrate and use MBD

Institutional capacity can be strengthened by developing toolkits and curricula offered through in-person workshops and e-learning by partner organisations, such as MNOs and the GSMA.

Revised frameworks and policies that integrate MBD as a new technology for urban planning

The frameworks are expected to provide ethical guidelines for data sharing and use, emphasise the need for and application of disaggregated data, and localise the use of MBD in various sectors affected by climate change and disasters to help reduce or limit exposure and vulnerability. The revision of frameworks should be considered a joint effort that includes MNOs and civil society organisations.

Mapping of priority areas that would benefit from the integration of MBD

The deep dives revealed that demand for MBD was strongest in transport, waste management, disaster response (fire, early warning, distribution-related finance), social protection and planning (informal settlements). Local governments need to tailor their interventions to ensure that no one is left behind.

Public-private collaborations and business models

MNOs play an integral role in the analysis of MBD. The deep dives highlight the current mismatch between the value of MBD, priority use cases and relevant actors. Combined with other data sets, local governments have been able to provide real-time responses to disasters and develop decarbonisation strategies for transport systems, food security and EWS as priority use cases for MBD.

Addressing the digital divide and mobile penetration in urban areas

City residents living in informal settlements face challenges accessing mobile phones due to cost and other barriers. This makes it challenging to provide equitable data that is disaggregated and inclusive of underserved groups (i.e. low income, low literacy, low education, rural and older people). Disaggregated data also provides a basis for gender-sensitive interventions to strengthen urban climate resilience. It is important to acknowledge the limitations of MBD to serve the most underserved. Certain demographics, such as women, are less likely to be digitally included (e.g. own a mobile phone or use mobile money and mobile internet) and are therefore less likely to be represented in the data. This means that using MBD to design new disaster warning systems and optimised public transport routes, for example, risks further excluding these groups.

MNOs to catalyse financing for urban climate resilience

The deep dives confirm that MNOs play a key role in financing risk transfer mechanisms or insurance, climate-proofing supply chains and business continuity. As mentioned earlier, spending on MBD can be viewed as a premium that can pay out like insurance for LMICs.

Several barriers and gaps affect the feasibility of mainstreaming MBD in urban climate resilience strategies and frameworks. These can be summarised in three broad categories:

- **Big data crumbs,** including access to, sharing and interoperability of various climate data types; data reliability, representativeness and replicability; and scientific challenges related to climate research.
- **Big data capacities**, both technical and human (including existing technical infrastructure and human and technological capacity gaps).
- **Big data communities**, including political and governance issues and ethical concerns.

05

Key considerations for development partners, MNOs and government

The research findings call on different actors to support the application of MBD for urban climate resilience. The following are key considerations for development partners, MNOs and national and city governments.

Development partners

- Seek partnerships to integrate MBD in municipal development plans in LMICs.
- Build capacity through workshops and e-learning programmes that help government stakeholders, MNOs, civil society organisations and other relevant stakeholders in LMICs understand the potential role and limitations of MBD in urban climate resilience.
- Support government stakeholders to identify gaps in data and evidence that could be addressed by insights from MBD.
- Invest sufficient time in promoting the idea of MBD and likely outcomes to governments, MNOs and civil society stakeholders, informed by evidence on how such initiatives can strengthen urban resilience effectively and be commercially viable for MNOs and government.
- Invest in face-to-face (F2F), nationally representative household surveys to complement MBD and ensure those who are digitally excluded are properly represented.

National governments

- Establish national innovation and digital transformation policies while encouraging municipal governments, national ministries and public utilities to engage in more data-sharing PPPs.
- Seek out private stakeholders with large data platforms and identify ways to create use cases that support national initiatives.
- Support the institutionalisation of data insights in strategies, policies, regulations and budgets.
- Help to scale up successful use cases and partnerships in other cities.
- Create clear data policy and regulatory frameworks that foster data privacy and security while enabling data-sharing partnerships.

Local governments

- Develop the capacity of national and/or city government departments to use MBD for urban climate resilience, including combining MBD insights with other data sources.
- Improve data infrastructure, such as hardware, software, data architecture and tools, to store data and perform analytics to support MBD for urban climate resilience.
- Support the development of necessary data governance regulations, including data privacy and cybersecurity laws, to build and sustain confidence in the use of MBD.
- Translate guidance and resources into local languages where this will improve the uptake and localisation of MBD initiatives by municipal government.
- Set up a collaborative initiative with relevant partners to define the priority use cases for urban climate resilience in their country/region.
- Recognise the limitations of MBD to capture populations that are digitally excluded and the most marginalised, and the biases that it may introduce. Complement MBD with other data, such as data derived from F2F surveys and mobile access and use by gender in national statistics databases.

MNOs

- Define shared value propositions by identifying economic, social and environmental goals and how these translate into initiatives that add value.
- Underpin data initiatives with funding/income streams that provide incentives for all parties to engage and invest.
- Develop appropriate data-sharing agreements in advance of a disaster so that MBD can be shared more rapidly in times of urgent need.
- Improve the capture of gender and other customer demographics at registration and during customer interactions (e.g. via agents or call centres).
- Create a dedicated team or department responsible for handling data requests or supporting external partners with data analytics.
- Proactively engage with governments on the potential of MBD and other innovative data sources to raise awareness of the potential of the data.
- Identify senior-level champions in the public sector, at both municipal and national levels, with strong data capacity and digital literacy.

Partnerships play an integral role in using MBD for urban climate resilience. To develop sustainable commercial models for collaboration, the research findings call on stakeholders to:

- Define the shared value proposition of MBD for urban resilience and establish metrics and ways of measuring the economic, social and environmental impact at the start of every collaborative project on MBD for urban resilience.
- Support MNOs to develop partnership and commercial models for MBD that enable them to produce and share data sets or post-analytics insights in a commercially viable way.
- Seek ways to share anonymised and aggregated big datasets with suitable partners, whether for free or under a feasible commercial arrangement, to have a strong social impact in local contexts.
- Ensure that data governance is clearly defined and accountability assigned for every urban climate resilience project. Develop guidance on how MBD applications comply with local regulation, and where and why certain uses will not.
- Raise awareness and build government and MNO capacity in partnership and commercial models. A key enabling factor is a financially viable and durable partnership between MNOs and public and/or private-sector entities.
- Build the capacity of government and MNOs to manage partnerships. This includes building on existing and past MBD initiatives with suitable partnerships, particularly in Indonesia, and identifying a lead government champion.
- Encourage data-sharing agreements between partners, such as MNOs and government departments, to ensure rapid implementation in the event of a disaster.
- Engage with cities to involve them at every stage of a municipal pilot project. This will help secure buy-in and create sustainable partnerships.
- Identify relevant overlaps between the interests of MNOs and other development partners, linking parallel fields of activity that interviewees say are often poorly connected.
- Draw on resources such as the GSMA Smart Data Privacy framework where necessary, which focuses on both smart data privacy laws and public policy.

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For more information, please visit the GSMA website at
www.gsma.com/mobilefordevelopment/climatetech/

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