City Resilience Framework

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The Rockefeller Foundation

ARUP

Acknowledgements

Foreword

In 1958, Jane Jacobs, a community activist, received a Rockefeller Foundation grant to expand upon her ideas about how a city should look, feel, and work. The book she published three years later – The Death and Life of Great American Cities – transformed how city dwellers, urban academics and policy-makers think about cities and urban planning. Jacobs challenged the prevailing assumptions of what makes a city thrive. Over the past five decades, the values and ideas put forward by Jacobs and others have been profoundly important as questions of identity, voice, inclusion, access and opportunity have been negotiated in the context of dynamic urban growth and globalisation.

This legacy of progressive urban thinking becomes even more crucial as we look to the future. Just as cities are hubs for innovations and investments that expand opportunities, they are also living laboratories forced to confront challenges of increasing complexity. Indeed, the role of cities has become central in debates around our planetary boundaries, economic futures, social stability and climate change. What and who makes a city resilient – and not just liveable now or sustainable for the long term – has become an increasingly critical question, one we set out to answer in late 2012 with our partners at Arup through the creation of a City Resilience Index.

The Rockefeller Foundation has been pioneering work on climate resilience in both rural and urban regions for more than a decade. By 2012, the idea of resilience as the critical lens through which to consider not only climate change, but also disaster risk reduction more generally, including financial shocks, terrorism and slow-moving chronic stresses, was gaining traction globally. But, producing a meaningful index for something as complex as the resilience of a city is fraught with reputational, conceptual and execution risk. We stumbled again and again on major conceptual and practical challenges.

We found potential partners ready to jump into the metrics and indicators, but few with the experience to work with us to understand what does and does not contribute to urban resilience. We risked investing in an index that measured and compared cities based on available data, but did not necessarily help cities better understand and assess their own resilience.

We found perspectives were siloed, shaped by experience and expertise in one or another aspect of resilience, disaster risk reduction, infrastructure resilience, climate change, national security or business continuity. What Arup has been able to bring is thought leadership and the capacity to create a comprehensive framework that reflects reality. A city's resilience depends on its physical assets as well as its policies, social capital and institutions.

This report presents the inclusive framework for articulating city resilience that the Foundation was looking for, to underpin the City Resilience Index. It has already proven useful in the agenda-setting workshops in cities across the globe that are participating in the 100 Resilient Cities Challenge. These workshops, in turn, have helped and will continue to help shape the framework and contribute to the final phase, developing the indicators and variables that will comprise the City Resilience Index.

This framework will form the basis of a tool that should enable all of us interested in city resilience to convene around a common understanding of that idea, and begin to 'baseline' what matters most for making cities more resilient. Both the framework and the index are intended to facilitate a process of engagement with and within cities that generates dialogue and deeper understanding. Ultimately, this will lead to new ideas and opportunities to engage new actors in civil society, government and business on what makes a city resilient.

Dr. Nancy Kete
Managing Director
The Rockefeller Foundation

"In order to get a grip on it, one must be able to relate resilience to other properties that one has some means of ascertaining, through observation."

Martin-Breen & Andries (2011) Resilience: A literature review. The Rockefeller Foundation: New York City, p. 11

Understanding city resilience

"By April 2014, to articulate urban resilience in a measurable, evidence-based and accessible way that can inform urban planning, practice, and investment patterns which better enable urban communities (e.g. poor and vulnerable, businesses, coastal) to survive and thrive multiple shocks and stresses."
Opportunity statement (Rockefeller Grantee Workshop, New York City, February 2013)

Why city resilience?

As the 21st century unfolds, an increasing majority of the world's population will live in cities. Human wellbeing in cities relies on a complex web of interconnected institutions, infrastructure and information. People are drawn to cities as centres of economic activity, opportunity and innovation. But cities are also places where stresses accumulate or sudden shocks occur that may result in social breakdown, physical collapse or economic deprivation. That is, unless a city is resilient.

Cities have always faced risks, and many cities that have existed for centuries have demonstrated their resilience in the face of resource shortages, natural hazards, and conflict. In the 21st century, global pressures that play out at a city scale — such as climate change, disease pandemics, economic fluctuations, and terrorism — pose new challenges. The scale of urban risk is increasing due to the number of people living in cities. Risk is also increasingly unpredictable due to the complexity of city systems and the uncertainty associated with many hazards – notably climate change.

Risk assessments and measures to reduce specific foreseeable risks will continue to play an important role in urban planning. In addition, cities need to ensure that their development strategies and investment decisions enhance, rather than undermine, the city's resilience. If governments, donors, investors, policy-makers, and the private sector are to collectively support and foster more resilient cities, there needs to be a common understanding of what constitutes a resilient city and how it can be achieved.

The City Resilience Framework responds to this challenge by providing an accessible, evidence-based articulation of city resilience. Over the coming months, it will be further developed to create the City Resilience Index, which will introduce variables that provide a robust basis for measuring resilience at the city scale. The primary audience for this tool is municipal governments. But, the framework, indicators and variables are also intended to support dialogue between other stakeholders who contribute to building more resilient cities globally.

What is city resilience?

Definition | City resilience describes the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter.

Resilience is a term that emerged from the field of ecology in the 1970s, to describe the capacity of a system to maintain or recover functionality in the event of disruption or disturbance. It is applicable to cities because they are complex systems that are constantly adapting to changing circumstances. The notion of a resilient city becomes conceptually relevant when chronic stresses or sudden shocks threaten widespread disruption or the collapse of physical or social systems. The conceptual limitation of resilience is that it does not necessarily account for the power dynamics that are inherent in the way cities function and cope with disruptions.

In the context of cities, resilience has helped to bridge the gap between disaster risk reduction and climate change adaptation. It moves away from traditional disaster risk management, which is founded on risk assessments that relate to specific hazards. Instead, it accepts the possibility that a wide range of disruptive events – both stresses and shocks – may occur but are not necessarily predictable. Resilience focuses on enhancing the performance of a system in the face of multiple hazards, rather than preventing or mitigating the loss of assets due to specific events.

(Image opposite)
Area of redevelopment in the Silo District, Cape Town.

Surat

Concepción
© Municipality of Concepción

New Orleans

Semarang

Cali

Learning from literature

Approaches | Various approaches have been taken to framing or assessing resilience. They focus either on urban assets or systems, and, to varying degrees, consider man-made infrastructure, the natural environment, urban management and human behaviour. Asset-based approaches tend to focus on physical assets, rather than considering intangible assets that influence human behaviour, such as culture, social networks and knowledge. They neglect the role that assets play in city systems, and, therefore, overlook the importance of assets outside the city boundary; for example, a reservoir that may be a critical part of the water supply or flood management system.

System-based approaches align more closely with the concept of resilience, and the long-standing notion of cities as 'systems of systems'. Social systems determine human behaviour, which is also influenced by physical systems in the urban environment. Various approaches exist, but they mostly examine the resilience of individual sub-systems rather than attempting to consider the resilience of the city as a system in itself. This promotes a sectoral approach and means that interdependencies between different systems at different scales, and the governing structures that influence the way systems work, are not easily considered.

Finally, empirical evidence throughout the literature suggests that urban systems that exhibit particular qualities (or characteristics) are more likely to be resilient. The seven qualities summarised opposite are derived from published literature, including the set of characteristics developed previously by Arup and the Institute for Social and Environmental Transition, as used by the Asian Cities Climate Change Resilience Network. These qualities apply at a city scale and to individual systems.

We concluded that what was missing is a comprehensive, holistic framework that combines the physical aspects of cities with the less tangible aspects associated with human behaviour; that is relevant in the context of economic, physical and social disruption; and that applies at the city scale rather than to individual systems within a city. Finally, it needs to incorporate the qualities that describe a resilient city (or system).

Learning from case studies

Functions and failure | A performance-based approach, which defines resilience in terms of a city's ability to fulfil and sustain its core functions, offers a more comprehensive and holistic approach. As a city's functions rely on a combination of assets, systems, practices and actions undertaken by multiple actors, a performance-based approach has greater potential to address questions of interdependency, power dynamics and scale.

Based on the literature review, a draft hypothesis was developed which proposed that urban resilience could be framed in relation to seven critical functions of a city. This was tested through a desk-based analysis of the 'factors' of resilience identified from more than 150 sources, which examined cities experiencing shocks or stresses, together with recent guidance on urban resilience.

This analysis resulted in a refined list of eight city functions that are critical to resilience. The functions propose that a resilient city: delivers basic needs; safeguards human life; protects, maintains and enhances assets; facilitates human relationships and identity; promotes knowledge; defends the rule of law, justice and equity; supports livelihoods; stimulates economic prosperity. The city's ability to perform these functions determines whether the city is resilient or not. Resilience could be perceived as good health, a safe environment, social harmony and prosperity. Conversely, a city that is not resilient would be identified by ill-health or insecurity, an unsafe environment, conflict and deprivation.

Learning from cities

Fieldwork | To ensure the framework is widely applicable and grounded in the experiences of cities, the second stage of research involved fieldwork in six cities: Cali, Colombia; Concepción, Chile; New Orleans, USA; Cape Town, South Africa; Surat, India; and Semarang, Indonesia. These cities were selected as they had either recently experienced a major shock or are suffering chronic stresses, and as a group are geographically diverse.

The primary purpose of the fieldwork was to understand what contributes to resilience in cities, and how resilience is understood from the perspective of different city stakeholder groups in different contexts. In each city, we carried out workshops, focus groups and key informant interviews with people from the municipal government, utility providers, business and civil society. Across the six cities, we collected data from 450 consultees and identified 1546 factors. Factors are defined as things (physical) or practices/procedures or behaviours (non-physical) that, in the opinion of the consultees, contribute to the resilience of their cities.

A detailed analysis of the factors identified 12 key themes: essential needs; health management; livelihood support; law enforcement; social harmonisation; information and knowledge management; capacity and coordination; critical infrastructure management; environmental management; urban strategy and planning; economic sustainability; accessibility. These themes represent what the city stakeholders perceived to be the key city functions relevant to improving resilience. They map very closely to the functions that were derived from the desk-top analysis, with the following exceptions:

Infrastructure + environment | Physical assets were least mentioned by consultees in the field, whereas they feature very strongly in the literature review. In the fieldwork research, emphasis was placed on proactive management and maintenance of infrastructure and the environment, rather

Cape Town

than its presence. Consultees also talked about connecting people and enabling flows of information, goods, and services as a result of integrated transport and communications infrastructure.

Two new aspects of resilience were identified:

Leadership + coordination | Consultees emphasised the critical importance of leadership, in the form of a committed city government that takes decisions on the basis of sound evidence; engages with business, citizens and civil society groups; and aligns with other governing bodies at the regional and national level.

Urban planning + strategy | Consultees proposed that cities should have a holistic cross-sectoral city vision, strategy or plan underpinned by appropriate data and delivered via policy, regulations, standards and codes.

Every city perceived resilience-building to be an integrated, ongoing process involving a multitude of actions at different scales. Across the six cities, there was a clear distinction between those cities which had experienced shocks, and those which had not. Different groups within the same city had different perspectives on, and priorities for, what makes their city resilient. This highlights the importance of inclusive consultation in resilience planning. Further research is needed to specifically understand the factors that contribute to the resilience of lower income groups. Our research suggested that their concerns and priorities were very different to those of the government and the private sector.

Further information on our journey to understand city resilience is captured in the research reports:

• City Resilience Index: Research Report Volume I: Desk Study (Arup, April 2014)
• City Resilience Index: Research Report Volume II: Fieldwork and Primary Data Analysis (Arup, April 2014)

These are available on www.arup.com/cri

Qualities of resilient systems

Reflective
Reflective systems are accepting of the inherent and ever-increasing uncertainty and change in today's world. They have mechanisms to continuously evolve, and will modify standards or norms based on emerging evidence, rather than seeking permanent solutions based on the status quo. As a result, people and institutions examine and systematically learn from their past experiences, and leverage this learning to inform future decision-making.

Robust
Robust systems include well-conceived, constructed and managed physical assets, so that they can withstand the impacts of hazard events without significant damage or loss of function. Robust design anticipates potential failures in systems, making provision to ensure failure is predictable, safe, and not disproportionate to the cause. Over-reliance on a single asset, cascading failure and design thresholds that might lead to catastrophic collapse if exceeded are actively avoided.

Redundant
Redundancy refers to spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures or surges in demand. It includes diversity: the presence of multiple ways to achieve a given need or fulfil a particular function. Examples include distributed infrastructure networks and resource reserves. Redundancies should be intentional, cost-effective and prioritised at a city-wide scale, and should not be an externality of inefficient design.

Flexible
Flexibility implies that systems can change, evolve and adapt in response to changing circumstances. This may favour decentralised and modular approaches to infrastructure or ecosystem management. Flexibility can be achieved through the introduction of new knowledge and technologies, as needed. It also means considering and incorporating indigenous or traditional knowledge and practices in new ways.
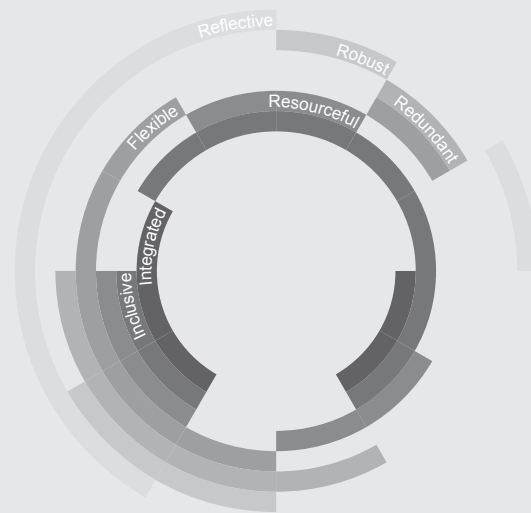
Resourceful
Resourcefulness implies that people and institutions are able to rapidly find different ways to achieve their goals or meet their needs during a shock or when under stress. This may include investing in capacity to anticipate future conditions, set priorities, and respond, for example, by mobilising and coordinating wider human, financial and physical resources. Resourcefulness is instrumental to a city's ability to restore functionality of critical systems, potentially under severely constrained conditions.

Inclusive
Inclusion emphasises the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build city resilience.

Integrated
Integration and alignment between city systems promotes consistency in decision-making and ensures that all investments are mutually supportive to a common outcome. Integration is evident within and between resilient systems, and across different scales of their operation. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops throughout the city.

City Resilience Framework - The Rockefeller Foundation | Arup

City Resilience Framework

Every city is unique. The way resilience manifests itself plays out differently in different places. The City Resilience Framework provides a lens through which the complexity of cities and the numerous factors that contribute to a city's resilience can be understood. It comprises 12 key goals that describe the fundamental outcomes of a resilient city.

A resilient city is a city where there is or are…

1. Minimal human vulnerability
Indicated by the extent to which everyone's basic needs are met.

2. Diverse livelihoods and employment
Facilitated by access to finance, ability to accrue savings, skills training, business support and social welfare.

3. Effective safeguards to human health and life
Relying on integrated health facilities and services, and responsive emergency services.

4. Collective identity and community support
Observed as active community engagement, strong social networks and social integration.

5. Comprehensive security and rule of law
Including law enforcement, crime prevention, justice, and emergency management.

6. Sustainable economy
Observed as sound financial management, diverse revenue streams, the ability to attract business investment, adequate investment, and emergency funds.

7. Reduced exposure and fragility
Indicated by environmental stewardship; appropriate infrastructure; effective land use planning; and enforcement of planning regulations.

8. Effective provision of critical services
Indicated by diverse provision and active management; maintenance of ecosystems and infrastructure; and contingency planning

9. Reliable communications and mobility
Indicated by diverse and affordable multi-modal transport systems and information and communication technology (ICT) networks; and contingency planning.

10. Effective leadership and management
Involving government, business and civil society, and indicated by trusted individuals; multi-stakeholder consultation; and evidence-based decision-making.

11. Empowered stakeholders
Indicated by education for all, and access to up-to-date information and knowledge to enable people and organisations to take appropriate action.

12. Integrated development planning
Indicated by the presence of a city vision; an integrated development strategy; and plans that are regularly reviewed and updated by cross-departmental working groups.

(Image across)
View of Cali, Colombia.
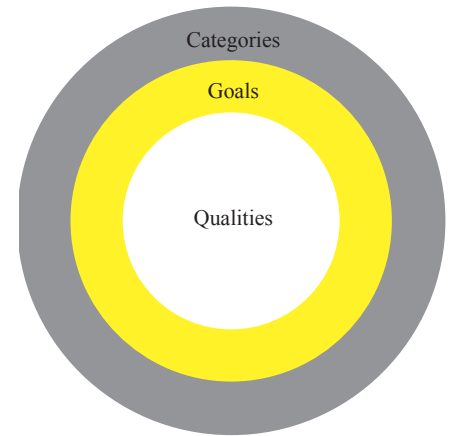
Categories

The 12 goals fall into four categories: the health and wellbeing of individuals (people); urban systems and services (place); economy and society (organisation); and, finally, leadership and strategy (knowledge). For each, it is possible to envisage a best case which represents a resilient city, and a worst case which equates to breakdown or collapse. A city characterised by poverty, social conflict, poor quality infrastructure and weak governance is not resilient. This is evident in Port au Prince, Haiti, where recovery following the devastation caused by an earthquake on 12 January 2010 has proven particularly challenging.

The categories can be used to explain New York City's resilience, as demonstrated following Superstorm Sandy in 2012, and, previously, after the 9/11 terrorist attack in 2001. This was due to the city's relative prosperity, but also to collective identity and effective city leadership. These factors meant that people were willing to help each other and unite around the common goal of getting the city back to normal as quickly as possible. Emergency plans were in place that meant that urban systems and services were rapidly reinstated and civil order was maintained.

Wealthier cities are not necessarily more resilient, as demonstrated by the decline of the US city of Detroit, which became overly dependent on a single industry, or the flooding which brought Bangkok, Thailand, to a standstill in 2010, affecting supply chains globally. Conversely, relatively poor cities can make choices that build resilience. Gorakhpur, India, is working to build resilience at the ward level in response to annual waterlogging in poorer parts of the city. By improving solid waste management practices to unblock drains, and increasing drainage of waterlogged areas, the city has reduced incidences of diseases such as malaria and Japanese encephalitis, which are spread by vectors that breed in waterlogged areas.

Goals

The relative importance of the 12 goals is likely to depend on the urban context and the challenges a city faces. However, our research tells us that, generally, these factors are what matter most when a city faces a wide range of chronic problems or a sudden catastrophe. They represent the backbone of a resilient city. They are what enable people to survive and thrive and businesses to prosper despite adverse circumstances.

The 12 goals provide a holistic articulation of resilience which equates to the elements of a city's immune system. A weakness in one area may compromise the city's resilience overall, unless it is compensated for by strength elsewhere. In Guangzhou, China, public squares were redesigned to encourage social interaction between migrant workers as part of an integrated approach to urban planning. In Surat, India, there has been substantial investment in health services to offset the lack of family support and social networks among migrant workers.

The goals are focused on performance; they describe the outcome of actions to build resilience, not the actions themselves. This acknowledges that resilience results from individual and collective action at various levels, delivered by multiple stakeholders ranging from households to municipal government. In Cape Town, South Africa, emergency response in some townships has fallen to community groups, as the city police force is unwilling to operate in these areas due to concerns for their safety. In the Philippines, the efficacy of a community-based early warning system in Metro Manila has been strengthened through access to data and knowledge as a result of a partnership between a local non-governmental agency and the university.

Qualities

The 12 goals are complemented by qualities that distinguish a resilient city from one that is simply liveable, sustainable or prosperous. These qualities are considered to be important in preventing breakdown or failure; or enabling appropriate and timely action to be taken. They can be observed in relation to the various assets, systems, behaviours and practices that collectively contribute to achieving the 12 outcomes (or goals). For example, health services that are flexible can reallocate staff to deal with an outbreak of disease. Protective infrastructure that is robust will not fail catastrophically when design thresholds are exceeded. Energy systems with redundancy can accommodate surges in demand or disruption to supply networks. Planning processes that are reflective are better placed to respond to changing circumstances. Families that are resourceful will have put aside savings or invested in insurance. Early warning systems that are inclusive will minimise loss of life and property.

City resilience is complex. The three layers of the City Resilience Framework – categories, goals and qualities – each contribute to a richer articulation of resilience. The framework can be used to facilitate a common understanding of resilience amongst diverse stakeholders. It can also be used to identify where there are critical gaps, where action and investment to build resilience will be most effective, or where deeper analysis or understanding is required. The final layer will be the variables and metrics that result in the City Resilience Index. This will enable cities to carry out an objective assessment of their resilience and measure progress against an initial baseline.

1. Minimal human vulnerability

This relates to the extent to which everyone's basic needs are met.

Minimising underlying human vulnerabilities enables individuals and households to achieve a standard of living which goes beyond mere survival. A basic level of wellbeing also allows people to deal with unforeseen circumstances. This is only possible once their physiological needs are met through a basic level of provision of food, water and sanitation, energy and shelter.

The focus of this goal is on providing an adequate and dependable supply of essential services to a city's whole population. Access to shelter and food – particularly for vulnerable groups – as well as sufficient, safe, and reliable citywide water, sanitation and energy networks are key to achieving this goal. Evidence from cities suggests that the affordability of these services is also critical to ensuring the whole population has daily access, including during times of disruption.

The robustness of essential city networks becomes particularly important in severe environmental events. For example: electricity power lines may be damaged by storms. If failure occurs, resourceful city utility companies are able to respond quickly in line with coordinated and pre-prepared emergency plans. Inclusive plans are also essential to ensure that all communities receive a minimum supply of basic assets, notably water and food, particularly in extreme circumstances.

Specific indicators that underpin this goal include: Housing; Energy supply; Drinking water; Sanitation; Food supply.

2. Diverse livelihoods and employment

This is facilitated by access to finance, ability to accrue savings, skills training, business support, and social welfare.

Diverse livelihood opportunities and support mechanisms allow citizens to proactively respond to changing conditions within their city without undermining their wellbeing. Access to finance, skills training and business support enables individuals to pursue a range of options to secure the critical assets necessary to meet their basic needs. Long-term, secure livelihoods allow people to accrue personal savings that will support their development, as well as their survival during times of crisis.

Mechanisms through which diverse livelihood and employment opportunities can be generated include training and skills development, microfinance, incentive and innovation programmes, as well as a living wage. Financial resources for business development and incentives for innovation allow individuals to seek diverse employment options during times of economic constraint or change. Contingency measures, such as insurance and social welfare, contribute to supporting households through challenging circumstances.

An inclusive approach to livelihoods ensures that all citizens in a city have unrestricted access to legitimate occupations, regardless of race, ethnicity, gender or sexual orientation. A range of dynamic small, medium and large businesses in different economic sectors helps people to access job opportunities, even during challenging macro-economic circumstances. In the long term, microfinance, savings, training, business support and social welfare form a safety net that enables people to be flexible during times of stress.

Specific indicators that underpin this goal include: Labour policies; Skills and training; Business development and innovation; Financing mechanisms; Protection of livelihoods.

3. Effective safeguards to human health and life

This relies on integrated health facilities and services, and responsive emergency services.

Health systems are critical to the day-to-day prevention of illness and the spread of disease, as well as protecting the population during emergencies. They comprise a diverse suite of practices and infrastructure, which help to maintain public health and treat chronic and acute health problems.

Health services encompass a variety of practices, including: education; sanitation; epidemiological surveillance; vaccination; and provision of healthcare services. These are focused on ensuring both physical and mental health. Accessible and affordable day-to-day individual healthcare, as well as appropriate population-based interventions (i.e. targeted at the community or city level), are key features of a functioning city health system.

Measures to address injuries and addiction are also important to reduce the burden of ill-health in urban settings. Effective, inclusive and well-prepared medical staff and procedures ensure that all individuals have access to health services before, as well as during, emergencies. Responsive emergency services provide surge capacity to support peak demand during a crisis. In order to achieve the above, appropriate health infrastructure is critical.

Learning and future planning ensure that public health practices − such as prevention through education − are appropriate for the social and physical context of a given city. Services or facilities that target vulnerable groups ensure that preventive and responsive strategies are inclusive and able to reach the entire population. In emergencies, a diverse network of medical practitioners and facilities throughout the city ensures the availability of additional resources (redundancy) that can be deployed immediately wherever they are needed.

Specific indicators that underpin this goal include: Public health systems; Quality healthcare; Medical care; Emergency response.

Health & wellbeing

Economy & society

4. Collective identity and community support

This is observed as active community engagement, strong social networks and social integration.

Communities that are active, appropriately supported by the city government and well-connected with one another contribute to the bottom-up creation of a city with a strong identity and culture. This enables individuals, communities and the city government to trust and support each other, and face unforeseen circumstances together without civil unrest or violence.

Creating cohesive cities has both social and physical dimensions. Reinforcing local identity and culture contributes to positive relationships between individuals while reinforcing their collective ability to improve the environment where they live, work, create and play. These relationships are supported by a number of practices, including social networks and community organisations, artistic expression and the preservation of cultural heritage, including religion, language and traditions. Ideally, these practices are underpinned by spatial interventions that shape the places where communities develop and connect. Provision of communal facilities, public spaces and physical accessibility can help to strengthen community cohesion and avoid isolation.

Inclusivity is promoted by community participation. For example: processes that encourage civic engagement in planning and decision-making processes. Social practices are reinforced by physical interventions that foster resourcefulness and integration, such as the provision of communal meeting places; and the development of mixed neighbourhoods that offer a range of housing opportunities to different social/income groups.

Specific indicators that underpin this goal include: Community support; Community cohesion; Identity and culture; Engaged Citizens.

5. Comprehensive security and rule of law

This includes law enforcement, crime prevention, justice, and emergency management.

A comprehensive and contextually appropriate approach to law enforcement facilitates the reduction and prevention of crime and corruption in a city. By instituting a transparent justice system based on ethical principles, cities can uphold the rule of law and promote citizenship in daily life. These norms are critical to maintaining order during times of stress. Well planned and resourced law enforcement facilitates peaceful recovery, and ensures a healthy population by reducing crime-related injury, fatality and stress.

An integrated approach to law enforcement combines deterrents with effective policing, emergency capacity, a transparent judicial system, and measures to reduce corruption. An effective judicial system promotes civic education as a preventive measure, as well as responsive action through fair justice. Sufficiently resourced policing practices that promote safety and security are a feature of daily life in a resilient city, and continue during times of unrest. Trust and transparency are identified as key attributes of policing, which can be achieved by reducing corruption and by involving other relevant actors in law enforcement, such as community leaders. Trust in city authorities and legal institutions is achieved by appropriate enforcement of laws and avoiding discrimination or violence in law enforcement.

Laws are upheld by resourceful and inclusive systems of policing, which actively involve city agencies, businesses and civil society. Social stability and security is also facilitated by inclusive public space design, which helps to avoid creating places where crime may proliferate, while maximising the safety and security of individuals.

Specific indicators that underpin this goal include: Systems to deter crime; Corruption prevention; Policing; Criminal and civil justice.

6. Sustainable economy

This is observed in sound management of city finances, diverse revenue streams, and the ability to attract business investment, allocate capital, and build emergency funds.

A robust economic system is critical to sustaining the investment that a city needs to maintain its infrastructure and provide for its communities. It helps to create contingency funds that both the private and public sectors can use to respond to emergencies and unforeseen events. As a result, cities are better able to respond to changing economic conditions and pursue long-term prosperity.

A sustainable city economy is developed by aligning fiscal procedures in government, and the ability of the private sector to function despite shocks and stresses. A careful structuring of city budgets will consider the availability of funds to regularly invest in infrastructure and to respond to emergencies. This is supported by a robust revenue base, supplemented by the city's ability to attract inward investment.

The private sector has a complementary responsibility to develop business continuity plans to ensure that businesses can also function during, and recover from, emergencies. City government can contribute to the sustainability of private economic activities by empowering different sectors within the economy and strengthening trade relationships beyond the city.

Resourcefulness is identified as a key quality for a healthy city economy. A diverse economy can absorb the impacts of sector-based shocks without major impact on the city's revenue streams. Resilient cities also optimise revenues and expenditures, and leverage funds from non-government and business sources where appropriate. For example: public-private partnerships, direct investment and grant funding.

Specific indicators that underpin this goal include: Public finances; Business continuity planning; Economic base; Business environment; Integration with regional and global economies.

7. Reduced exposure and fragility

This relies on environmental stewardship, appropriate infrastructure, effective land use planning and enforcement of planning regulations.

Conservation of environmental assets preserves the natural protection afforded to cities by ecosystems. Among other things, this might include the absorption of tidal surges by coastal wetlands or fluvial flooding by upstream woodlands. The protective function of infrastructure relies on appropriate design and construction. This is as important for homes, offices and other day-to-day infrastructure as it is for specific defences, like flood barriers. Working together, both natural and man-made assets help to improve protection against severe conditions, avoiding injury, damage or loss.

Ecosystems and built infrastructure designed as integrated urban systems effectively contribute to reducing physical exposure and vulnerability. For example: river basins, forests, drains and sewers all play a role in protecting cities from flooding. In coastal areas, for example, robustness can be better achieved by using natural wetlands and man-made dykes as part of an integrated approach to coastal flooding.

A resilient city values ecosystem services and has in place robust environmental policies to protect ecosystems in situ. In resilient cities, man-made infrastructure and buildings are well-conceived, well-constructed and safeguarded against known hazards. Building codes and standards promote long-term robustness, flexibility to adapt in the future and safe failure mechanisms in the event of a shock.

Cities in seismic zones can be better prepared for earthquakes by updating and enforcing building codes on the basis of reflective learning and new understanding of future conditions.

Specific indicators that underpin this goal include: Hazard exposure and mapping; Codes, standards and enforcement; Protective ecosystems; Protective infrastructure.

8. Effective provision of critical services

This results from diversity of provision, redundancy, active management and maintenance of ecosystems and infrastructure, and contingency planning.

Ecosystems and infrastructure both provide critical services to urban populations. However, these services depend on more than just the presence of assets; their quality and performance are only maintained through proactive management. During times of stress, some ecosystem services and infrastructure become central to the city functioning. Well-maintained systems are better able to accommodate abnormal demand, withstand unusual pressures and continue functioning. Well-established management practices create enhanced knowledge of system components, so that infrastructure managers are better prepared to restore disrupted services.

Educating communities and businesses is essential to ensuring that ecosystem services of importance to urban populations – such as natural drainage capacity and flood defences – remain robust and are not undermined by careless or unwise actions, such as natural resource extraction or destruction of coastal dunes and mangroves. The management of man-made infrastructure includes frequent monitoring together with regular plans for upgrade and renewal. Demand management is critical in the continuity of critical services, ensuring that neither built nor natural systems are overloaded, and can maintain sufficient redundancy to absorb surges in demand. A resilient city also implements continuity plans to ensure that infrastructure managers are ready to maintain service provision and avoid disruption during extreme events.

Active management of ecosystem services and infrastructure ensures long-term robustness and flexibility in changing conditions. For example: through monitoring and maintenance programmes. Reflective approaches may use intelligent technologies and education to monitor the integrity of assets and disseminate alerts in the event of declining performance.

Specific indicators that underpin this goal include: Stewardship of ecosystems; Infrastructure services; Spare capacity; Maintenance; Continuity for critical assets and services.

9. Reliable mobility and communications

This is enabled by diverse and affordable multi-modal transport systems and information and communication technology (ICT) networks, and contingency planning.

Reliable communications and mobility create daily connectivity between places, people and services. This fosters a positive environment for everyday working and living, builds social cohesion, and also supports rapid mass evacuation and widespread communication during emergencies.

A combination of transport links and the provision of ICT are fundamental to connectivity in contemporary cities. Transport links enable physical mobility and should be characterised by a wide coverage of the city, as well as good service quality and affordability. Good infrastructure capacity, safety and efficiency are essential for the effective operation of transport networks. Business logistics and freight infrastructure are an important consideration to support the city's economic functioning.

Consultations undertaken in this research suggest that communication technologies are also critical for a city's connectivity. These include a diverse range of technologies, such as radio networks, internet and mobile phone services, as well as specific channels such as social media. The availability of reliable and inclusive forms of communication is critical to disseminate information during emergencies – particularly to the most vulnerable residents of a city, such as the poor and the elderly.

Inclusive multi-modal transport networks allow safe and affordable travel between all neighbourhoods and key facilities across the city. Multi-modal systems incorporate redundancy and flexibility by providing alternative options in the event of failure or surges in demand. Robust and redundant ICT services enable safe communication and access to information, including coordination of emergency services.

Specific indicators that underpin this goal include:Transport networks; Transport operations and maintenance; Communications technology; Technology networks.

10. Effective leadership and management

This relates to government, business and civil society and is recognisable in trusted individuals, multi-stakeholder consultation, and evidence-based decision-making.

Clear and purposeful leadership promotes trust, unity and a shared understanding of a city's trajectory. Leadership is a key ingredient in encouraging individuals and communities to take action during challenging times. A committed city government that takes decisions on the basis of sound evidence enables a city to thrive from day to day, and to respond to shocks and stresses.

Cross-sector collaboration that challenges 'siloed' approaches in government is critical to effective decision-making. Multi-stakeholder alignment and consultations with communities, including the private sector, are measures that support relevant and effective decision-making. Evidence gathered in cities suggests that effective city governments are given the necessary power to make decisions at local level. The presence of a strong local government leader is also an asset in this context. Integrated, multi-stakeholder decision-making is also supported by coordinated practices and procedures, such as emergency management structures and response plans.

Inclusive governments recognise the importance of grassroots knowledge to help them understand local challenges, and they value the research and innovation that universities and businesses can contribute to solve city problems. By forging cross-sector relationships, resilient cities are better able to coordinate people and access private resources and support during times of need. Integration and reflectiveness are essential to emergency coordination and capacity-building, enabling appropriate and timely government responses.

Specific indicators that underpin this goal include: Government decision-making; Co-ordination with other government bodies; multi-stakeholder collaboration; hazard monitoring and risk assessment; Government emergency management.

11. Empowered stakeholders

This is underpinned by education for all, and relies on access to up-to-date information and knowledge to enable people and organisations to take appropriate action.

Individuals and communities that know what to do during unexpected events are invaluable assets to a city. The provision of early warnings and access to education, information and knowledge empowers citizens and gives them the tools to take appropriate decisions in the face of shocks and stresses. As a consequence, urban stakeholders are better positioned to act, learn, and adapt.

The generation of information and knowledge depends on a city's investment in research, data collection and risk monitoring. By leveraging relevant information for evidence-based decision-making, resilient cities can take better decisions and act appropriately in changing circumstances. Multiple and well-used channels of communication help to make this process effective. In addition, resilient cities ensure that information shared with their citizens can be understood. Other forms of knowledge exchange between communities and cities – such as city networks or 'twin city' schemes – are also beneficial when it comes to disseminating best practice.

Inclusive provision of education and information enables citizens to protect themselves in emergency situations. For example, in many cities that are vulnerable to seismic activity, television and radio stations automatically switch to deliver official earthquake information following an event, which alerts the public to risks and precautionary measures. Sharing knowledge, experience and best practices between cities enables reflectiveness through broader exchange of information, feedback loops, learning and adaptation.

Specific indicators that underpin this goal include: Education for all; Community awareness and preparedness; Mechanisms for communities to engage with government.

12. Integrated development planning

This is indicated by the presence of a vision, an integrated development strategy, and plans that are regularly reviewed and updated by cross-departmental groups.

Development plans and land use regulations are instruments that cities use to coordinate and control urban development and guide future investments. The creation and implementation of plans and regulations ensures that individual projects and programmes are aligned and sufficiently address uncertainty. Integrated plans create a formalised framework to deal with multidisciplinary issues, such as climate change, disaster risk reduction or emergency response.

A critical aspect of delivering a comprehensive development and planning framework is the presence of a city vision. The development of a shared and integrated city vision requires understanding of and alignment between the motivations of different stakeholders involved in designing and implementing projects in the city. This, in turn, requires ongoing processes of communication and coordination at all stages of planning. A vision should be underpinned by appropriate evidence and acceptance of uncertainty, and delivered via policy and regulations. Land use plans should be permanently enforced and regularly updated. Preparation of plans relies on collecting up-to-date and relevant data, as well as the ongoing monitoring of urban trends.

The implementation of integrated strategies and plans ensures that different projects and programmes across a city are aligned, mutually-supportive, reflective of past experience and resourceful in the face of future uncertainty. These processes should be truly inclusive, incorporating consultations with residents and others who will experience their effects.

Specific indicators that underpin this goal include: City monitoring and data management; Planning process; Land use and zoning; Planning approval process.

"Surat started off as a place with household workplaces specialising in high skill products –hand woven textiles, diamond cutting/ polishing and embroidery. Due to scarcity of labour, competition in the country and demand for craftsmanship, employers had to be nice to their immigrant employees – they needed to retain their employees. They tried to understand their issues and treated them like family…This sentiment has continued."

Elected standing commitee member

Recognising resilience

Building cross-sectoral leadership for disasters, **Surat**

As the fastest growing city in India, and despite its economic prosperity, Surat struggles to keep up with demands on its infrastructure and services. It has experienced several shocks in recent decades, including floods, social unrest and an outbreak of the pneumonic plague. This has strongly influenced the city's successful efforts to enhance resilience.

Surat is well-known for its flooding challenges. However, 20 years ago, a chain reaction following a flood permanently changed Surat's approach to flood management. After the flood in 1994, poor sanitation in vulnerable communities is reasoned to have caused an outbreak of pneumonic plague. While the number of suspected cases was limited, the unexpected nature and fear of a relatively unknown disease caused panic which started locally but quickly spread nationally and internationally.


Door to door solid waste collection
© JNNURM

Following this catastrophe, a municipal commissioner was put in place to lead the city back to normality and rebuild trust internally and externally. There was a recognised need for improved infrastructure, such as sewerage and stormwater drainage, as well as better flood management to reduce the chances of a recurrence. This event also raised awareness of public health generally and the wellbeing of the workforce to contribute to economic prosperity. The local government put in place measures to prevent rapid disease spread, such as monitoring at household level, and provided local health centres in the most vulnerable areas to anticipate and respond to a disaster.

Civil hospital quaratined by Indian military officials © Laurie Garett
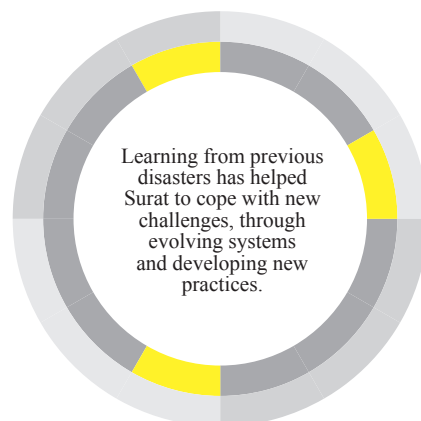
It took longer to restore trust in the security of Surat after the disaster than it did to clean up the streets and control the disease. This lack of trust delayed residents from returning to the city and impacted heavily on business continuity. In light of this, the business community, led by the Chamber of Commerce, now contributes strong leadership in planning for disasters and being on the ground during emergencies, helping to disseminate information and resources. This complements government recognition of the importance of providing fast, reliable information to the public about emergencies and their management.

Learning from previous disasters has helped Surat to cope with new challenges, through evolving systems and developing new practices.

Addressing seismic risk beyond building codes, Concepción

"In Concepción we had two earthquakes: the 8.8 one and the social earthquake – looting, arson… I think the last one affected our soul most violently."

Mayor of Concepción

Events following the massive 8.8 earthquake that hit Concepción's metropolitan area on 27 February 2010 highlight the physical and social aspects of resilience. Due to the presence and enforcement of building codes in Chile, buildings sustained moderate damage and there was limited loss of life considering the magnitude of the earthquake. Critical services – electricity, water and sewerage networks – were disrupted and transport came to a standstill.

What was unexpected was the almost total breakdown of communication networks: internet, telephone and radio. Officials were unable to communicate with each other, obtain help from disaster management agencies in Santiago, or inform the public as to what was happening. Reports of food shortages, looting and arson led to rumours about gangs stealing from homes. An overriding sense of insecurity led to panic, which escalated into widespread looting and anxiety. Neighbours demonstrated community cohesiveness by joining forces to protect each other and setting up shifts to keep watch after dark and guard their home.

The only communication network that continued to function was Radio Bio Bio, thanks to its continuity planning and back-up systems. By providing the public with a source of information about what was happening and enabling residents to communicate with one another, the radio station became a centre point for keeping some level of social stability.

Arrival of military to Coronel, Gran Concepción © Radio Bio Bio/Leesly Leal

Order was gradually restored after the arrival of the military and the imposition of a curfew that was welcomed by the population. The level of social instability after the disaster, as well as its link to inadequate emergency communications, were key learning points for the city. The situation in Concepción after the earthquake demonstrates that it can take a city longer to recover from the social and human impacts of disasters than to restore the physical elements.

Social systems and communications were critical to allow a rapid response after a major earthquake in Concepción.
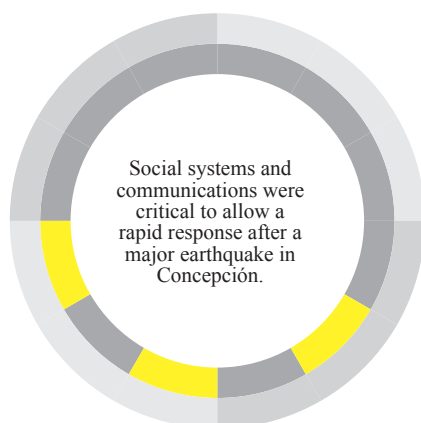
Emergency drill at Concepción municipality

Enhancing resilience through community-led actions, **New Orleans**

"A lot of residents feel a strong sense of belonging here. They had a chance to evacuate and start a life somewhere else, but most of them chose to come back here because it reminded them of a little Vietnam. This really feels like a community – you can't keep a secret here, people are so close."

Deputy Director of Mary Queen of Vietnam Community Development Corporation

The city of New Orleans has endured two significant disasters recently: Hurricane Katrina in 2005 and the BP oil spill in 2010. Located close to both the Gulf of Mexico and Lake Pontchartrain, many local residents rely on these water resources for their livelihoods in the fishing and food processing industries. One such community is the city's Vietnamese community in the neighbourhood of Versailles. Their proximity to open water has made the community particularly vulnerable to the recent disasters. Their response illustrates the importance of social aspects of resilience, particularly the fundamental role of strong, unified communities.

Retail activities in Versailles

Katrina displaced almost the entire population of Versailles; destroyed and damaged homes and businesses, including fishing boats; forced the permanent closure of the nearest hospital and schools; and left the community temporarily without power or water. Galvanised by the leadership of the local Catholic priest, himself supported by a network of community leaders, evacuated residents began to return to Versailles a few weeks after Katrina. Learning that the government was unable to provide the necessary resources for the recovery as quickly as they were needed, the community rebuilt both its physical and social structures on its own.

Resumption of Catholic masses at the Mary Queen of Vietnam church – led by the priest who had displayed such leadership – helped to promote a sense of normality, and reminded residents of their shared religion, their common language (Vietnamese) and their collective identity and cultural heritage. Residents were encouraged to rebuild their homes by bartering their skills with one another. For example: local electricians helped to restore power to the homes of roofers; in exchange, the roofers helped to replace damaged tiles and roofs on the electricians' homes.

In 2006, the Mary Queen of Vietnam Community Development Corporation (MQVN CDC) was founded to help local residents rebuild not only their homes but also their lives after Katrina. This organisation still exists, promoting redundancy by providing social services and care in the continued absence of health facilities in the neighbourhood, and also training residents in alternative livelihoods.

The Deepwater Horizon BP oil spill in 2010 polluted many of the fishing waters that local fisherfolk relied on for their livelihoods. The MQVN CDC now re-trains fisherfolk in market gardening and aquaponics, providing them with alternative livelihood options.

Original homes of the first Vietnamese migrants in New Orleans (damaged by Hurricane Katrina)

Communities unite behind strong neighbourhood identities in New Orleans to overcome disaster.
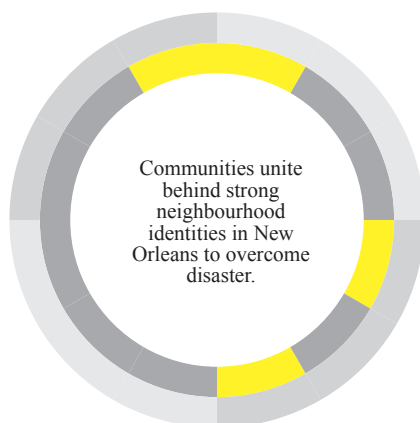
Balancing natural resources under challenging conditions, Semarang

"There are three water vendors in this area, including me… There is limited water and the well is getting dry."

Water vendor

Semarang suffers from regular flooding and landslides. These issues are made worse by inadequate basic services provided to some of the residents, which cause them to extract water locally. This is an example of the inter-relationships between stresses, which lead to further problems.

Drinking water in Semarang is not easily accessible for some communities. Despite their proximity to water, residents in Semarang's coastal communities are often most affected by water shortages. They commonly purchase water of unknown quality from formal or informal vendors. Wells are another alternative water source for communities or individuals who cannot be supplied by water mains. However, in some coastal areas wells are becoming salinised, while wells in other parts of the city are running dry during periods of peak demand.

Flooding in Semarang streets

Forced to extract groundwater to meet its residents' basic needs, Semarang is facing another significant urban challenge. Land subsidence is a side-effect of groundwater extraction, taking place at a rate of up to 10cm a year according to some estimates. This environmental process has increased the city's vulnerability to flooding by lowering the city's ground level. Tidal flooding, which occurs on a daily basis in some communities, has significant impacts on communities living along the coast. Homes, shops and roads are regularly flooded, and fishpond farmers have had their fish stocks washed out to sea, affecting their livelihoods.

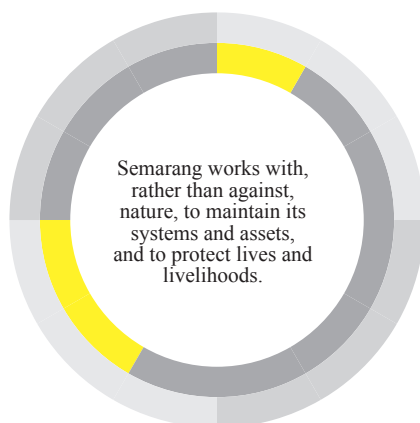Semarang waterfront © Rockfeller Foundation

To prevent further damage to their homes, some coastal communities have installed floating floorboards in their houses, and put aside money every year to raise the height of their houses. Fishpond farmers now use nets in their ponds to reduce loses during floods. With the support of local universities, some fishpond farmers have also experimented with cultivating mussels as an alternative crop, as they grow tethered to rocks rather than floating free in the water.

Close by, in Semarang Port, private- and state-owned businesses appear to be far less affected by coastal flooding. With larger financial resources at their disposal, they have been able to invest in hard infrastructure – such as automatic pumping systems – to reduce operational disruption caused by flooding. Businesses have also improved their transport access to the Semarang Port area by laying a new road 50cm higher than the previous road level. This local adaptation enables access to the port to continue during coastal flooding events, allowing one of Semarang's key economic assets to function. This ensures continuity in the availability of goods, services and jobs, which benefits the local communities, and the wider city.

Semarang works with, rather than against, nature, to maintain its systems and assets, and to protect lives and livelihoods.

Minimising vulnerabilities through multiple approaches, **Cali**

Cali is the third largest city in Colombia, located in the broad, fertile Cauca River valley. The city's rapid growth since the 1970s has forced large numbers of people, often the poorest, to live in flood-prone areas, among them the Aguablanca district. To improve these vulnerable areas, the local government and grassroots groups have developed parallel and complementary approaches that serve as an example of creating resilience.

The first levees to protect Aguablanca from river flooding were built around 30 years ago, but the structural integrity of the defences has been compromised over time. Local residents have placed pipes for domestic water supply through the levees and extracted materials for construction aggregates. To protect the levees, the city government, supported by national and international partners, is implementing a number of interventions. In this process, the municipality has recognised that ensuring the robustness of the infrastructure in the long term requires the engagement of the local communities.

Providing information about the risks associated with degrading infrastructure has ensured that communities can better appreciate the value of the flood defence and understand how it works. This integrated approach to community participation has also resulted in the passive surveillance of public spaces and better control of illegal dumping next to the levees.

Grassroots organisations, such as Fundación Paz y Bien, have developed community-led approaches to address community vulnerabilities that have been challenging for the city government and threaten social breakdown. With the aim of empowering communities and diversifying livelihoods, Fundación Paz y Bien provides training, microfinance and emotional support.

One of this organisation's major achievements is the implementation of a popular microcredit programme in Aguablanca. Their deep understanding of the community's problems has enabled the organisation's members to develop a reflective and inclusive approach that specifically targets needs identified by the community itself. With this approach, Fundación Paz y Bien has helped to build a more cohesive community and has become a key point of support and guidance for families suffering the impacts of violence, extreme poverty, and economic instability in Aquablanca.

Community workshop at Fundación Paz y Bien

Multiple actors cooperate in Cali to create and strengthen vibrant communities, through actions which place community needs and capacities centre stage.

Mayor of Cali visiting Aguablanca district
© Alcaldía de Santiago de Cali.

Valuing spatial planning and leadership, **Cape Town**

"The city wasn't designed by economic forces; instead it was designed by social engineering. Maybe we need social engineering to change it again?"

Representative of the Cape Town Partnership

Many of the stresses currently faced by Cape Town are the legacy of the segregation and discriminatory practices of South Africa's apartheid system. Apartheid planning processes promoted spatial segregation and resulted in disconnected neighbourhoods and a limited transport system in the city. These challenges are starting to be addressed through improved leadership and a new approach to spatial planning.

A typical informal house in Sweet Homes, Khayelitsha

Capetonians live in residential areas which are still often categorised by the race or economic status of their inhabitants. New housing developments typically only occur on the periphery of the city, while redevelopment of brownfield sites in the city is uncommon. Integrated mixed-use developments are extremely rare. Therefore, to travel between home and work, residents rely heavily on a limited transport network, with few choices of route or safe and affordable modes. Some areas of the city still lack any public transport.

Particular areas of the city lack basic services, specifically the informal settlements in which 14% of Capetonians live. Many of these settlements exist in the flood-prone Cape Flats area. The City of Cape Town would like to relocate residents in these settlements to safer locations where they could provide them with basic services such as water and electricity. However, the
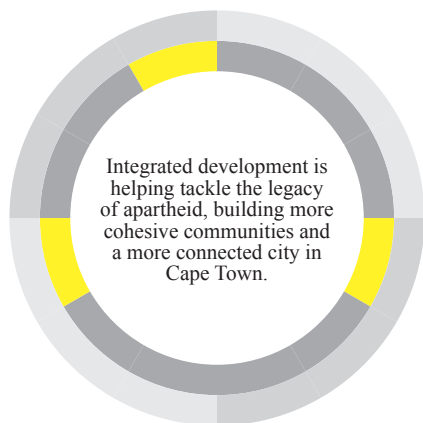
city budget is not sufficient to do so. The city government also struggles to maintain security in these areas. The conditions of isolation and lack of basic needs and security contribute to the residents' lack of empowerment and a feeling of being inadequately engaged in decision-making processes.

As part of an effort to address these challenges, the City of Cape Town has drafted a Spatial Development Framework (2012) which promotes a new integrated approach to planning and development of neighbourhoods and services. A new integrated transport system – headlined by the MyCiTi bus system – is also in development by the government body, Transport for Cape Town.

Within informal settlements, the City and NGO partners are undertaking inclusive re-blocking exercises to better engage residents and increase community cohesion. This involves rebuilding areas within the settlements to allow greater space for socialising and also to allow access for service provision, particularly for emergency services to respond to incidents such as domestic fires.

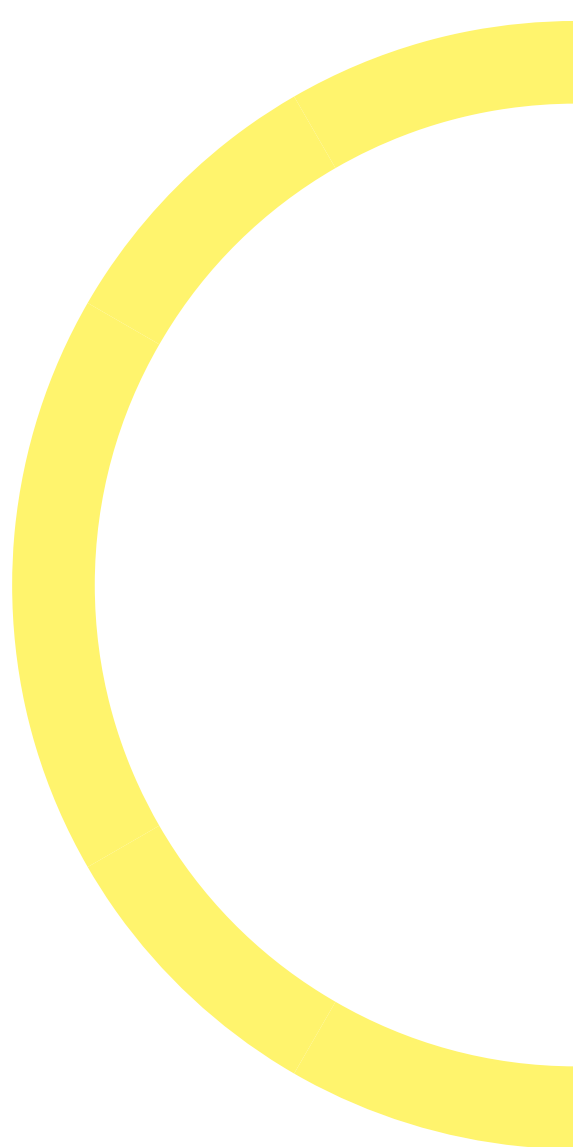

MyCiTi bus and feeder station, Gardens

Integrated development is helping tackle the legacy of apartheid, building more cohesive communities and a more connected city in Cape Town.

What next?

A year ago, we set out to create a City Resilience Index. Our objective was not to rank and compare cities. Rather, we set out to better understand what it is that makes a city resilient. The purpose of the City Resilience Index is to provide cities with a robust, holistic and accessible basis for assessment so that they are better placed to make investment decisions and engage in urban planning practices that ensure people living in cities – particularly the poor and vulnerable – survive and thrive no matter what shocks and stresses they encounter.

The City Resilience Framework is the first step. It provides the foundation for the Index, defining its structure; the categories, the goals and indicators. We have also developed a preliminary list of variables and metrics. As far as possible, these are based on data that is already available, and aligned with variables used today by cities to measure other aspects of urban performance. They will be reviewed and refined over the coming months based on consultation with experts in specific areas and the cities we have engaged with to date; also the 100 Resilient Cities and the Asian Cities Climate Change Resilience Network.

By the end of 2015, we hope to have a final version of the City Resilience Index that will have been piloted in several cities. We are also exploring opportunities to develop tools, based on the data we have collected, that provide a more specific lens for organisations interested in understanding resilience to particular types of hazard, in different sectors or at specific scales. Our hope is that the City Resilience Framework and City Resilience Index will also facilitate collaboration and alignment of global efforts to create safer and more resilient cities that will ensure the wellbeing of the majority of the world's population as the 21st century unfolds.