



OPEN DATA INFRASTRUCTURE FOR CITY RESILIENCE A ROADMAP SHOWCASE AND GUIDE



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Making Cities
Resilient Campaign

My City is
Getting Ready



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INTRODUCTION



Credit: UN Photo, Color Adjustment

DATA IS INFRASTRUCTURE.

It underpins transparency, accountability, public services, business innovation and civil society. A data infrastructure consists of the data assets, the organisations that operate and maintain them and guides describing how to use and manage the data.¹ The effectiveness of data infrastructure lies in its openness to use, which lies at the heart of the "smart cities" community and the movement to align urbanisation with ecological sustainability. Open data is data that is publicly available to openly use and share. Nothing less than a data revolution is occurring in many of our cities, driven by improvements in earth observation, digital technologies, data collection, processing, mapping and visualisation. Open data is becoming the new currency of that revolution and a major driver of innovation to meet the myriad challenges that cities face.

OPEN DATA AS A KEY ENABLER OF CITY DISASTER RESILIENCE

The Roadmap, Showcase and Guide to **Open Data Infrastructure for City Resilience** aim to help place data at the centre of another growing practice area that intersects with the smart cities sector – that of urban resilience and disaster risk reduction. It has a particular focus on open data as a key enabler of the kind of collaborative problem definition, risk analysis and response that resilience action planning requires. It also highlights how investments in open data-based approaches combined with the use of geospatial data and geographic information systems (GIS) can generate strong resilience dividends for city authorities.

A RESOURCE FOR URBAN PLANNERS AND RISK MANAGERS

Open Data Infrastructure for City Resilience has been developed as a resource for city officials with responsibilities that include urban planning, risk reduction, resilience building and civil contingency. It has been designed, therefore, to help cities to integrate open data policies and infrastructure into their wider city data strategies and the development of their resilience action plans.

¹ Open Data Institute 2016

BRIDGING THE URBAN RESILIENCE AND OPEN DATA COMMUNITIES

The publication builds squarely upon the discussion paper 'How can we improve urban resilience with open data?'² The paper is part of an ongoing effort by the Open Data Institute, the International Development Research Centre (IDRC) and the Open Data for Development Group to strengthen much needed practical collaboration between two important groups: urban resilience practitioners and the open data community.

NEW TOOLS FOR URBAN RESILIENCE AND THE MAKING CITIES RESILIENT CAMPAIGN

Finally, the Roadmap, Showcase and Guide form part of a suite of new tools for practitioners developed by UNISDR and its partners for the Making Cities Resilient Campaign.³ These include an updated [Disaster Resilience Scorecard for Cities](#) and a [Quick Risk Estimation \(QRE\) Tool](#).

These tools are all oriented toward the Ten Essentials for Making Cities Resilient, a ten-point checklist developed for the Making Cities Resilient Campaign by leading urban resilience experts. The Ten Essentials serve as a practical framework to support a city's commitment to improving its resilience. Over 3,500 cities across all global regions have signed up to the Campaign and to using the Ten Essentials and Disaster Resilience Scorecard for Cities in their resilience building.

There are three types of Essentials: enabling, operational, and building back better. Each one of the 10 falls under one of these types, acting as critical and independent steps toward implementing the Sendai Framework for Disaster Risk Reduction⁴ at the local level.

² [How can we improve urban resilience with open data?](#)
Open Data for Development, Open Data Institute, OpenNorth.

³ Making Cities Resilient Campaign: <http://www.unisdr.org/campaign/resilientcities/>

⁴ Sendai Framework for Disaster Risk Reduction 2015-2030:
<https://www.unisdr.org/we/coordinate/sendai-framework>

THE TEN ESSENTIALS FOR MAKING CITIES RESILIENT

ENABLING ESSENTIALS

- 1** Organize for disaster resilience
- 2** Identify, understand and use current and future risk scenarios
- 3** Strengthen financial capacity for resilience

OPERATIONAL ESSENTIALS

- 4** Pursue resilient urban development and design
- 5** Safeguard natural buffers to enhance the protective functions offered by natural ecosystems
- 6** Strengthen institutional capacity for resilience
- 7** Understand and strengthen societal capacity for resilience
- 8** Increase infrastructure resilience

BUILD BACK BETTER ESSENTIALS

- 9** Ensure effective preparedness and disaster response
- 10** Expedite recovery and build back better

GUIDE NAVIGATOR: OVERVIEW

A

Section A is a **ROADMAP** to assist city authorities in the creation of an information and data framework for the 10 Essentials with practical guidance on key steps for strategy development and implementation. Two key assessment tools for understanding the level of data maturity (capacity) of a city are presented, alongside a set of tried and tested approaches to advancing the Roadmap.

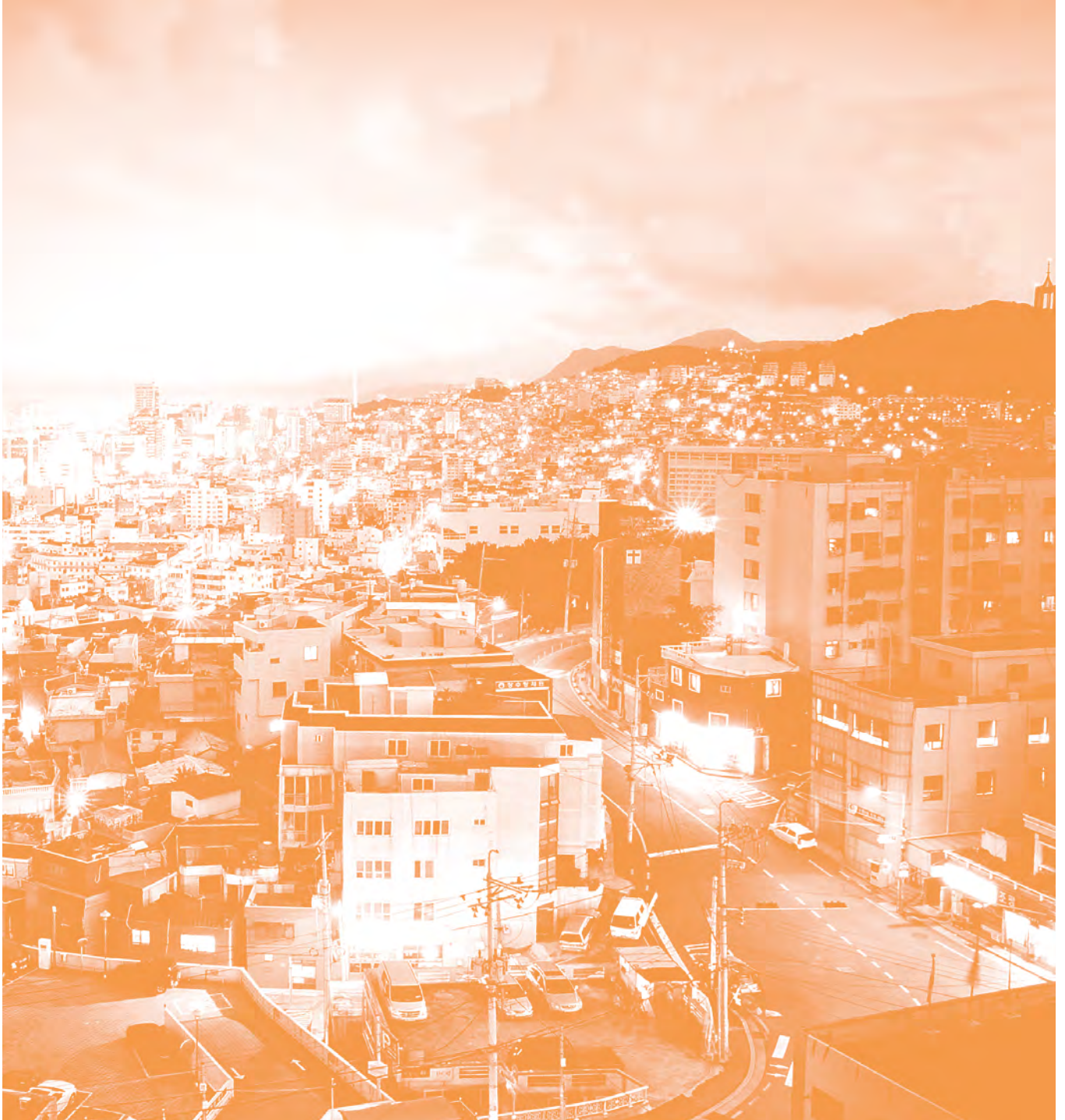
B

Section B is a **SHOWCASE** of real world cases illustrating the innovative use of open or mixed uses of data linked to each of the 10 Essentials and the Disaster Resilience Scorecard. In recognition of the highly divergent levels of data capacity of the cities in the Making Cities Resilient Campaign, the guide includes use cases from a range of developed and developing country cities.

C

Section C, the **GUIDE**, makes the resilience case for developing local open data infrastructure. It covers cross-cutting issues such as how to develop crowdsourced mapping, data standards, open innovation and risk communication.

SECTION A: THE ROADMAP



Credit: UN Photo, Color Adjustment

THE ROADMAP FOR OPEN DATA INFRASTRUCTURE: TEN KEY STEPS

The Roadmap for Open Data Infrastructure is designed to help cities develop a wider data strategy and the open data policies required to implement the Sendai Framework for Disaster Risk Reduction 2015-2030 at the local level. Each step is designed to reinforce the Disaster Resilience Scorecard for Cities and progress on the 10 Essentials. The Roadmap outlines 10 steps to create an information and data framework for building disaster resilience by helping cities gather and manage data for sharing amongst all stakeholders.



STEP ONE: UNDERSTAND AND ADVOCATE

- Apply the Disaster Resilience Scorecard for Cities and Quick Risk Estimation (QRE) Tool in consultation with your key stakeholders (community groups, private sector, education/research organizations, other public agencies) to identify your broad data needs for resilience planning.
- Understand your city's data maturity (capacity) level and open data readiness.
- Learn from real world city cases to advocate for investments in data and open data infrastructure for resilience and disaster risk reduction.



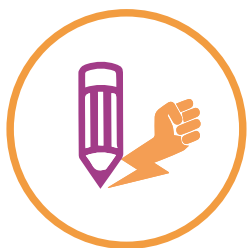
STEP TWO: RESOURCE AND GOVERN

- Allocate resources to develop a city data strategy and financing plan.
- Create a governance structure for your data strategy that includes the private and community sectors.
- Appoint a person in charge, such as a Chief City Data or Analytics Officer, to oversee implementation of the strategy.



STEP THREE: ALIGN AND INTEGRATE

- Ensure alignment between your city data strategy, your smart city policy and your resilience action plan.
- Connect your city data strategy to your city's innovation and economic development programmes.



STEP FOUR: CREATE AND COMMIT

- Create a strong open data policy within your city data strategy and adopt the Open Data Charter.
- Commit publicly to evidence-based city resilience action planning and to an open data policy as part of your stakeholder engagement strategy.
- Create an open data portal that brings together all datasets useful to building a picture of your city's resilience.



STEP FIVE: SECURE AND PROTECT

- Invest in robust cybersecurity measures including a risk framework and incident response planning.
- Assure continuity of computer systems and data critical to city operations in that they are mirrored and accessible remotely.
- Apply best practices in personal data privacy and protection.



STEP SIX: BUILD CAPACITY AND PURSUE STANDARDS

- Conduct training for city officials to build capacity in open data for resilience challenges.
- Build capacity in open geospatial data, access to earth observation data and geographical information systems (GIS).
- Improve data quality and consistency, applying international data standards.
- Partner locally to designate an entity, such as a learning lab in a local university to support data policy, capacity and innovation.



STEP SEVEN: PRIORITISE AND CROWDSOURCE

- Convene your stakeholders and prioritise resilience challenges related to the 10 Essentials.
- Select challenges likely to show early impact in order to build traction for further investment in open data infrastructure.
- Work with your stakeholders to identify data of greatest concern to them when planning for the 10 Essentials and, where relevant, crowdsource it through them.



STEP EIGHT: CONNECT AND COMMUNICATE

- Develop a 'city data sharing marketplace' to connect data that is not accessible as open data from key city stakeholders such as infrastructure or utility companies.
- Engage in public communication and outreach to extend the reach of data analysis related to the risk to your citizens.



STEP NINE: MAINTAIN AND SUSTAIN

- Curate and maintain your city data using a data lifecycle model to help preserve, store, reuse and update data for predictive analysis for resilience purposes.
- Ensure the financial sustainability of your city data strategy and plan, embedding it in core budgets.
- Communicate your financing strategy and commission research on impact to make the business case for ongoing or external funding.



STEP TEN: LISTEN, ADJUST AND SHARE

- Evaluate where investments in data are making an impact, and where there are emerging needs and opportunities that should be incorporated in your strategy.
- Seek feedback from key stakeholders on whether their data needs are being met.
- Collect, manage and openly publish your data to quality standards via key international and city-to-city reporting process and platforms such as the Making Cities Resilient Campaign.

The Roadmap assumes that individual city members of the Campaign will be at different stages of data capacity and have varying degrees of access to financial resources. For cities with highly constrained resources, a combination of working with local and regional specialists and adopting an open source policy for all data platforms and applications is recommended.

DATA ASSESSMENT TOOLBOX

Cities need to understand where they stand in terms of data maturity and open data readiness. Two resources are available to assess where cities of all levels are located in terms of governance and management of their data for planning purposes and day-to-day operations, as well as in terms of the development of their open data infrastructure and ecosystem.

The first resource, a recently produced [Cities Alliance funded Data Toolkit](#),⁵ allows a city to develop a data management plan from a very low point of data capacity or to improve a city's data management from a more mature or advanced starting point.

The second, the World Bank [Open Data Readiness Assessment \(ODRA\)](#)⁶ Tool, allows national governments and cities to take a deeper assessment of the capacities and dynamics at city level needed to ensure that open data will make an impact on specific sectors.

⁵ Cities Alliance funded Data Toolkit: <http://www.developmentgateway.org/blog/deep-dive-cities-data-toolkit>

⁶ Open Data Readiness Assessment (ODRA): <http://opendatatoolkit.worldbank.org/en/odra.html>

Footnotes relating to page 17:

⁷ Adapted from the paper 'How can we improve urban resilience with open data?' Open Data for Development, Open Data Institute, OpenNorth: <https://drive.google.com/file/d/0B8BZxtR6WDBJcHYzallaZFNBFRFU/view>

⁸ Sunlight Foundation Open Data Policies: <https://sunlightfoundation.com/policy/opendatamap/>
Policy Guidelines: <http://sunlightfoundation.com/opendataguidelines>

⁹ Word Bank [Planning an Open Cities Mapping Project](#)

¹⁰ See recommendations from the European Data and Portal at: https://www.europeandataportal.eu/sites/default/files/edp_s3wp4_sustainability_recommendations.pdf?utm_content=bufferfa3d6&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

¹¹ Method Report: What Works in Open Data Challenges: <https://theodi.org/article/what-works-in-open-data-challenges/>

¹² Open Data Leaders Network: <https://theodi.org/open-data-leaders-network>

¹³ Open Data Institute Certification: <https://certificates.theodi.org/en/>

¹⁴ Open Standards with an urban planning dimension: <http://www.openpermit.org/> ; <https://github.com/PlaceSpeak/LUCD> ; https://en.wikipedia.org/wiki/Common_Alerting_Protocol

APPROACHES TO STRENGTHENING OPEN DATA INFRASTRUCTURE⁷

- 1** Developing and publishing an open data policy.
[Sunlight Foundation City Level Open Data Policies](#)⁸
- 2** Conducting training to build capacity in city officials and city users of data to collect, publish and convene around open data.
[Planning an Open Cities Mapping Project](#)⁹
- 3** Engaging in best practice in open data portal design.
[Recommendations from European Data Portal Project](#)¹⁰
- 4** Convening stakeholders from different sectors (tech developer, private sector, city planner, community) to define challenges and an inclusive data-driven problem resolution process.
[What works in Open Data Challenges](#)¹¹
- 5** Creating spaces for collaboration inside and between cities through city data labs located in city offices or universities and through data leader networks that engage local leaders.
[Open Data Institute Data Leaders Network](#)¹²
- 6** Crowdsourcing data with your stakeholders to address resilience issues.
[Semarang under Essential 1 \(Page 24\)](#)
- 7** Enabling the private sector to use open data in addressing resilience issues.
[Budapest under Essential 3 \(Page 35\)](#)
- 8** Improving data quality and consistency, applying data standards.
[Open Data Institute Data Certification Scheme](#)^{13, 14}
- 9** Increasing the use of open data in crisis and recovery situations.
[Accra and Jakarta under Essential 9 \(Page 71\)](#)

SECTION B



Credit: UN Photo/Shareef Sarhan, Color Adjustment

THE SHOWCASE: THE 10 ESSENTIALS AND INNOVATIVE USE CASES

This section presents use cases that leverage open data. They are structured around the Ten Essentials for Making Cities Resilient.

This section also relates each Essential to the information and data related components of the Disaster Resilience Scorecard for Cities which has two levels of assessments:

- 1) Preliminary Assessment with 47 questions/indicators which can be used in a 1-2 days city multi-stakeholder workshop; and
- 2) Detailed Assessment including 117 indicator criteria which may take 1-4 months of multi-stakeholder consultations, serving as the basis for detailed city resilience action plan.¹⁵

¹⁵ Drawn from the Guidance Notes of the [Disaster Resilience Scorecard for Cities](#)

ESSENTIAL 1



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

ENABLING ESSENTIALS: ORGANISE FOR DISASTER RESILIENCE

This Essential lays the foundation for the 9 other Essentials, calling for strong leadership and commitment at the highest elected level to ensure that a organisational structure, policies and plans are put in place to understand and act on reducing exposure and vulnerability in cities. In order to build resilience across all stakeholders, it stresses building alliances across the public, civil society, community and private sectors.

Essential 1 calls upon city authorities to 'put in place an organizational structure and identify the necessary processes to understand and act on reducing disaster risks'. It calls on city authorities to 'create policies to gather and manage data for sharing amongst all stakeholders and citizens' and stresses that data sharing is important in helping to organise for resilience. Essential 1 asks city officials to put in place 'reporting mechanisms for all citizens that capture key information about resilience and promote transparency, accountability and improved data capture over time and enable information sharing with other organizations and with the public'. An open data policy at city level, as well as platforms that publish data from multiple sources, provides practical opportunities to achieve this.

RIO DE JANEIRO, BRAZIL: THE CENTRE OF OPERATIONS (COR)



Credit: David Levene for the Guardian

The Centre of Operations (COR), Rio de Janeiro was the world's first city operations centre to bring together data for all phases of disaster management – prediction, mitigation, preparedness and capture feedback from the system to manage future incidents. The COR grew out of devastating floods and a landslide in 2010 which killed 68 people; spurring serious conversations about the city's social and environmental capacity to respond to a disaster. The COR ensures that government officials and citizens alike have access to vital information in both day-to-day activities and more extreme crises.

The COR acts as central command and control centre for environment, transport, crime and medical matters, integrating the data of around 30 municipal and state agencies. Developed in partnership with IBM and Oracle, the Centre

processes geospatial data from rain gauges and radar sensors, bus GPS systems, imaging software and social media and then feeds emergency information and instructions back to the public via social media and news outlets. The COR has been part of a drive by the city of Rio to increase information transparency and openness in order to strengthen its citizens' ability to cope with extreme weather events, natural hazards, crime and other challenges. For instance, it has installed a space for local and national journalists who have rapid, if not instant, access at the Centre to the outcomes of data analysis of incidents as they occur.

For more information:

<https://www.centreforpublicimpact.org/case-study/ioe-based-rio-operations-center/>

GWANGJU, SOUTH KOREA: SAFEMAP AND OPEN PUBLIC DATA SERVICE FOR LOCAL AUTHORITIES AND CITIZENS



Credit: Wikimedia Commons

Sixteen local city authorities in South Korea have been accessing and contributing to a national portal, Safemap, which collects open real time and static data on issues such as weather, air pollution, health, crime and disaster response from 20 agencies on a GIS platform. It is the first portal site of the safety map, covering eight different categories (and 227 different themes). Safemap's Open Public Data Service makes many of these datasets available for use and reuse by city authorities and all stakeholders, including citizens via an open API. All of the information can be visualized in 2D and 3D maps, ensuring relevant information can be displayed and communicated with clarity.

Safemap is accessible via smartphones, and is customizable for citizens by their location and hazard type. For instance under the category of 'crime' a parent may be more interested in crime

involving children and such maps could be produced on the spot. Further, the city authority of Gwangju has repurposed the maps into a paper version which acts as a guide for citizens who don't use electronic devices. Since its launch in 2014, Safemap has attracted over 1 million users and developed a collaborative provider-user model and governance structure that includes core data providers from the government and users from the community and private sectors. The government has praised the platform for being low-cost and efficient, but most of all for helping to ensure the safety of all citizens.

For more information:

<http://www.safemap.go.kr/>;

<http://www.slideshare.net/safemap/2016-public-safetymap2>

SEMARANG, INDONESIA, PETA KOTA: OPEN DATA FOR URBAN HAZARD MAPPING



City Officials working with members of Kolectif Hysteria to map the city of Semarang.
Credit: Kolectif Hysteria, Color Adjustment

The city of Semarang has developed a six point strategy for resilience includes improving transparency on risk information and governance through the use of open data and crowdsourcing tools. The project also heavily emphasizes bringing in voices which are often left out of urban decision-making processes by leveraging local artists to help design the 'Peta Kota' ('City Map' in Indonesian) with local communities.

In order to address a dearth of local level information on the city, local officials have been working in partnership with a community partner, Kolectif Hysteria, and the technology non-profit, Ushahidi, on the 'Peta Kota.' It was developed in two stages. Firstly, members of the community collective were trained in how to map buildings and key features of the city such as mosques, schools and clinics in order to create a shared picture of the city. Over 50,000 buildings were mapped by members of the community collective within three months of them being trained, and all the information was placed into an Open Street Map of the city. Secondly, this map was

integrated within the Ushahidi platform, which collects citizen reports about hazards, such as local areas with a history of flooding and vector borne diseases. This process has helped Semarang city officials prepare better for crisis response, but has equally boosted engagement between communities and the authorities mandated to protect them. It has created shared insight into the risks and resilience challenges that need to be addressed at local levels.

The city hopes to continue these efforts by having the community help them to identify underutilized buildings, instances of stagnant water and other concerns they may have to ensure that the city is proactive in their resilience strategy.

For more information:

<http://www.100resilientcities.org/blog/entry/kath-mandu-semarang-citizen-engagement-and-open-data-mapping-in-two-cities>

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 1 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 1.2 Organization, coordination and participation

Is there a multi-agency/sectoral mechanism with appropriate authority and resources to address disaster risk reduction?

P 1.3 Integration

Is resilience properly integrated with other key city functions/portfolios? (e.g. planning, sustainability, investment case approval, finance and compliance, community engagement, emergency management, code compliance, infrastructure management, communications etc.)

DETAILED ASSESSMENT

1.1 Plan Making

1.1.2 Consultation in plan making

Is the risk consideration in the City Plan developed through inclusive, participatory multi-stakeholder consultation?

1.4 Data capture, publication and sharing

1.4.1 Extent to which data on the city's resilience position is shared with other organizations involved in the city's resilience

Is there a single "version of the truth" – a single integrated set of resilience data for practitioners?

Information and data that cities will require to make progress on this Essential:

Organization charts; lists of organizations by area, subject and other criteria as applicable, Memoranda of Understanding (MOUs) and other role descriptions for each organization concerned; names of key individuals involved; meeting minutes and actions from the organizations concerned; a list of information and data available to each stakeholder.

ESSENTIAL 2



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

ENABLING ESSENTIALS: IDENTIFY, UNDERSTAND AND USE CURRENT RISK SCENARIOS

This Essential calls for city governments to identify and understand their risk scenarios and to ensure that all stakeholders recognise them. Essential 2 also underlines that risk scenarios should be the means for current and future investment decisions.

Essential 2 emphasizes that: 'City Governments should identify and understand their risk scenarios, and ensure that all stakeholders both contribute to, and recognize, these. Risk scenarios should identify hazards, exposures and vulnerabilities in at least the "most probable" and "most severe" ("worst-case") scenarios.'

Grounding risk assessment in a collaborative open data-based approach provides cities with the opportunity to collect or to crowdsource data on their buildings, infrastructure and communities. The collected data can then be fed into risk models using hazard data from multiple national and international sources. . It generates broader engagement, if not ownership, of the outcomes of the risk assessment process by those most likely to be affected by the risk or by public measures to mitigate it. It also enables different groups to assess the data and to add new layers for enhanced assessment. This allows for risk assessments to be dynamic and constantly updated as new data is created and added to global platforms such as OpenStreetMap.

PARTICIPATION CHENNAI, INDIA: AN OPEN GEOSPATIAL DATASTORE TO BREAK DOWN SILOS



Credit: Wikimedia Commons

Following the severe flooding that affected the city in November and December 2015, a partnership between the Citizen Consumer and Civic Action Group (CAG) and the Hydrata company collaborated with the city government of Chennai to create actionable, robust, and transparent flood management data. The platform ChennaiFloodManagement.org was launched in late April 2016 to facilitate collaboration around data to improve flooding risk assessments and to reduce the impact of future flood events on the city.

Designed to increase both transparency and accuracy of flooding risk data, the platform initially housed datasets and reports collected by CAG volunteers, data from Arappor Iyakkam's "Audit of Chennai Waterways – A Citizen's Report" and infrastructure data from the India Open Data Portal. It now contains a rich offering of data from multiple sources such as crowdsourced civil infrastructure survey data from a mobile application, land use planning data from Open Street Map, satellite observations of flooded areas from India's National Remote Sensing Centre and geospatially tagged and timestamped

twitter photographs of flood elevations and velocities.

A modelling platform transforms this data into agile flood maps and flood warning systems using the open-source hydraulic model, ANUGA to create flood maps from the terrain and rainfall inputs. ChennaiFloodManagement.org has been designed from the ground up to play a role that no existing organisation can fully cover given that:

Engineering consultancies generally cannot publish any data except their own.

Property developers produce publicly.

Important data to support land development projects, however are often not motivated to publish this.

Citizens generally do not have the technical skills or resources to turn their crowdsourced data into effective decision making tools for use by government or property developers.

BATTICALOA, SRI LANKA: OPEN CITIES MAPPING

The Open Cities Project was created by the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR) to create open data infrastructure and capacity in vulnerable cities in ways that would facilitate innovative, data-driven urban planning and disaster risk management. Despite being in a hazardous area subject to droughts, floods and cyclones, the city of Batticaloa lacked detailed building data for response planning and risk mitigation of existing and future projects. Working with the National Disaster Management Centre, Survey and Census Departments and with 48 university graduates who were trained by the project, a team that included staff from Batticaloa Municipal

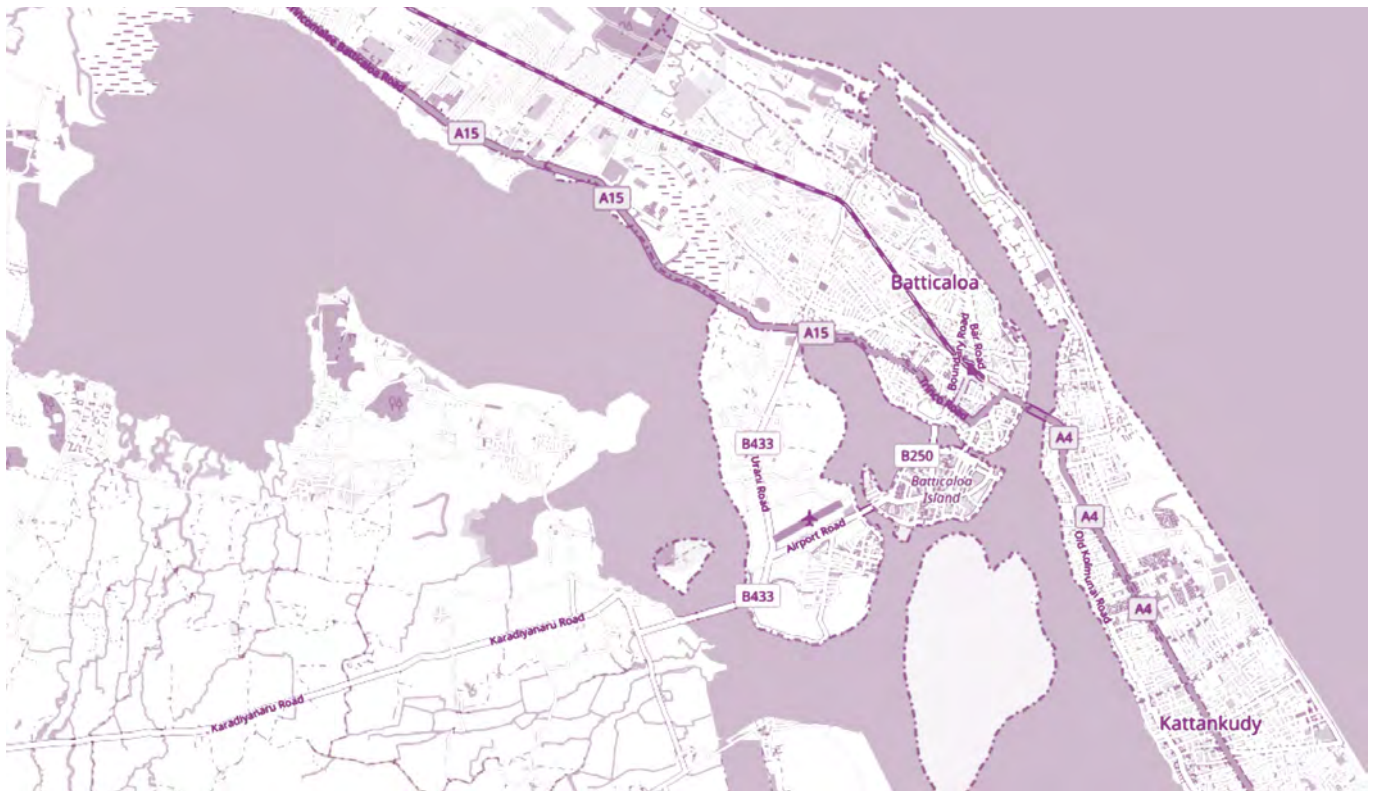
Council surveyed and mapped critical infrastructure, covering roads and 30,000 buildings in the area. The data collection focused on information relevant to vulnerability assessments (number of floors, usage, and construction materials of walls and roof).

It is now publicly available as open data on OpenStreetMap and on Riskinfo, Sri Lanka's public disaster risk platform.

For more information:

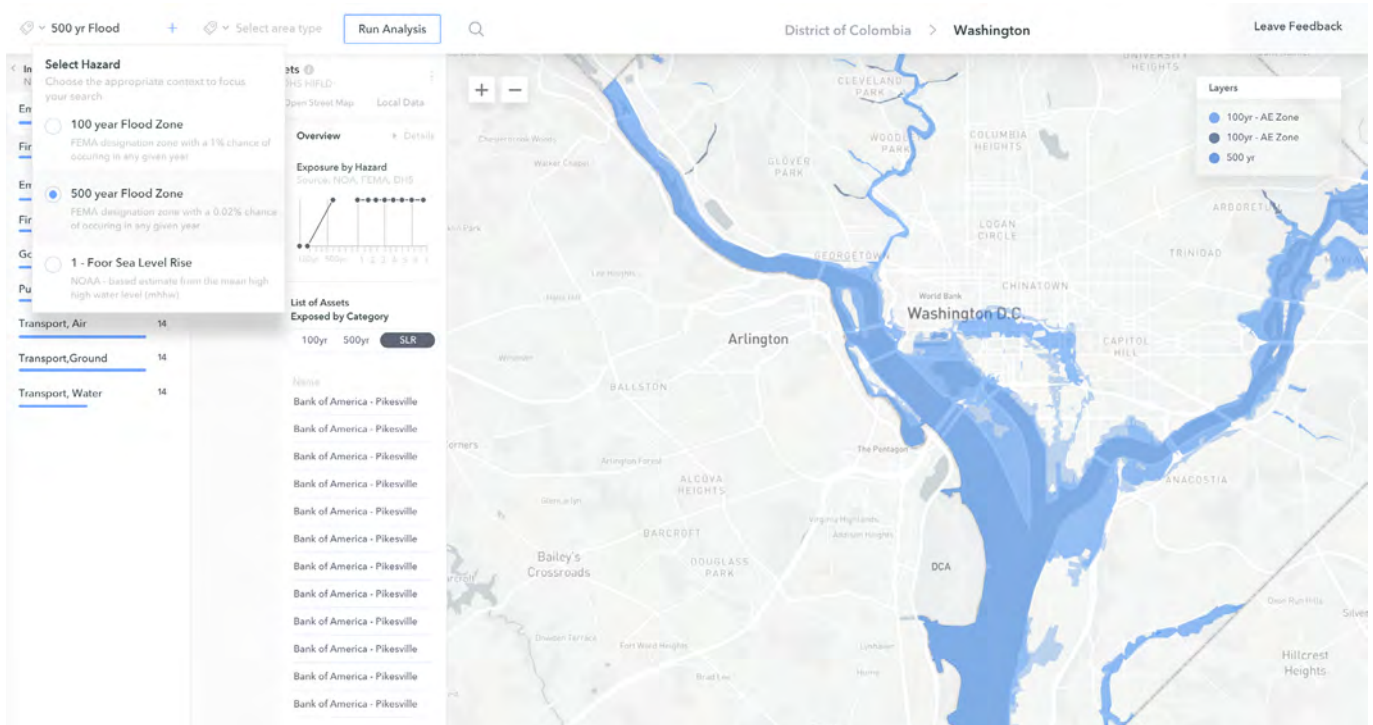
<http://www.riskinfo.lk>

http://www.opencitiesproject.org/OpenCities_Book_LoRes.pdf



Credit: RiskInfo, Color Adjustment

WASHINGTON DC, USA: VIZONOMY AND OPEN DATA FOR CITY CLIMATE RISK ASSESMENT



Credit: Vizonomy LLC

Washington DC and several other US city authorities are understanding their evolving flood and sea-level risk scenarios through a new open data-driven platform that combines open source modelling software components with over 70 open data layers. City authorities are able to import their own local data and create localised or city-wide climate risk assessments for their communities. The platform is able to produce highly visual and accessible risk assessments customisable by city locality, city infrastructure type and exposure to economic losses.

The platform automatically imports any new city data uploaded onto OpenStreetMap and allows for the integration of real time weather alerts, assessing risk, therefore, on a dynamic basis. Importantly, its accessibility through its ease of use and visualisation allows a broad range of stakeholders beyond risk experts – from the public, private and community sector – to engage with and discuss the results and implications of the risk analysis.

For more information:

<http://climate.vizonomy.com>

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 2 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 2.1 Hazard assessment

Does the city have knowledge of the key hazards that the city faces and their likelihood of occurrence?

P 2.2 Shared understanding of infrastructure risk

Is there a shared understanding of risks between the city and various utility providers and other regional and national agencies that have a role in managing infrastructure such as power, water, roads and trains.

P 2.3 Knowledge of exposure and vulnerability

Are there agreed scenarios setting out city-wide exposure and vulnerability from each hazard or groups of hazards (see above)?

P 2.4 Cascading impacts

Is there a collective understanding of potentially cascading failures between different city and infrastructure systems under different scenarios?

P 2.5 Presentation and update process for risk information

Do clear hazard maps and data on risk exist? Are these regularly updated?

DETAILED ASSESSMENT

2.2 Knowledge of exposure and consequence

2.2.2 Damage and loss estimation

Do risk assessments identify business output and employment at risk, populations at risk of displacement, housing at risk, agricultural land and ecosystems at risk and cultural heritage at risk for key identified scenarios?

2.5 Updating of scenario, risk, exposure and vulnerability information

2.5.1 Update process (of scenario, risk, exposure and vulnerability information)

Is there a process ensuring frequent and complete updates of scenarios?

Is the process agreed upon between all relevant agencies to update hazard estimates every 3 years or less?

Is there a process agreed between all relevant agencies to update exposure and vulnerability assessments and asset inventory every 18 months or less?

Information and data that cities will require to make progress on this Essential:

Hazard, exposure and vulnerability data, climate trends and future projections, list of critical assets and infrastructure including an assessment of their interdependencies.

ESSENTIAL 3



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

ENABLING ESSENTIALS: STRENGTHEN FINANCIAL CAPACITY FOR RESILIENCE

This Essential calls cities to 'understand the economic impact of disasters and the need for investment in resilience. Identify and develop financial mechanisms that can support resilience activities.' To do so, cities must analyze the significant direct and indirect costs of disasters and the costs and benefits of investment in prevention. Essential 3 emphasizes that an understanding of the costs of disasters is informed by past experiences, while taking into account future risk.

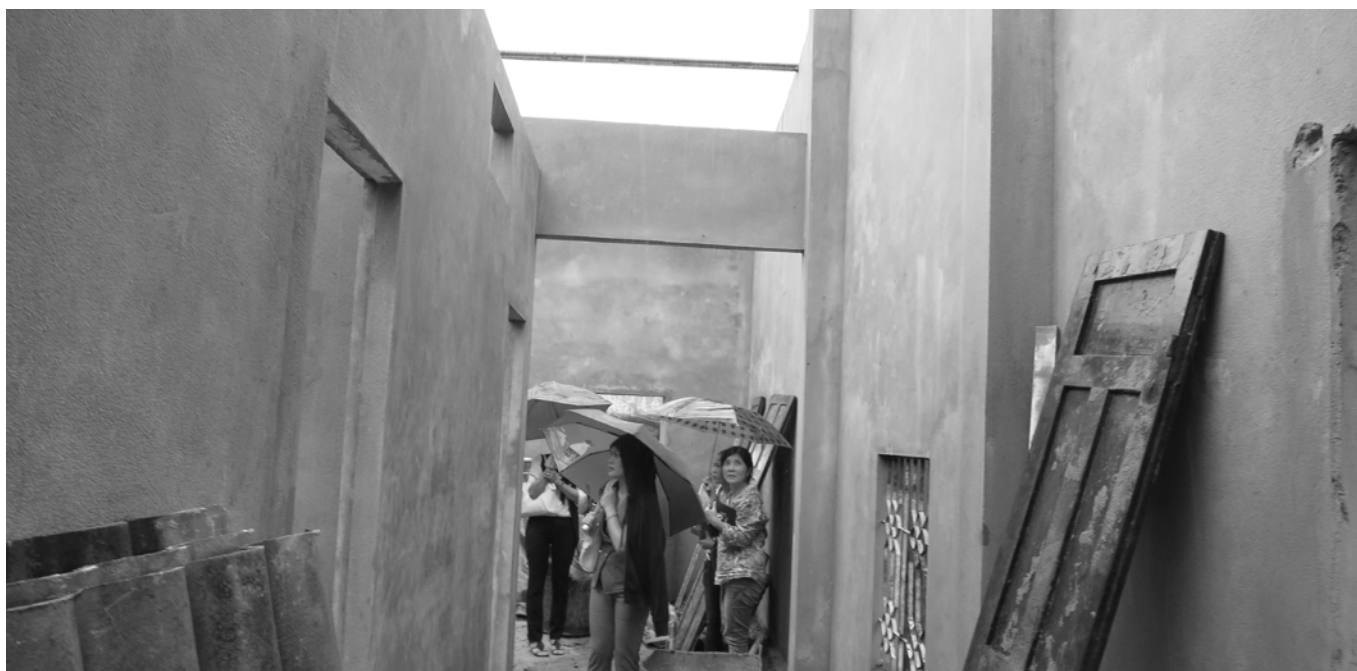
Data on permitting, planning and capital spending informs an understanding of disaster risk levels and its financial implications. To develop a budget for resilience, it is necessary to gather and make available information on actions taken to manage and reduce disaster risk in cities. Risk is not static, and its relative impact on investment varies depending on evolving climate and economic trends. Cities should provide and utilize dynamic open data based approaches as a mechanism for strengthening financial capacity for resilience on an ongoing basis in ways that engage key stakeholders.

Key actions include:

Creating incentives for homeowners, low-income families, communities, businesses and public sector to invest in reducing the risks they face (e.g. business continuity planning, redundancy, building upgrades).

Applying (if necessary, generating) insurance coverage for lives, livelihoods, city and private assets and reducing uninsured losses.

DA NANG, VIETNAM: HOUSING INSURANCE AND FLOODING PREPAREDNESS PROJECT



Credit: CDKN

The Climate Change Coordination Office (CCCO) of Danang has worked with domestic and international insurers to establish a programme to help poor communities repair and build stronger homes after flooding and storm damage. The re-insurer SwissRe has been helping the CCCO to create a comprehensive insurance package adapted to the city's particular vulnerability to extreme weather related events. It is the first model introduced to Vietnam that offers minimum fees to poor house owners and has been developed in concert with an open data-driven flood risk map to make people more aware of problem areas. Data on flood levels in previous years is being used to provide further information during the storm season from October to December. The offering is part of a service to help communities prepare

for and recover from the storms, hurricanes and floods that affect Danang. The project builds on an earlier programme funded by the Rockefeller Foundation in partnership with ISET International and Da Nang's Women's Union to assist low-income households in hazard-prone areas to borrow money from the fund with low interest and a 5-year period payment in order to reconstruct, renovate or construct their houses with storm-resistant techniques.

For more information:

<https://isetinternational.wordpress.com/tag/danang-ccco/>

http://ccco.danang.gov.vn/106_108_960/Danang_Climate_Change_Coordination_Office.aspx

BUDAPEST, HUNGARY: OASIS PLATFORM - OPEN AND COMMERCIAL DATA FOR CLIMATE INSURANCE AND ADAPTATION PLANNING

Oasis is an open source platform and standard accepted by financial markets that provides a catastrophic risk assessment and financial modelling to help end users better understand and financially plan or insure for disaster mitigation and response. It provides end-users, including (Re)insurers, cities and industry, with an open source risk calculation software. It encourages open access to risk data and builds capacity to adequately develop and secure the risk data needed for risk assessment and climate adaptation planning.

Oasis encourages the development of reliable data that meets the accepted standard for financial markets and climate models for cities in the face of growing urban climate risk, including floods and storms, as well as other geo-physical risks. Because the standard is accepted by financial markets, it encourages more accurate risk assessments that can generate investments and empower policy-makers, urban planners and large scale investors. The methodologies and "ground-up loss" data standards are fully open in order to facilitate stronger relationships between the insurance/reinsurance sectors and project planners, managers and investors in ways that closes the gap between insured and uninsured climate losses. The platform provides three elements – The Oasis Loss Modeling Framework (the open source software), Oasis Hub (E-market) and www.oasishub.co. Free and commercial datasets can be uploaded, accessed and crowdfunded to assist decision makers and their stakeholders on fi-

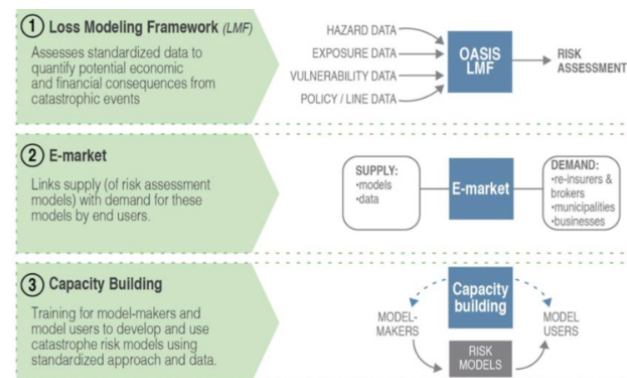
nancial and climate planning. All elements are adaptable to specific conditions and constraints in order to calculate potential climate risk and economic damage.

The City of Budapest is working with the Oasis Community on a regional project and are responding to questions from city stakeholders, assessment of the Hungarian portion of the Danube River Basin.

For more information:

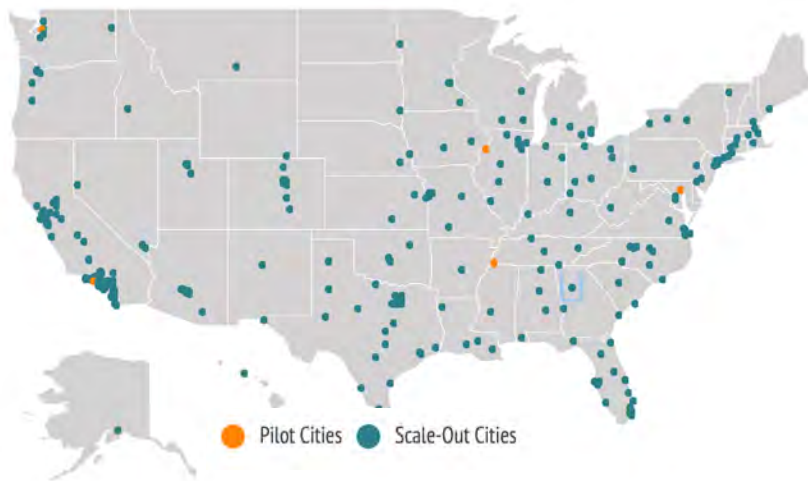
<http://www.oasisdanube.eu/>;

<https://www.oasishub.co>



Credit: Oasis Loss Modelling Framework Limited

SEATTLE, MEMPHIS, LOS ANGELES, BALTIMORE AND DAVENPORT: DATA FOR THE ND GAIN URBAN ADAPTATION ASSESSMENT



Credit: University of Notre Dame

The University of Notre Dame's Global Adaptation Initiative (ND-GAIN) five-city is using the results from a five city pilot project to assess the vulnerability and adaptive capacity of over 270 US cities to projected climate change impacts. The ND-GAIN project prioritizes working with open data from multiple sources to understand and track urban vulnerability to climate change by exploring the linkage between the capability of cities to adapt and the impacts of climate stresses and shocks on them. The current project is expected to be completed in 18 months and will include data on the readiness of cities to cope with climate risk and to attract private sector investment. The Urban Adaptation Assessment is highly relevant to municipal decision making on infrastructure, land use, water resources management, transportation and to climate resilience/adaptation financing for infrastructure projects.

The pilot project revealed a steep increase in the projected heat wave hazard in all five

pilot cities, and in Memphis and Davenport in particular. In general, measures needed to reduce this vulnerability will require financing, which is highlighted by analyzing city capacity under the dimensions of economic, governance, and social readiness. Data related to the economic dimension may include but not be limited to city government deficit/surplus ratio, credit worthiness/attractiveness to bond buyers, access to financial services and the existence of adaptation tax incentives.

As the ND-GAIN project scales up, it continues to use open climate hazard data from a range of government agencies and to encourage cities to build up their own local open data infrastructure in order to support and enrich its adaptation and investment readiness assessment.

For more information:

<http://gain.nd.edu/our-work/urban-adaptation/cities/>

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 3 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 3.1 Knowledge of approaches for attracting new investment to the city

The city/lead agencies understand all sources of funding and all available routes to attract external funding and are actively pursuing funds for major resilience investments.

P 3.2 Financial plan and budget for resilience, including contingency funds

Does the city have in place a specific 'ring fenced' (protected) budget, the necessary resources and contingency fund arrangements for local disaster risk reduction (mitigation, prevention, response and recovery)?

P 3.3 Insurance

What level of insurance cover exists in the city, across all sectors - business and community?

P 3.4 Incentives

What incentives exist for different sectors and segments of business and society to support resilience building?

DETAILED ASSESSMENT

3.2 Resilience budgets within the city financial plan including contingency funds

3.2.1 Adequacy of financial planning for all actions necessary for disaster resilience

Do financial (capital and operating) plan(s) exist with a reasoned set of priorities, based on disaster resilience impact achieved?

Are they linked to "most probable" and "most severe" scenarios in Essential 2?

Are the priorities for disaster resilience investment \$\$ clear and defensible, based on a view of most beneficial impact?

Are the priorities assembled into 5-year plan that integrates spending by all key organisations and will meet scenarios in Essential 2?

Information and data that cities will require to make progress on this Essential:

Budget and capital plan documentation; documentation of any incentives or financing schemes (for example, loans for seismic upgrades) with a disaster resilience impact, together with take-up statistics for each area of the city; insurance coverage statistics.

ESSENTIAL 4



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

OPERATIONAL ESSENTIALS:

PURSUE RESILIENT URBAN DEVELOPMENT & DESIGN

This Essential provides guidelines for the assessment of the built environment, using the risk mapping results from Essential 2.

Essential 4 is strongly connected to SDG Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable. This can be supported by the utilisation of open data to develop and share up-to-date risk maps, and inform decisions on urban planning using data on land use, population demographics, income levels, economic activity, building codes and infrastructure.

GREATER MANCHESTER, UNITED KINGDOM: OPEN DATA INFRASTRUCTURE MAP (GMODIN)



Credit: GMODIN, Color Adjustment

Mapping GM provides a series of open data maps to support an open and inclusive approach to sustainable and resilient development in Greater Manchester. The maps enable the visualisation of spatial information through use of planning, housing, environmental, social, economic and demographic data.

The Greater Manchester Open Data Infrastructure Map (GMODIN) was originally produced to provide developers and planners with infrastructure and housing related information across Greater Manchester on a single, easily accessible map. The map has been a key tool for informing the development of the Greater Manchester Spatial Framework (GMSF), a plan which aims to ensure that Greater Manchester has the right land to deliver the homes and jobs required up to 2035, along with identifying the new infrastructure (such as roads, rail, Metrolink and utility networks) required to achieve this.

To support this, the GMSF Call for Sites map was built in Autumn 2015 to engage with the public and developers and to help gather information about potential development sites from local residents, businesses, landowners and developers. This is complimented by the GMSF consultation map which provides a view of the proposals contained within the draft GMSF.

By drawing upon a range of public and private sector data, including data on flood risk areas and critical infrastructure, this work also benefits Greater Manchester in other aspects of Disaster Risk Management, including through the development of emergency plans and live use of digital maps during emergency response.

For more information:

<https://mappinggm.org.uk/gmodin/>;

<https://mappinggm.org.uk/about>;

<http://www.neweconomymanchester.com/our-work/planning-housing-environment/greater-manchester-s-open-data-infrastructure-map>

DAR ES SALAAM, TANZANIA: COMMUNITY MAPPING AND FLOOD RESILIENCE: RAMANI HURIA

Created in 2015, Dar Ramani Huria ("Dar Open Map," in Swahili) is a community-based mapping project for improving flood resilience, aimed at developing highly accurate maps of flood-prone areas in Dar es Salaam. This project is supported by the World Bank's Global Facility for Disaster Reduction and Recovery (GFDDR) and utilizes the OpenStreetMap platform to store and map collected data. Dar Ramani Huria trains local university students and community members to partake in a four stage mapping process (Mapping, Digitizing, Modelling Risk and Sharing) of the cities most flood-prone neighborhoods. Every year the city faces major flooding which destroys roads, homes, and results in many deaths and millions of dollars worth of damage. The intention is that this mapping can help pinpoint areas conventionally 'off the map,' such as unplanned or informal settlements and provide better prevention and response rates.

In collaboration with OpenStreetMap, the data collected via GPS, Fieldpapers, OpenMapKit, OpenData-Kit Apps, Drones, Street View Imagery is digitised and loaded into a web platform to provide an open access database that can be used as an up-to-date reference for community based socio-economic development programmes. Natural hazard impact scenarios and risk models for flood prone areas are analysed using open source InaSAFE modelling software to run realistic natural disaster scenarios. These scenarios are used in training in disaster preparedness for ward officials and community members. They emphasise the use of open data tools to develop risk informed decisions for emergency planning and land use. All maps are made publicly available online, and can be accessed by city authorities and citizens alike.

For more information:

<http://ramanihuria.org/>



Credit: Ramani Huria

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 4 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 4.1 Land use zoning

Is the city appropriately zoned considering, for example, the impact from key risk scenarios on economic activity, agricultural production, and population centers?

P 4.2 New urban development

Are approaches promoted through the design and development of new urban development to promote resilience?

P 4.3 Building codes and standards

Do building codes or standards exist, and do they address specific known hazards and risks for the city? Are these standards regularly updated?

P 4.4 Application of zoning, building codes and standards

Are zoning rules, building codes and standards widely applied, properly enforced and verified?

DETAILED ASSESSMENT

4.1 Resilience budgets within the city financial plan including contingency funds

4.1.2 Economic activity at risk

What is the percentage of employment at risk? What is the percentage of business output at risk?

4.1.3 Agricultural land at risk

What is the percentage of agricultural land at risk?

4.3 Building codes and standards

4.3.1 Existence of building codes designed to address risks identified in Essential 2

Do building codes (specifically evaluated for ability to deal with "most probable" and "most severe" scenarios in Essential 2) existed and applied to all physical assets?

Information and data that cities will require to make progress on this Essential:

Land use, housing, critical infrastructure, population, income levels and economic activity by segment of the city; and also relevant building codes and their application on a property-by-property basis.

ESSENTIAL 5



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

OPERATIONAL ESSENTIALS:

SAFEGUARD NATURAL BUFFERS TO ENHANCE THE PROTECTIVE FUNCTIONS OFFERED BY NATURAL ECOSYSTEMS

Ecosystem services play an important role in strengthening a city's capacity to withstand and cope with the effects of disasters. Essential 5 calls for 'the identification, monitoring and protection of critical ecosystem services that confer a disaster resilience benefit. Relevant ecosystem services may include, but are not limited to: water retention or water infiltration; afforestation; urban vegetation; floodplains; sand dunes; mangrove and other coastal vegetation; and pollination.'

These services act as protective barriers against disaster risk and provide environmental benefits, such as clean air and water. A city's risk reduction strategy should integrate and manage ecosystem services to prevent and protect from natural disasters. To better include ecosystems services in resilience planning, it is important to assess and anticipate climate trends and urban development.

Collecting and assessing data allows city officials and planners to incorporate urban resilience through nature-based solutions into land use management, urban design, and various investment projects. This planning process should be an open, collaborative effort amongst local authorities, and the use of open data allows all stakeholders to have access to and participate in these endeavours. Mapping urban-ecosystem interactions, trends and projections allows local authorities to be aware of and explore vulnerability challenges when making policy and planning decisions.

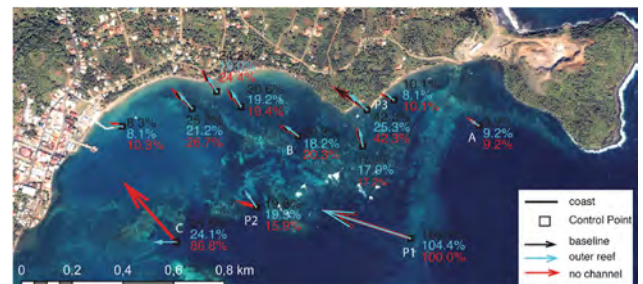
GRENVILLE, GRENADA: THE NATURE CONSERVANCY'S COASTAL RESILIENCE MAPPING PROJECT

The Nature Conservancy's (TNC) [Coastal Resilience](#) program includes a spatial planning and decision support tool for assessing coastal hazard risks and identifying nature-based adaptation solutions. Through a step-by-step process, the tool provides access to TNC's open data, pooled from a variety of data resources, and a host of online applications to help city officials identify where coastal ecosystems can reduce community risk and invest in blue or green infrastructure. The process involves (1) assessing risk of sea level rise, storm surge and other flood events, (2) identifying nature-based adaptation solutions, (3) taking action through restoration and conservation efforts, and (4) measuring effectiveness of an area's coastal resilience and ecosystem services.

An accompanying online mapping portal provides support for planners, city officials, and communities to assess post-storm disaster impacts and manage natural resources that provide coastal protection. The science of nature-based solutions in reducing coastal flood risk is growing rapidly; the Coastal Resilience decision support tool examines when and where they are most effective. In celebrating its 10th anniversary this year, the program has trained and supported over 100 communities around the world on the uses and applications of Coastal Resilience, focusing on the identification of specific nature-based adaptation and risk mitigation solutions.

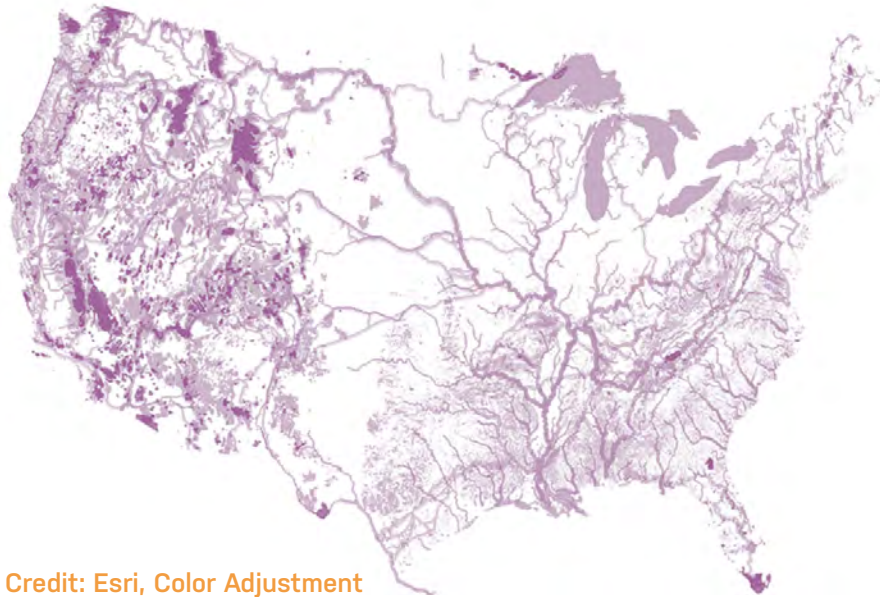
Coastal Resilience projects around the U.S., encompassing 17 coastal states, in the Caribbean, across Mexico and Central America, and

a global effort enable planners, government officials, and communities to develop risk reduction, restoration and resilience strategies. In one Coastal Resilience project in [Grenville, Grenada](#), TNC is working with city officials and citizens using open data on an innovative reef restoration project. This coastal mapping and planning project is part of a greater TNC effort called "At a Water's Edge," which is a community-based initiative focused on reducing urban coastal vulnerability to climate change, with a focus on coastal erosion and flooding. This project involves piloting submerged breakwater structures designed to reduce wave energy and grow live coral. By restoring the reef, over time it will provide a number of ecosystem services, including biodiversity, fisheries livelihoods, recreation and tourism, and strengthen coastal protection to communities onshore.



Credit: The Nature Conservancy

RICHMOND, SOUTH CAROLINA: Esri's GREEN INFRASTRUCTURE FRAMEWORK FOR SUSTAINABLE GROWTH



Credit: Esri, Color Adjustment

Esri, the company behind ArcGIS and one of the leading data based mapping systems in the world has developed a suite of tools to help city-level authorities develop green infrastructure strategies. Their vision is that cities across the globe will be able to 'preserve and connect open spaces, watersheds, wildlife habitats, parks, and other critical landscapes' with the aid of their data platforms. Examples of these tools and data infrastructure being put into action can be found in Richland County, South Carolina which was devastated by water damage from Hurricane Joaquin in 2015.

The county utilised a document by Esri, Evaluating and Conserving Green Infrastructure across the Landscape, to better understand why the flooding occurred and how they could create natural buffers and safeguards in their city. Using data, science and GIS, the county

identified how to protect critical resources with green infrastructure, resulting in a better understanding of why the flooding happened and how they can prevent it in the future. In this process they were able to conduct landscape and land-use analyses, assess risks and prioritize opportunities for green infrastructure.

Esri also manages platforms such as a [ArcGIS Living Atlas of the Planet](#), which is a global collection of geographic information geared towards helping decisions makers with critical questions they have. One such information base is Esri's [6 Step Guide to Green Infrastructure](#), which advises clients on how to set goals, review data, map ecological assets, assess risk, rank assets and determine opportunities.

For more information:

<https://livingatlas.arcgis.com>

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 5 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 5.1 Awareness and understanding of ecosystem services/functions

Beyond just an awareness of the natural assets, does the city understand the functions (or services) that this natural capital provides for the city?

P 5.2 Integration of blue and green infrastructure into city policy and projects

Is green and blue infrastructure being promoted on major urban development and infrastructure projects through policy?

P 5.3 Transboundary environmental issues

Is the city aware of ecosystem services being provided to the city from natural capital beyond its administrative borders?

Are agreements in place with neighbouring administrations to support the protection and management of these assets?

DETAILED ASSESSMENT

5.1 Existing natural environment and ecosystem health

5.1.1 Awareness of the role that ecosystem services may play in the city's disaster

Are Ecosystem services specifically identified, and managed as critical assets?

5.3 Transboundary environmental issues

5.3.1 Identification of critical environmental assets

How many critical ecosystem assets have been identified outside of the city boundaries that act towards enhancing city resilience?

5.3.2 Transboundary agreements

Are there transboundary agreements and collaborations in place to enable policy and planning for the implementation of ecosystem based approaches?

Information and data that cities will require to make progress on this Essential:

Land use and zoning documentation, plus data on the extent and health of relevant ecosystems as measured by applicable indicators.

For more information: <http://ecocitizenworldmap.org/>

ESSENTIAL 6



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

OPERATIONAL ESSENTIALS: STRENGTHEN INSTITUTIONAL CAPACITY FOR RESILIENCE

Institutional Capacity focuses primarily on expanding the knowledge, skills and overall capacity for cities and their staff to ensure they have comprehensive expertise in resilience practices. Essential 6 emphasizes that 'capacity should be developed across the five key Disaster Risk Reduction (DRR) areas of understanding, prevention, mitigation, response and recovery planning'. In support of this capacity, city authorities should focus on 'creating and implementing information and data frameworks for resilience and disaster risk reduction that build consistency in data capture and storage and enable data access, use and reuse by multiple stakeholder groups for regular development processes.'

Skill building needs to include knowledge about which risks cities might face, how to mitigate them and how cities can leverage open data and data analysis to ensure their strategies are as effective as possible. Potential skills to invest in include, but are not limited to:

- Hazard and risk assessment;
- Risk-sensitive planning (spatial and socio-economic);
- Integrating disaster and climate risk considerations in project evaluation/design (including engineering design);
- Communication and coordination;
- Data and technology management;
- Disaster management, response, recovery, assessment of structures post disaster; and
- Business and services continuity planning

It is imperative that the data frameworks built through this process are consistent in their data capture and storage. Data should be able to be used and reused by multiple stakeholders, creating opportunities for other institutions to build their own applications and solutions from city datasets.

CAIRO, EGYPT: TRAINING IN SURVEYING AND DATA COLLECTION FOR CITY SUSTAINABILITY AND RESILIENCE

The EcoCitizen World Map Project is a global initiative in collaboration with the Making Cities Resilient campaign and GeoInformation for Sustainable Urban Management and Resilience (GeoSUMR) to utilize geospatial crowdsourced data for sustainable resilient urban development. The project provides tools, data and training to understand and strengthen urban health and resilience strategies for citizens and public officials. This is done through collecting and assessing crowdsourced data in combination with mobile mapping technology to chart the status and progress of urban environmental and social sustainability. Additional hands-on training enhances the quality and relevance of data by using smart phones, tablets, and civic science methods, as well as encouraging participation by all levels of citizenry.

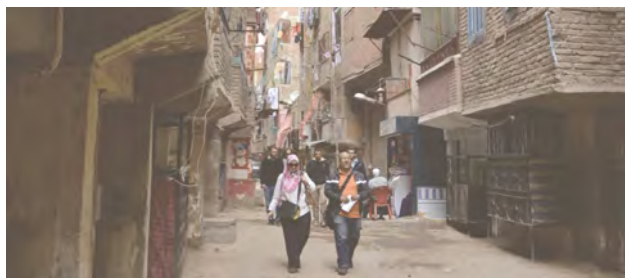
The project has piloted in three cities – Cairo, Medellin and Casablanca. Cairo provides a robust example of creating and utilizing systematic and crowdsourced data to strengthen its capacity for

disaster response and resilience. The Cairo project, focusing on the densely-populated Imbaba neighborhood, uses crowdsourcing and mapping to calculate the ecological footprint of neighborhoods. The aim is to highlight the infrastructural and social challenges of a neighborhood in order to recognize citizen understanding of the environmental and social impacts. The project encourages citizen participation and data gathering through "Boot Camps," where citizens are interviewed then trained on survey methods and on-the-ground data collection. Urban indicators for data collection can include access, air quality, energy, food, community, biodiversity, and materials. The Cairo pilot examined quality of life, neighborhood archetypes and water quality. The collected data is publically available through an interactive online platform, where viewers can turn indicator layers on and off, change the basemap and view specific projects in detail.

The results of this citizen-based knowledge exchange and data visualization training generated a list of individual and civil solutions to examine and respond to the challenges of local resource consumption, quality of life and urban environmental quality in Cairo.

For more information:

<http://ecocitizenworldmap.org/about/the-project/#>



Credit: EcoCitizen World Map, Cairo

LONDON, UK: MASTODON C COLLABORATION WITH GREATER LONDON AUTHORITY



Credit: Mastodon C (2017)

The Greater London Authority (GLA) has partnered with Mastodon C, a data science consultancy, to grow the institutional capacity of the city's 33 boroughs with regards to data storage and analysis. In this instance, the city authorities chose to collaborate with other groups in order to expand and grow their institutional capacity. Mastodon C has developed a city-based decision making modelling tool and data management application, Witan, to aid cities with future planning initiatives. The platform comes with pre-populated models on demographics, energy, waste, water, employment and local planning and has emphasized customer support as a pivotal part of the experience. Their team

is on call and ready to advise, answer questions, and educate city officials on how to best utilise and maximize the potential of this data. Lastly, the entire platform and its models are open source, allowing any institution to download and run Witan.

By partnering with Mastodon C, the GLA has managed to expand its data infrastructure, bringing in new capabilities to their team specifically with regard to data and technology management.

For more information:

<http://www.mastodonc.com/products/witan/>

AFRICA (MULTIPLE CITIES): FUTURE CITIES AFRICA

Future Cities Africa is a collaboration between the Cities Alliance and the UK Department of International Development to support cities across four African Nations (Uganda, Ethiopia, Ghana and Mozambique) by building their knowledge and information base and providing them with mechanisms and tools needed to evaluate their risks. The program focuses specifically on the municipal level and emphasizes how cities assess their risks, as well as design and implement necessary interventions which respond to these risks. As a part of this program, cities can also learn from the challenges and progress of other cities through their shared online platform which connects stakeholders and tracks progress across cities.

The online platform not only promotes a culture of openness, but it also includes innovative tools for planning and investment decision-making, which is being developed by Resilience Brokers. These tools leverage data to ensure each city receives localized insight which directly applies to their circumstances and context. Further, each of the cities involved was assessed by Arup, resulting in comprehensive reports about the current status of their risk, pinpointing areas where intervention is needed, and imagining what such an intervention should entail.

For more information:

<http://www.citiesalliance.org/FCA-launch>;

<http://www.citiesalliance.org/futurecitiesafrica>;

http://publications.arup.com/publications/f/future_cities_africa_future_proofing_city



ARUP CitiesAlliance
Cities Without Slums

Credit: ARUP Cities Alliance, Ethiopia

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 6 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 6.1 Skills and experience

Does the city have clear access to all the skills and experience it believes it would need to respond to reduce risks and respond to identified disaster scenarios?

P 6.2 Public education and awareness

Does a coordinated public relations and education campaign exist, with structured messaging and channels to ensure hazard, risk and disaster information (that can be understood and used) is properly disseminated to the public?

P 6.3 Data sharing

Extent to which is data on the city's resilience context is shared with other organizations involved with the city's resilience.

DETAILED ASSESSMENT

6.1 Skills and experience

6.1.1 Availability of skills and experience in disaster resilience – risk identification, mitigation, planning, response and post event response

Does the city assess the key skills and experience relevant to urban disaster resilience within its organisations and provide the necessary training or access to resources?

6.3 Data sharing

6.3.1 Extent to which data on the city's resilience position is shared with other organizations involved with the city's resilience

Is a single "version of the truth" - a single integrated set of resilience data available for practitioners?

6.3.2 Extent to which data on the city's resilience position is shared with the community organization and public

Is a single "version of the truth" - a single integrated set of resilience data available for citizens and community organizations?

6.4 Training Delivery

6.4.1 Availability, take-up of training focussed on risk and resilience (professional training)

Does the city provide training to resilience professionals (from city government, voluntary or other sources)?

6.6 Learning from others

6.6.1 Effort taken to learn from what other cities, states and countries (and companies) do to increase resilience

What are the learning activities executed with other cities and other practitioners to improve coordination of response management and resilience planning?

Information and data that cities will require to make progress on this Essential:

Training curricula; training records for those trained, courses run; school and university curricula; survey and market research data on effectiveness.



Credit: Resurgence

ESSENTIAL 7



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

OPERATIONAL ESSENTIALS: UNDERSTAND AND STRENGTHEN SOCIETAL CAPACITY FOR RESILIENCE

Essential 7 encourages city officials to better understand their inhabitants' current capacity for disaster risk reduction through the collection and dissemination of open data and disaster risk reduction to respond and adapt to crisis, together. The Essential stresses the importance that 'social "connectedness" and a culture of mutual help have a major impact on the actual outcomes of disasters of any given magnitude.' Societal capacity is the aggregate of voluntary relationships between individuals, groups and/or organisations that create an ability to act positively for mutual benefit and a larger common purpose.¹⁶

Collaborations around open data can be utilized to build stronger connections, form online networks of support and provide critical information when it is needed most. Participatory mapping around data can help pinpoint which areas are most at risk of being affected by a crisis, as per Essential 2, in ways that engage those that ultimately 'own' the risk. It should also be emphasized that 'providing community groups with "unvarnished" data on risk scenarios, the current level of response capabilities and thus the situation they may need to deal with,' is necessary so they can interpret and understand their risks at an individual level.

¹⁶ Rahmani, S. and Kausel, T. (2013). 'Coastal Community Resilience to Tsunami: A Study on Planning Capacity and Social Capacity, Dichato, Chile', IOSR Journal of Humanities and Social Science, 12(6): 56.

KAMPALA, UGANDA: FECAL SLUDGE MANAGEMENT PROJECT

Kampala, Uganda's largest city is located alongside Lake Victoria, one of Africa's great lakes. Originally a city on six hills, Kampala has expanded to accommodate a resident population of 1.5 million that doubles during the day. It has become the largest urban centre in Uganda accounting for 80% of the country's industrial and commercial activities; generating 65% of national GDP.

The mission of the City's administration is to transform Kampala by building key institutional, infrastructural and social structures that will ensure the delivery of goods and services and respond to the challenges of increasing population and urbanization. Sanitation has been prioritized as a key investment to drive improved and timely citywide access to services as well as minimize public health and environmental hazards. Kampala Capital City Authority recently launched a new initiative to provide better sanitation services to citizens which goes beyond the provision of hard infrastructure to planning, monitoring and maintaining services using digital and mobile technology. This will improve overall health of citizens by reducing the amount of untreated waste and fecal sludge disposed into the environment.

With support from the Bill and Melinda Gates Foundation, Department for International Development (DFID-UK) and Deutsche Gesellschaft für International Zusammenarbeit (GIZ), the initiative is targeting sanitation service delivery, particularly fecal sludge management, in the underserved urban poor areas of Kampala city through an efficient and affordable private sector led model. The initiative includes 'home sanitation visits' through which data on spatial and existing levels of service is assessed at a citywide scale to guide long-term investment.

Collecting data in real time on which areas are served, the quality of services provided and the areas still unserved is key to the success of this initiative. A Contact Centre has been established to monitor service delivery, provide information to the public and to support and improve service delivery on toilet emptying in the communities.

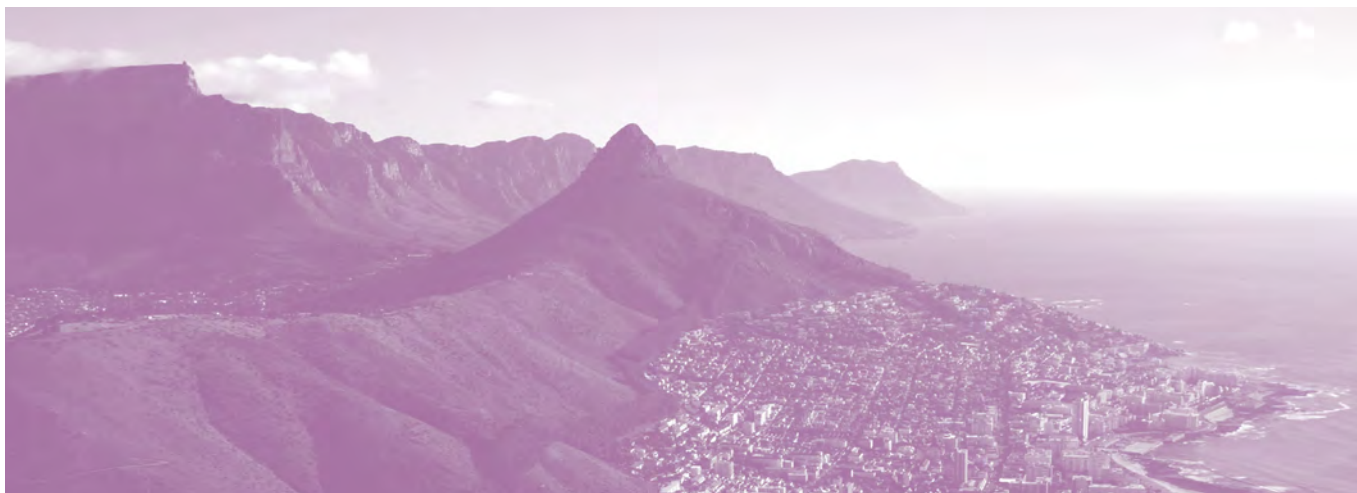
For more information:

<http://www.kcca.go.ug/uDocs/KCCA%20LAUNCHES%20HOME%20SANITATION%20VISITS.pdf>



Credit: Kampala Capital City Authority (2017), Color Adjustment

CAPE TOWN, SOUTH AFRICA: DISASTER RISK MANAGEMENT CENTER



Credit: 100 Resilient Cities, Cape Town, Color Adjustment

Cape Town, South Africa has burgeoning informal settlements which are greatly at risk of wildfires, storm surges, earthquakes and droughts. Understanding that risk information is pivotal to all citizens, the City of Cape Town has created a Disaster Risk Management Center (DRMC) that identifies, prevents or reduces 'the occurrence of disasters and to soften the impact of those hazards that cannot be prevented' (Government of Cape Town, 2017).

The DRMC has created community level and household level disaster preparedness guidelines which discuss a multitude of hazards and how to prepare, respond, and rebuild after they occur. Each guide is openly available online. The online portal for the DRMC allows citizens

to report hazards as they happen, such as fires, flooding and rockfalls as they occur, allowing city officials to respond in a timely, efficient manner. These guides include preparedness checklists for households in four different languages to reach as many citizens as possible; additionally many of the guides include specific provisions for informal settlements, acknowledging the greater risks they face during crises. Further, they also host Community Risk Assessment workshops within communities to better understand their current challenges and communicate the risks they face during crises.

For more information:
<https://www.westerncape.gov.za/facility/city-cape-town-disaster-risk-management-centre>

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 7 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 7.1 Community or "grassroots" organizations, networks and training

Are grassroots or community organizations participating in pre-event planning and post-event response for each neighbourhood in the city?

P 7.2 Social networks "leave no one behind"

Are regular training programmes provided to the most vulnerable and at need populations in the city?

P 7.3 Private sector/employers

What proportion of businesses have a documented business continuity plan that has been reviewed within the last 18 months?

P 7.4 Citizen engagement techniques

How effective is the city at citizen engagement and communications in relation to DRR?

DETAILED ASSESSMENT

7.2 Social networks

7.2.1 Social connectedness and neighbourhood cohesion

What is the likelihood that residents will be contacted immediately after an event, and regularly thereafter to confirm safety, issues, needs etc?

Does the city have sufficient volunteers from community organizations to give "reasonable confidence" that 100% of residents will be contacted within 12 hours of an event?

7.4 Citizen engagement techniques.

7.4.2 Use of mobile and e-mail "systems of engagement" to enable citizens to receive and give updates before and after a disaster

What is the use of mobile and social computing-enabled systems of engagement (supported by e-mail)?

7.4.3 Validation of effectiveness of education

What is the city's understanding of the "most probable" risk scenario and knowledge of key response and preparation steps throughout the city?

Information and data that cities will require to make progress on this Essential:

List of grassroots organizations and information on their size, roles and how they operate; details of how the city works with disadvantaged groups – for example, those in areas of high poverty; transient or nomadic communities; residents of informal settlements; the elderly; physically or mentally sick or disabled; children; non-native language speakers.



Credit: Creative Commons McKay Savage, Color Adjustment

ESSENTIAL 8



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

OPERATIONAL ESSENTIALS: INCREASE INFRASTRUCTURE RESILIENCE

This Essential is concerned with 'understanding how critical infrastructure systems will cope with disasters the city might experience (see Essential 2) and developing contingencies to manage risks caused by these outcomes'.

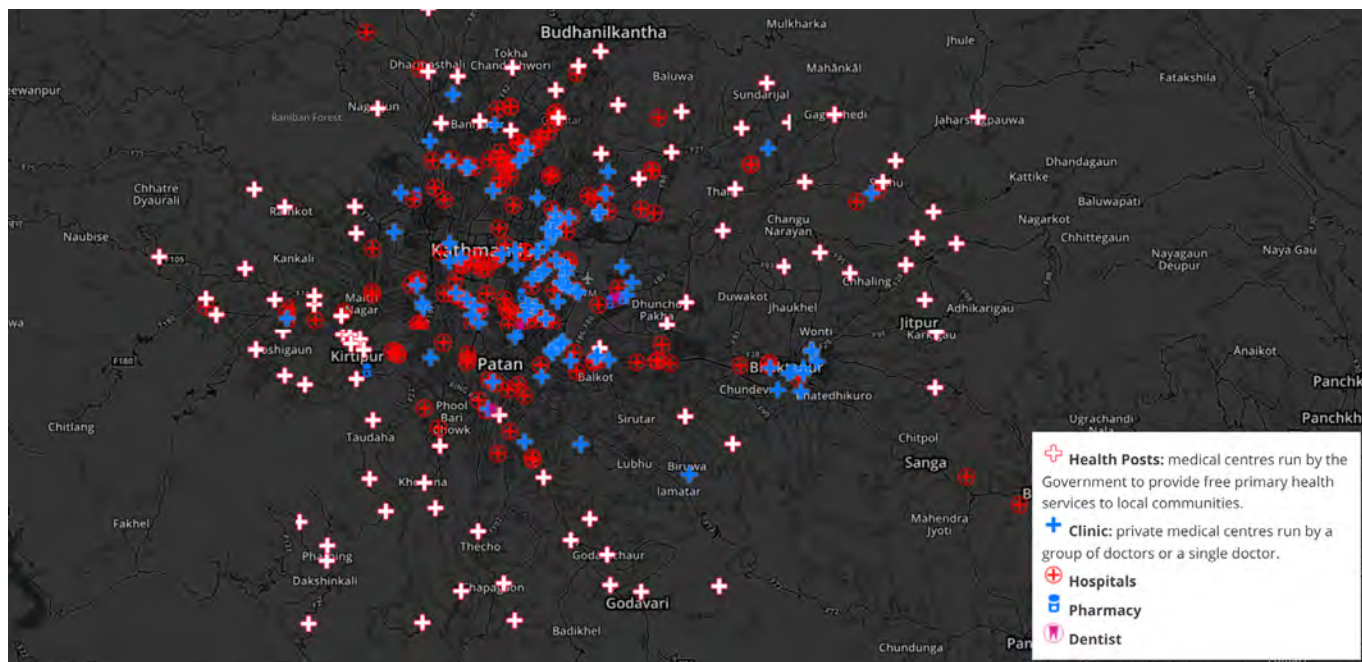
Improving the ability of a city's infrastructure system to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner is a significant challenge. This includes the preservation and restoration of its essential basic structures and organizational structures and facilities (e.g. buildings, roads, power supplies) needed to function and anticipating 'possible damage to parallel infrastructure (for example, impact on evacuation capacity if one of two roads out of a city is blocked); and consider linkages between different systems (for example, impact if a hospital loses its power or water supply).'

Open data based approaches can play an important role in supporting information sharing about critical infrastructure systems and assessing the quality and capacity of infrastructure to withstand shocks. These approaches can also help to pinpoint key interdependencies that may trigger failure chains. Data analysis of city infrastructure systems can provide guidance for city officials to make contingency plans and to take risk informed decisions for emergency response and post disaster damage assessment.

Risk assessment of infrastructure using open data-driven risk models can identify the likelihood of cascading events. These models can also support the management of infrastructure assessments post-disaster and assist decision makers in prioritising the retrofitting or replacement of unsafe infrastructure. Climate change adaptation and risk planning should be considered appropriately in infrastructure project planning in order to reduce future risk in the design, operational and maintenance cycles of infrastructure. This is best achieved through data sharing on infrastructure systems in order to support decision making and partnerships between agencies for cohesive infrastructure resilience planning.

This Essential places significant emphasis on ensuring the continuity of computer systems and on the preservation and security of data critical to the functioning of critical infrastructure and of the city government itself.

KATHMANDU, NEPAL: OPEN DATA FOR CRITICAL HEALTH AND EDUCATIONAL INFRASTRUCTURES MAPPING



Credit: Open Cities Project

In partnership with the Government of Nepal, the World Bank and GFDRR Open Cities Project, the Critical Health and Educational Infrastructures Mapping project has been developed to build seismic resilience in the Kathmandu Valley. It has been conceived as a model to prioritize plans for the retrofitting of schools and health facilities to improve structural integrity in the face of earthquakes. Working with universities, technical communities, community groups and a local NGO, Kathmandu Living Labs, structural data has been collected in collaboration with all stakeholders in order to create a robust asset inventory and to expand OpenStreetMap (OSM) coverage of the Kathmandu Valley. Over 2,300 individuals participated in OSM trainings

or presentations during the first year of the project. A comprehensive base map of the valley was developed by digitizing over 100,000 building footprints, to create a disaster risk model and to determine the relative vulnerability of buildings. The road network was mapped and information collected on other major points of interest. This has resulted in the mapping of over 100,000 buildings and the collection of exposure data on 2,256 educational and 350 health facilities within Kathmandu Valley.

For more information:

<http://www.opencitiesproject.org/casestudy/health/>;
<http://www.opencitiesproject.org/casestudy/schools/>

ACCRA, GHANA: OPEN DATA FOR URBAN WATER, SANITATION AND HYGIENE (WASH) INFRASTRUCTURE PLANNING

Led by the Ecological Sequestration Trust, the Greater Accra Population Socio Economics and Water Access database was created in collaboration with the Greater Accra Metropolitan Area (GAMA) city authorities. This project aims to help city planners model how to achieve 100% access to water and sanitation by 2030. It combines open datasets on land use, WASH infrastructure, population and household data along with WASH sector flows, including supply and demand. The data tables available at the Africa Open Data portal contain information on water and sanitation technology cost, infrastructure, flow rates, population socio-economics, water access, water use and sewage needs.

The analysis covers fifteen districts in the Greater Accra Metropolitan Area.

For more information:

openAFRICA: GAMA WASH open dataset tables
<https://africaopendata.org/dataset/greater-accra-population-socio-economics-and-water-access>

The Ecological Sequestration Trust: WASH sector prototype debut in Ghana
<http://resilience.io/portfolio/wash-sector-prototype-debut-in-ghana/>



Credit: Ecological Sequestration Trust

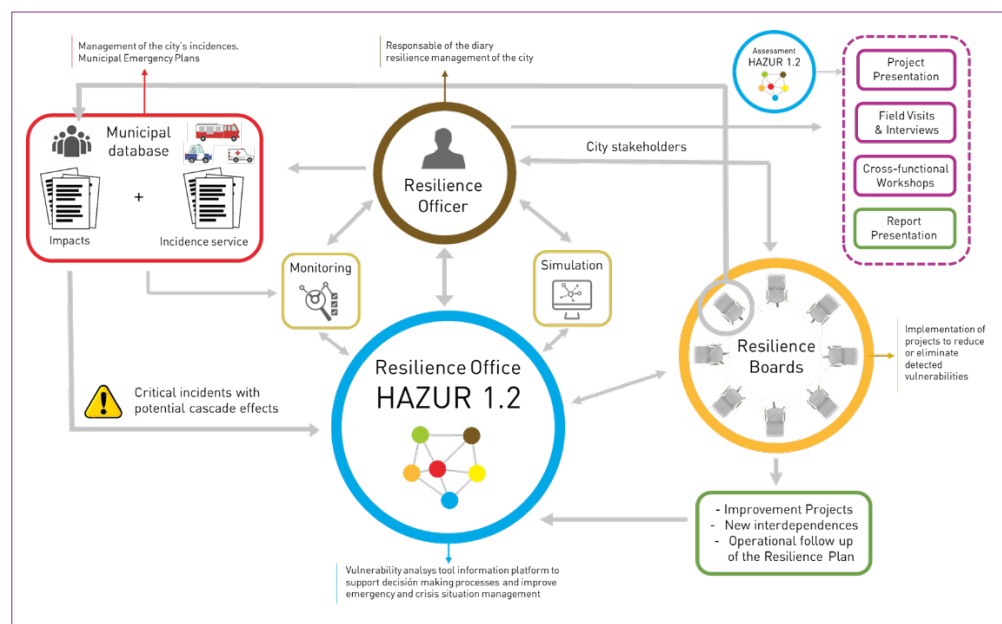
LISBON, BRISTOL AND BARCELONA: HAZUR: OPEN AND CLOSED DATA TO IDENTIFY INFRASTRUCTURE INTERDEPENDENCIES

The city authorities and resilience officers of Lisbon, Bristol and Barcelona are deploying a software tool, HAZUR, developed by the Spanish company Opticits, to help them improve the resilience of their city infrastructure and services in the face of climate change impacts. These impacts range from urban flooding and sewer overflow during heavy storm events to coastal erosion, river flooding, drought, heat waves and sea level rise.

Local HAZUR experts have been collecting and organizing essential basic information about the systems of the three cities. This information is analysed to identify interdependencies and cascading effects between different urban infrastructure systems and services. From this first assessment, critical points in potential failure chains can be identified. The implementation of the HAZUR process includes organising city

stakeholder workshops and compiling, analyzing and validating city data in order to generate a final city resilience assessment report with a strategic but also technical scope. The data model for HAZUR involves using a mix of open hazard data from government agencies, open city data made available by the city authorities of Bristol, Barcelona and Lisbon and closed proprietary data from infrastructure operators.

The HAZUR system combines assessment information with real-time data, enabling both the simulation of risk scenarios at city systems level as well as equipping city managers, resilience officers and infrastructure operators with tools for service network monitoring on an ongoing basis that capture data across city systems at a glance.



Credit: Opticits

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 8 KEY INDICATORS

Preliminary Assessment

P 8.1 Critical infrastructure overview

Is critical infrastructure resilience a city priority, does the city own and implement a critical infrastructure plan or strategy?

P 8.2 Protective infrastructure

Is existing protective infrastructure well-designed and well-built based on risk information?

P 8.3 Water-potable and sanitation

Would a significant loss of service for potable water and sanitation services be expected for a significant proportion of the city under the agreed disaster scenarios?

P 8.6 Communications

Would a significant loss of communication services be expected for a significant proportion of the city in the 'worst case' scenario event?

Detailed Assessment

8.2 Water Sanitation

8.2.2 Designated critical asset service days (for example, service to hospitals or other critical assets) at risk of loss from water or sanitation failure

What are the mechanisms for city assessments for losses in critical water or sanitation assets?

8.6 Communications

8.6.2 Designated critical asset service days at risk of loss from communications failure

What are the mechanisms for city assessments for losses in communication assets?

8.11 Computer systems and data

8.11.1 Assurance of continuity of computer systems and data critical to government continuity

What percentage of critical applications and associated data (to include social services and other personal records) imaged at, and accessible from, remote site?

8.11.2 Assurance of continuity of computer systems and data critical to infrastructure systems

What percentage of critical applications and associated data imaged at, and accessible from, remote sites (i.e. is all critical application and data routinely backed up and accessible within 15 minutes at a remote site not known to be vulnerable to any events affecting the city)?

Information and data that cities will require to make progress on essential 8:

Transport – roads, rail, airports and other ports; vehicle and heating fuel supplies; telecommunication systems; utilities systems (water, wastewater, electricity, gas, waste disposal); health care centres, hospitals; schools and educational institutes; community centres, institutions; school facilities; food supply chain; police and fire service; jails.

Data on infrastructure required for disaster response may include the above, plus data on emergency or incident command centres, and associated communications and monitoring/situation awareness systems – these may include cameras, sensors and crowdsourcing mechanisms such as reading of SMS and Twitter feeds; additional fire, police and ambulance vehicles; national guard or other military services; earth and debris-removing equipment; pumps; generator; sports facilities, school buildings and so on that provide places of shelter; mortuaries; backup computing facilities.

Other useful data include: disaster resilience plans for each infrastructure system (each may be owned by one or more separate agencies), and data on execution of those plans; location of, and relationship between, critical assets, the populations they serve, and documentation linking their loss or damage to the scenarios in Essential 2.



Credit: Resurgence

ESSENTIAL 9



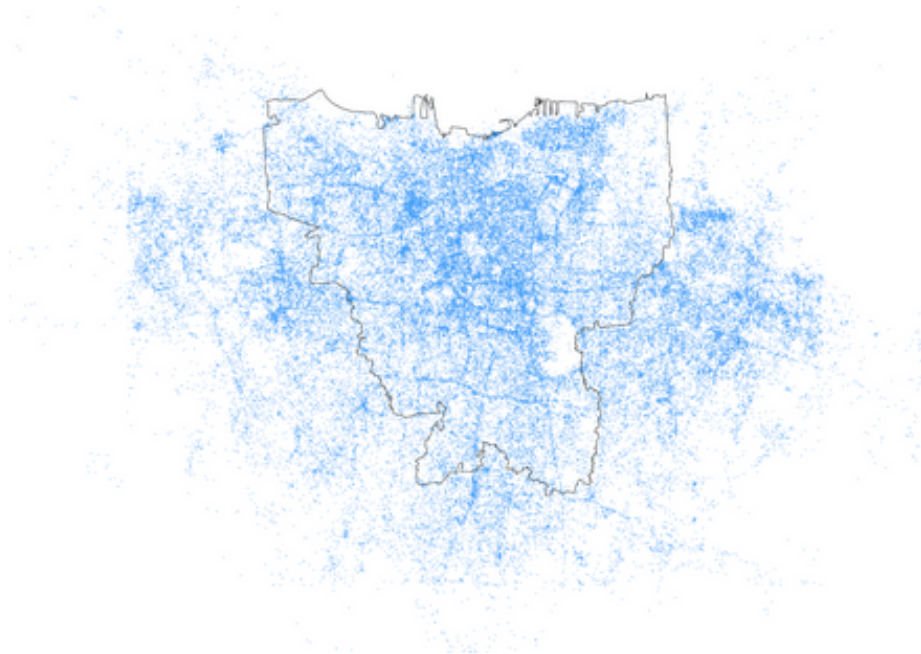
UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

BUILD BACK BETTER ESSENTIALS: ENSURE EFFECTIVE DISASTER RESPONSE

Effective disaster response is one of the most pivotal aspects in ensuring that when disasters occur, a city is able to provide early warning alerts, effective communication channels and emergency preparedness plans to reduce the potential risks faced by citizens. Essential 9 seeks to ensure effective response by 'developing and installing detection and monitoring equipment and early warning systems and effective associated communication systems to all stakeholders and community groups.' City officials need to consider strategies which help mitigate climate crises and how to respond to them when they do occur.

As city authorities develop and install disaster detection and monitoring systems, they must consider making this information readily available online with real-time updates. This allows any civilian to have the ability to inform themselves of the current state of affairs. Opening this data to the public has the potential to ensure that evacuations, safety procedures and relocation happen in the most efficient manner possible, saving not only lives, but time and resources.

JAKARTA, INDONESIA: PETABENCANA (FORMERLY PETA JAKARTA)



Map of flood-related Tweets across Jakarta between Nov. 2013 – Feb. 2014 Credit: PetaJakarta.org.

Jabodetabek (greater Jakarta), is home to over 30 million people making it the second largest urban region on Earth. Jakarta, in particular, is at remarkably high risk of flooding during monsoon season as roughly 40% of its landmass is below sea level. Led by the local government, NGO PetaBencana.id, and the Urban Risk Lab at the Massachusetts Institute of Technology (MIT), the online application combines data from hydraulic sensors with citizen knowledge gathered via social media, creating real-time flood mapping. The project has since expanded to other regions of Indonesia including Surabaya and Bandung.

PetaBencana leverages city-provided data on transportation, water and energy to ensure the app is as comprehensive as possible. Next, the

application sorts through tweets which mention the word "banjir" (flood) and tags @PetaJkt; in 2016 their Twitter had a following of more than 50,000 people and analyzed over 10,000 tweets pertaining to floods.¹⁷ Jakarta's Disaster Management Agency, Badan Nasional Penanggulangan Bencana (BNPB), now uses the app as a part of its daily emergency management operations, encouraging citizens to participate in flood monitoring as part of their civic duty.

The application was built using CogniCity software, which is free and open sourced, making the application easily replicable globally.

More information:

¹⁷ <https://www.oecd.org/gov/innovative-government/embracing-innovation-in-government-indonesia.pdf>

ACCRA, GHANA: FLASH FLOODING FORECASTING APP

Located along the southern boundary of Ghana, where the country meets the Atlantic coast, Accra, a city of a million people, faces climate challenges such as flash flooding and drought. With large portions of its population living in informal settlements in structures built of mud and clay, flash flooding is one of the major disrupters of civic life in Accra. Specific areas of the city are flooded several times a year, so seeking to improve the rate at which communities are aware of possible flash floods is pivotal to their safety. The project is a spinoff from a national strategy developed alongside the United Nations Development Programme (UNDP), and is implemented and organized by the National Disaster Management Organization (NADMO), a disaster organization in Ghana.

The Flash Flooding Forecasting App determines the likelihood of a flood based on recent rainfall and hydrological models. With the inclusion of 'Early Warning Signals,' the mobile app alerts residents living in risk prone areas before a flood is likely to occur. The app is free to download, as the project was co-funded by private-sector partners.

Not only does the app provide people with the information they need to be safe, but it also provides city officials with the data allowing them to be proactive about the impact of the floods.

For more information:

<https://www.viawater.nl/projects/flash-flood-forecasting-app-ghana>



Credit: Royal Haskoningdhv;
Effects of Flash Flooding in Accra.

UNITED KINGDOM (MULTIPLE CITIES): ResilienceDirect Project



Credit: ResilienceDirect, Color Adjustment

Under the UK Public Sector Mapping Agreement (PSMA), emergency responders now have access to open source location data via a fully accredited and secure information sharing platform called ResilienceDirect. ResilienceDirect leverages open data on a closed platform which is only available for emergency responders to access. The application allows for first responders to better coordinate their actions and share information with one another. It has the capacity to work alongside other programs and processes. This means that no matter what an individual city's emergency response plan entails, any city affected by the same risk can access information from other cities, learn from their initiatives and lean on one another for support and aid.

ResilienceDirect allows for real time information sharing to take place across organizational and geographical boundaries. The application is free to download and use, making it a vital component of the emergency response plan. According to the Ordnance Survey, it has already saved the UK over £760k in efficiency savings. Within the application, there are multiple products that are utilised to survey and respond to crisis such as the [OS MasterMap Topography Layer](#), [OS VectorMap District](#) and [OS VectorMap Local](#).

For more information:

<https://www.gov.uk/guidance/resilient-communications>

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 9 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 9.1 Early warning

Does the city have a plan or standard operating procedure to act on early warnings and forecasts?
What proportion of the population is reachable by early warning system?

P 9.2 Event management plans

Is there a disaster management plan outlining city mitigation, preparedness and response to local emergencies?

Detailed Assessment

9.1 Early warning

9.1.1 Existence and effectiveness of early warning systems

What is the availability of warnings system for all hazards known to be relevant to the city, and will this allow time for reaction (as far as technology permits)?

9.1.1.1 Reach of warning

Will 100% of population receive it?

9.2 Event response plans

9.2.1 Existence of emergency response plans that integrate professional responders and community organizations (for post-event response - see Essential 10)

Are the city's existing emergency response plans formulated to address "most likely" and "most severe" scenarios, shared and signed off by all relevant actors (including citizen organizations)?

9.6 Interoperability and inter-agency working

9.6.1 Interoperability with neighbouring cities/states and other levels of government of critical systems and procedures

What is the city's ability to cooperate at all levels (communications systems; data; emergency management applications; assumptions, rehearsed procedures and priorities; accountabilities (see Essential 1); territorial coverage) with neighbouring cities and other levels of government?

Information and data that cities will require to make progress on this Essential:

Which warning systems exist and whom they will reach; emergency management plans and procedures that specifically consider the impact of the scenarios; documentation of first responder – staffing and equipment - capabilities; records of drills and practices; identification of systems where interoperability with other agencies is critical and of the standards adopted; records of evaluations, learning points and improvements enacted.

ESSENTIAL 10



UN Photo/UNICEF/Marco Dormino on Flickr, Color Adjustment

BUILD BACK BETTER ESSENTIALS: EXPEDITE RECOVERY AND BUILD BACK BETTER

Essential 10 can easily be planned for before a disaster happens and indeed should be planned for before one occurs. The essential calls for 'the needs of the survivors and affected community to be placed at the centre of recovery and reconstruction with support for them and their community organizations to design and rebuild shelter, assets and livelihoods at higher standards of resilience'.

City authorities should have a clear idea of where post-disaster funding will come from (see Essential 3) and a clear set of procedures which they intend to follow to ensure all of these ideals are met.

The inclusion of open data in these processes and procedures will not only ensure transparency with the local community, but it also builds capacity for collaboration in rebuilding projects. With multiple scales of rebuilding projects set to happen after a disaster, it is imperative that these projects leverage one another's effort to maximize time and monetary resources. Open data can provide a platform to visualize projects and initiatives, which will help reduce future vulnerabilities.

CHRISTCHURCH, NEW ZEALAND: EARTHQUAKE CLUSTERS

In 2011, Christchurch, New Zealand was struck with a 6.3 Magnitude earthquake, which resulted in the death of 175 civilians and significant damage to urban infrastructure. Emergency response organizations and city councils leveraged open data and trusted data sharing and crowdsourcing to develop new applications. These applications allowed them to track emerging conditions and innovate solutions rapidly and efficiently. In the aftermath of the earthquake, city councils and emergency responders were under capacity in terms of search and rescue missions, as well as other emergency measures, and turned to the usage of open data and eager volunteer teams to aid in the recovery process. One such creation was an openly available online application which used Geographic Information Systems (GIS) data to crowdsource information from citizens, thus creating a comprehensive depiction of the hazards and risks in Christchurch. This information informed volunteer teams across the city, making their efforts more efficient and targeted.

During the recovery and rebuild stage, a Forward Works Viewer was also created to help visualize all the rebuilding projects occurring in the city. These included demolishing 1,200 commercial buildings, repairing all below-ground infrastructure (wastewater, stormwater, water supply, power, and broadband), and beginning the process of reconstructing new buildings. The viewer allowed users to manage and view projects and their impacts spatially and over time, and detect potential clashes and opportunities for collaboration. It is estimated that the Forward Works Viewer saved NZ\$4 million in construction costs within the first year alone, with total savings potentially reaching NZ\$20 million.

Govlab case study at:

<http://odimpact.org/case-new-zealands-christchurch-earthquake-clusters.html>



Credit: Gabriel Goh (2011), via flickr, Color Adjustment

MEXICO (MULTIPLE CITIES): FONDEN PROJECT

In 1996, the National Government of Mexico established a Fund for Natural Disasters (FONDEN). Annually the national government spends roughly US\$1.5 billion on reconstruction of public assets and low-income housing after natural disasters (GFDRR, 2013). The government considers FONDEN to be a financial vehicle which they use to improve their budgetary management of adverse natural effects and supply the required finances to build back better after a crisis occurs. By law, FONDEN must receive at least 0.4 percent of the federal budget (approx. US\$800 million in 2011) to the FONDEN Trust and Emergency Relief Fund.

During a crisis, the state either labels an event a "state of emergency" or a "disaster." If labelled a "state of emergency," funds become immediately available from the Emergency Relief Fund. While if labelled a "disaster," an assessment of damages

and loss is conducted to eventually indicate the cost of reconstruction. The government leverages open data in the assessment phase with the use of an online system which integrates geocoding and digital imagery to help allocate funds and ensure accuracy when detailing damages and losses. FONDEN begins by financing 100% of public assets damaged, followed by 50% of local assets damaged. Over the years, the Government of Mexico has also emphasized the need to build back better, encouraging reconstruction of infrastructure to be built with higher standards and relocate public assets and lower-income communities to safer areas.

For more information:

<https://www.yumpu.com/en/document/view/21491509/fonden-mexicos-natural-disaster-fund-proteccion-civil>



Credit: UN Photo/Jean Claude Constant, Color Adjustment

DISASTER RESILIENCE SCORECARD FOR CITIES

ESSENTIAL 10 KEY INDICATORS

PRELIMINARY ASSESSMENT

P 10.1 Post event recovery planning – pre event

Is there a strategy or process in place for post-event recovery and reconstruction, including economic reboot, societal aspects, etc.?

10.2 Lessons learnt/learning loops

Do post-event assessment processes incorporate failure analyses and the ability to capture lessons learned that then feed into design and delivery of rebuilding projects?

DETAILED ASSESSMENT

10.1 Post event recovery planning – pre event

10.1.1 Planning for post event recovery and economic reboot

Does the city have fully comprehensive plans to address economic, infrastructure and community needs after "most probable" and "most severe" scenario?

10.1.2 Extent to which there has been stakeholder consultation around the 'event recovery and reboot' plans

Have all stakeholder been involved in build back better plan?

10.2 Lessons learnt / learning loops

10.2.1 Learning loops

Is there a process and format for "post-mortems" on what went well and less well in the event response and post-event phases?

Information and data that cities will require to make progress on this Essential:
Post-event plans, potentially from multiple organizations and agencies.

SECTION C: THE GUIDE



Credit: United Nations, Geneva, Color Adjustment

PART 1: The Disaster Resilience Case For Local Open Data Infrastructure

PART 2: Opportunities For Smart Resilient Urban Development

PART 3: Developing Data Quality And Standards At City Level

PART 4: Managing Open Innovation Processes With Multiple City Stakeholders

PART 5: Moving Beyond Data: Effective Public Engagement & Risk Communication

PART 1



Credit: United Nations, Geneva, Color Adjustment

THE DISASTER RESILIENCE CASE FOR LOCAL OPEN DATA INFRASTRUCTURE

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015. The guiding principles for the implementation of the Sendai Framework outline that 'Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data, including by sex, age and disability, as well as on easily accessible, up-to-date, comprehensible, science-based, non-sensitive risk information, complemented by traditional knowledge.'¹⁸

In 2010, the UN Office for Disaster Risk Reduction (UNISDR) launched the Making Cities Resilient Campaign, with the objective to "increase understanding and encourage commitment by local and national governments to make disaster risk reduction and resilience a policy priority and to bring the global Hyogo Framework closer to local needs."¹⁹

Rapid urbanisation and the growing impacts of climate change are now combining to create new vulnerabilities for all cities of the Campaign, presenting particular challenges to urban resilience beyond those posed by natural and manmade hazards. Whether they are based in high, middle or low income countries, all cities are exposed to climate change impacts. They need major investments in low carbon, climate resilient urban infrastructure that will require financing of between US\$57 and US\$90 trillion at the global level by 2030 in order to meet the Sustainable Development Goals (SDGs).²⁰

Of vital importance to achieving the targets set out by Sendai Framework, Sustainable Development Goals (SDGs) and to making progress on the 10 Essentials is the need for cities to have access to a very different kind of critical infrastructure: to robust global and local open data infrastructure capable of bringing together different groups - public, private, civic - to identify risk to urban assets, systems and communities and of supporting their resilience.

¹⁸ [Sendai Framework for Disaster Risk Reduction, Guiding Principles, Paragraph 19, Section \(g\), P.13](#)

¹⁹ [Local HFA Tool, HFA Monitoring and Review, Sendai Framework, Preventionweb, 2016](#)

²⁰ [Studies by McKinsey and the Global Commission on the Economy and Climate respectively.](#)

BUILDING GLOBAL OPEN DATA INFRASTRUCTURE FOR RESILIENCE

Investments in global open data infrastructure are already significant. In the EU, for instance, the [INSPIRE Directive](#) establishes the infrastructure for spatial data and services related to the environment for EU member states. International networks such as the Global Earth Observation System of Systems (GEOSS) are creating the infrastructure at the global level for the sharing of environmental data and analysis, and improving access to earth observation data for urban application. GEOSS convenes a large number of activities that can support city resilience including:

**Earth Observations for Disaster
Risk Management**

**GEO Geohazard Supersites and
Natural Laboratories (GSNL)**

**Data Access for Risk Management
(GEO-DARMA)**

Global Flood Risk Monitoring

The Joint Research Centre of the European Commission has created and released the [Global Human Settlements Layer](#) (GHSL) - a complete, consistent, global, open dataset on human settlement based on more than 12.4k billion individual image data records collected by different satellite sensors in the past 40 years. It aims to support monitoring of the post 2015 international frameworks, including the Sendai Framework for Disaster Risk Reduction.

A range of public agencies has developed significant open global resources across the areas of disaster damage and loss, hazards, socio-economic indicators and exposure, such as the [Global Exposure Database for the UNISDR Global Assessment Report \(GAR\)](#).

These public investments are paralleled by the geographic information systems (GIS) infrastructure services provided by private sector actors such as Esri and via the crowdsourced efforts of the international volunteer mapping community and, more recently, of governments and city authorities through [OpenStreetMap](#).

"DATA IS INFRASTRUCTURE."

It underpins transparency, accountability, public services, business innovation and civil society. A data infrastructure consists of the data assets, the organisations that operate and maintain them and guides describing how to use and manage the data. Trustworthy data infrastructure is sustainably funded and has oversight that provides direction to maximise data use and value by meeting the needs of society. Data infrastructure includes technology, processes and organisation.

Data connects multiple sectors. Open weather data will be used by everyone from farmers to the transport industry to individual citizens. Mapping data is published by the public sector and then built on by organisations as diverse as Google, construction companies, and the home insurance industry. Data is infrastructure for our cities and our nation across each and every sector. "

**Open Data
Institute
2016**

DEVELOPING LOCAL OPEN DATA INFRASTRUCTURE WITHIN A PROBLEM DEFINITION AND USER FRAMEWORK FOR THE 10 ESSENTIALS

The global data infrastructure assets outlined above offer significant resources to cities. Many have, however, been created on a predominantly top-down basis. They need to be matched by the development of local city level data infrastructure that can access and utilise these global data resources and generate scalable bottom-up and peer-to-peer approaches to risk management.

Local open data infrastructure user framework for the 10 essentials



Credit: Nuha Eltinay

CREATING DATA INFRASTRUCTURE FIRST AS A GATEWAY TO OPEN DATA

City authorities need to first develop broad, robust data infrastructure that can securely support the full range of data types, including closed restricted data. Within a wider data strategy, making appropriate city-level data open and consistent with global best practices as embodied in the International [Open Data Charter](#)²¹ is of particular importance to supporting urban resilience. The need for system-wide approaches that can assess risk beyond individual sectors and build collaborative solutions requires an open, inclusive approach to identifying problems and to identifying the data required to understand and address them.

An important reason to support local open data infrastructure within a broader data strategy at the city level is to increase the capacity of key stakeholders to collaborate in the process of identifying risks and resilience challenges. This can also build their understanding of how data can play a role in helping them assess and resolve these challenges.

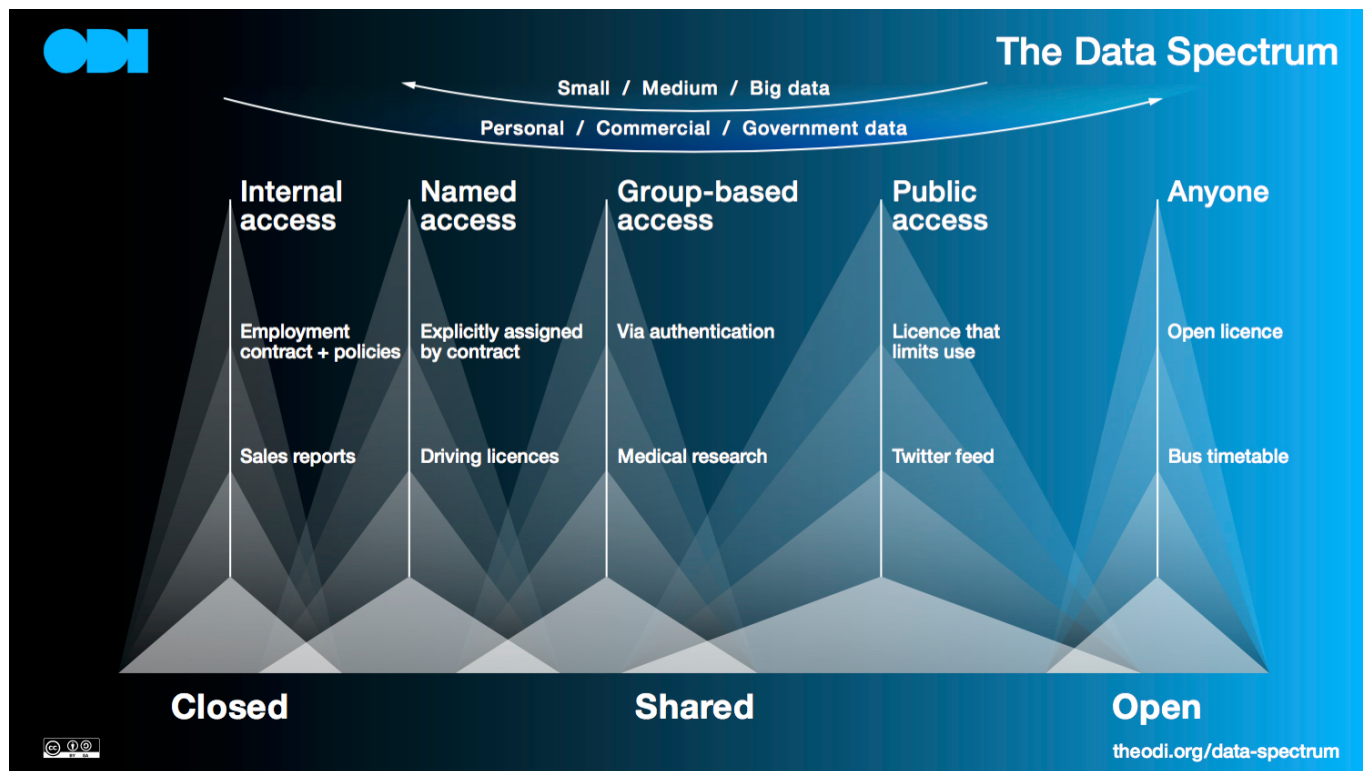
Above all in the cases of cities that are less data advanced, a problem-based approach grounded in the priorities of city officials and wider stakeholders related to the wider framework of the 10 Essentials is more likely to generate collaboration and impact. This can generate further investments in systematic data collection and management leading to a consolidated open data infrastructure.

Adopting this approach requires an understanding of:

- How data operates across the spectrum from the closed to the open;
- The different forms that data can take from sensor data to crowdsourced data;
- The importance of Geospatial Data and Geographic Information Systems (GIS);
- The broad range of data 'owners' that operate at city level extending beyond local government and public agencies;
- The benefits that both financial and human investment in open data infrastructure can bring to bear on local resilience challenges.

²¹ The International Open Data Charter captures principles and best practices for the release of governmental open data. The charter was formally adopted by seventeen governments of countries, states and cities at the Open Government Partnership Global Summit in Mexico in October 2015.

UNDERSTANDING THE DATA SPECTRUM



Credit: Open Data Institute

The graphic shows that, whether data is big data or not, or originates from an individual or a government source, the key factor is the way in which it is licenced.

THE RANGE OF DATA FORMS ²²

OPEN DATA

Data that anybody can access, use and share. It must:

- be accessible, which usually means published on the web
- be available in a machine readable format
- have a licence that permits anyone to access, use and share it.

SHARED DATA

Data that is shared with specific people and organisations for a specific purpose: to provide services, connect information, contribute to research.

Shared data can include licensed commercial data.

CLOSED DATA

Data that only its owners or people within an organisation can access, for reasons such as privacy, commercial sensitivity and security.

SENSOR DATA

Data gathered by sensors and devices in public, private or citizen ownership. It can be open or restricted.

BIG DATA

A term for data that is large or complex and derived from digital sources such as satellites, sensors, mobile phones and social media production. Big data requires powerful processing and analytic capabilities to generate insights.

CROWDSOURCED DATA

Data provided, collected and disseminated by citizens through digital devices and social media channels.

The concepts of open data, big data and crowdsourced data extend beyond the datasets themselves. They include the capacity to analyse and use that data, and the people and communities who produce, analyse, manage and use the data. They form a part, in effect, of wider data infrastructure.²³

²² Adapted from '[How can we improve urban resilience with open data?](#)' Open Data for Development, Open Data Institute, OpenNorth

²³ [Data-Pop Alliance Synthesis Report: Big Data for Climate Change and Disaster Resilience](#)

GEOSPATIAL DATA AND GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Risk and resilience challenges have strong locational and spatial aspects that require the collection, management and processing of geospatial data and its combination with hazard data. GIS platforms and applications now widely available provide powerful modelling, analysis and visualisation to support evidence-based decision making and stakeholder engagement to identify and to act on risk. The graphic below illustrates the process that GIS offers to cities implementing the 10 Essentials.

City applications of GIS and geospatial data in Section B in the following use cases:

Essential 1 Organize for Disaster Resilience:
Rio de Janeiro, Gwang-Ju, Semarang

Essential 2 Understand Risk: Washington DC,
Batticaloa, Chennai

Essential 3 Strengthen Financial Capacity:
Budapest, Da Nang, USA

Essential 4 Resilient Urban Development/Design:
Greater Manchester, Dar es Salaam

Essential 5 Protect Natural Buffers:
Grenville, Richmond

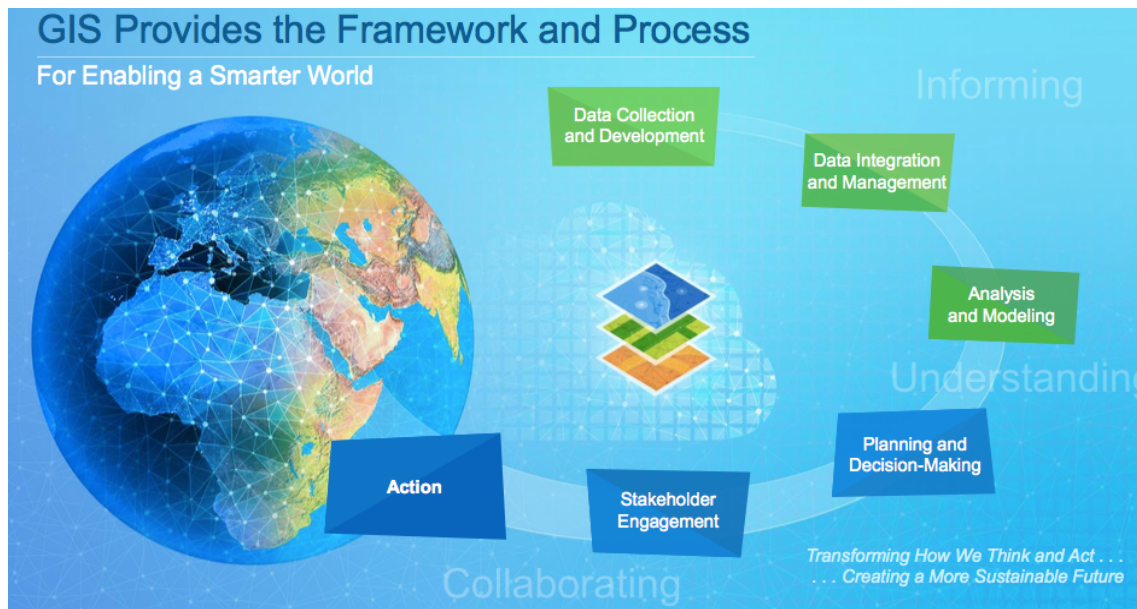
Essential 6 Strengthen Institutional Capacity:
London, Cairo, Africa

Essential 7 Strengthen Societal Capacity for
Resilience: Kampala, Cape Town

Essential 8 Increase Infrastructure Resilience:
Kathmandu, Accra, Lisbon/Bristol/Barcelona

Essential 9 Ensure Effective Disaster
Response: Accra, Jakarta, UK

Essential 10 Expedite Recovery and Build Back
Better: Christchurch, Mexico



Credit: Esri

THE RANGE OF DATA OWNERS AT CITY LEVEL

Non-public organisations in cities that have a key role to play in risk mitigation such as utilities, telecommunications providers, insurers, infrastructure operators and land developers are data 'owners' that have specific approaches as to how data is to be shared. These organisations all need to be encouraged to release data as open data with the incentive of gaining access to more data themselves. If non-public agencies will not release their data, they should be encouraged to pool their data through platforms that combine elements of the city open data store with a city data market that allows for licensing models.²⁴

Encouraging open release of datasets does not contradict the need for data related to security issues, is commercially sensitive or of a personal nature to remain closed. Nor does open release of datasets take away the importance of data security across all data and digital infrastructure.

The value of the open culture, collaborative spaces, networks and processes that are characteristics of the open data community is becoming apparent to urban resilience practitioners, given that challenges and solutions often lie across individual sectors and across practice areas.

Smart and Resilient Cities

Smart Cities apply networked ICT and data analytics through the Internet of Things (IoT) to improve operational performance across city infrastructure systems such as transport, energy or water. These approaches present major opportunities to improve resilience by applying IoT, for instance, to early warning systems, urban mobility and flood management.

Smart City approaches do not, however, currently integrate systematically natural hazard risk assessment - including extreme climate events - into their deployment strategies. The data utilised on smart city projects is often closed, proprietary, lacking standards to facilitate interoperability, and managed in a stovepipe fashion, which precludes collaboration. Developing ways to share and to open up smart city data, along with ensuring that catastrophic risk modelling is woven into the fabric of smart city planning is vital to ensuring the resilience of city infrastructure and protecting communities.

²⁴ [Data for London: A City Data Strategy and its plan to build into the London Datastore a City Data Market function.](#)

ALIGNING OPEN DATA INFRASTRUCTURE AND URBAN RESILIENCE INVESTMENTS

Cities at all levels of data maturity need to invest in their local open data infrastructure. The case for investment in local open data infrastructure to improve city disaster resilience lies in the following:

1) Collaborative problem definition: bringing together local authorities, resilience experts and open data specialists around open data can lead to more inclusive and innovative evidence-based resilience solutions, avoiding the imposition of top-down measures by city authorities which may not have the trust of communities.²⁵

Rio de Janeiro, Gwang-Ju, Semarang, Essential 1
Greater Manchester, Dar es Salaam, Essential 4

2) Participatory risk assessment: using open data based approaches or hybrid approaches that combine open with closed data allows the participation of different stakeholders including communities that facilitate engagement in risk issues in order to build stronger local ownership and action. These stakeholders can range from technology developers, disaster response organizations, local community social assistance organizations; companies, including local technical consultancies, business organizations, service providers, infrastructure contractors, insurers, software and hardware companies; universities and research centers.

Kampala, Cape Town, Essential 7

3) Risk mitigation and insurability: combining multiple open datasets can yield insights into interlinked cascading risk and potential failure chains at a city systems level that need to be addressed and be adequately insured; at local postcode level, standardised open data on building and demographics can identify risks to communities that need to be addressed and to highlight insurance issues.

Budapest, Da Nang, Essential 3

4) Support to reporting and standards processes: open data policies will facilitate the publishing of data for standardised indicators in city performance for national and international reporting processes and standards.

New ISO standard on indicators for urban resilience under development by the World Council on City Data (WCCD) and UNISDR.

5) Analysis and comparability of resilience metrics between cities: enabling the exchange and 'peer-to-peer review of data can spur good practice in risk reduction and resilience and attract investment into cities.

Peer-to-peer review of the Disaster Resilience Scorecard for Cities tool developed under the European Commission's supported UScore2 Project.²⁶

²⁵ See collaborative problem definition exercise on page 15 of '[How can we improve urban resilience with open data?](#)' Open Data for Development, Open Data Institute, OpenNorth

²⁶ <http://uscore2.eu/>

PART 2



Credit: United Nations, Geneva, Color Adjustment

OPPORTUNITIES FOR SMART RESILIENT URBAN DEVELOPMENT

The Sendai Framework for Disaster Risk Reduction calls upon governments and local authorities 'to promote real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data.'²⁷

GIS systems when combined with information and communication technologies (ICTs) can generate significant benefits to cities across a range of areas including land use planning, urban climate resilience for infrastructure and communities, and open data governance. GIS platforms enabled by ICT are able to process vast flows of structured and unstructured big data flowing from combinations of earth observation, sensor data and social media.

²⁷ [Sendai Framework for Disaster Risk Reduction: Priority 1: Understanding Disaster Risk: Paragraph 24 Section F Page 14](#)

FIVE BENEFITS OF BIG DATA

A study by the DataPop Alliance²⁸ highlights that Big Data is deployable across five key areas:

- 1 MONITORING HAZARDS** via seismographs, satellites, and drones with data enriched by smartphone twitter feeds offers tremendous potential for monitoring such hazards as earthquakes and floods;
- 2 ASSESSING EXPOSURE AND VULNERABILITY TO HAZARDS.** Satellite images enable experts to identify geographical and infrastructure risks;
- 3 GUIDING DISASTER RESPONSE** by analysing social media to provide early warning on health or food insecurity threats or early assessment of flooding hurricane and earthquake damage;
- 4 ASSESSING THE RESILIENCE OF NATURAL SYSTEMS.** Satellite images revealing changes in, for example, soil quality, tree cover or urban water availability;
- 5 ENGAGEMENT OF COMMUNITIES** through the potential of Big Data to increase citizen awareness in ways that enable them to take action that helps them manage their local natural systems, infrastructure and community networks.

Many of these approaches can help compensate cities with constrained capacity and resources in data standards, acquisition and management to map their local built environment and communities. A further resource is the data on building sizes, and types available from the [Global Human Settlement Layer \(GHSL\)](#) of the European Commission that can assist data-poor cities in assessing building vulnerability.

²⁸ [Data-Pop Alliance Synthesis Report: Big Data for Climate Change and Disaster Resilience](#)

CROWDSOURCED MAPPING

Crowdsourced or participatory mapping is a second major resource for identifying local urban exposure. Crowdsourced projects engage citizens on a voluntary basis to map local geographic information, drawing upon a combination of local knowledge, imagery and social media. OpenStreetMap is the best known crowdsourced resource and has almost over 3.5 million registered users and local groups in over 80 countries, OpenStreetMap volunteers upload onto a single database details of roads, buildings, community facilities and often create maps at a level of quality and detail that is high in comparison to many official national mapping agencies.

Since 2004 OpenStreetMap has become a free editable map of the whole world, available as open geodata. Through the Humanitarian OpenStreetMap initiative, it has been used to map infrastructure exposure to flooding in urban areas and is increasingly being used to collect urban exposure data which is then fed into open source catastrophic risk modelling software. Crowdsourced mapping can help collect local level exposure data where the capacity of national or local government is lacking, and can prove critical in helping disaster responders in the many crisis zones that fall outside the footprints of well resourced national mapping agencies.

Rio de Janeiro, Gwang-Ju, Semarang, Essential 1

Washington DC, Batticaloa, Chennai, Essential 2

A HOLISTIC APPROACH TO USING BIG DATA VERTICALLY AND HORIZONTALLY ACROSS SECTORS FOR URBAN RESILIENCE

The approach includes creation of open sourced data brokerage systems to enable access to, and inter-operability between, a wide variety of data sources, including space-based observations and location data, national, regional and local open datasets, proprietary datasets, ground-based sensors and crowdsourced data. In order to achieve this level of data access, every effort is required to link with ongoing existing efforts to discover and access any observations in, on or around the earth. A defined cataloguing and data processing service will be required to build an integrated view of these Collaboratories (collaborative laboratories for the development of collective intelligence) that will turn collected data into useful evidence, increasingly in real time to support day-to-day decision making and making risk assessed investments. Crucially capacity building in data policy and technical processing is needed at a local level.

[Ecological Sequestration Trust Roadmap 2030: Financing and Implementing the Global Goals in Human Settlements and City- Regions](#)

IMPLEMENTATION APPROACHES

- 1** Exploit earth observation data and other Big Data through ICT enabled GIS platforms
- 2** Partner on and pilot data brokerage platforms that allow access to a variety of predominantly open datasets from a range of sources (satellite, national, regional, and local)
- 3** Engage with the OpenStreetmap Community and participate in local mapping parties.



Credit: Resurgence

PART 3



Credit: United Nations, Geneva, Color Adjustment

DEVELOPING DATA QUALITY AND STANDARDS AT CITY LEVEL

The first enabling Essential, Organise for Disaster Resilience, calls upon cities to 'Create policies to gather and manage data for sharing amongst all stakeholders and citizens'.

Given that local level data is often unstructured, inconsistent, fragmented or missing, the challenge for cities goes beyond inclusive data sharing policies and interoperability into issues of quality and standards. This lack of local standards and interoperability - mirrored by universities, research institutes and at the national level - can lead to major discrepancies in local city risk assessments. In the capital of West Sumatra, Padang, for instance, twelve tsunami risk assessments undertaken by different organisations generated very different results²⁹.

A lack of consistency and standards at the local level contrasts with the rigorous and standardised data collection and reporting on disaster damage and loss at the global level of four well established and recognised databases including [DesInventar](#) developed by UNISDR, [EM-DAT](#), operated by the Centre for the Epidemiology of Disasters (CRED), NatCatSERVICE, maintained by Munich Re and by Sigma, operated by Swiss Re, that are used to estimate future prevention, preparedness, recovery and insurance needs.

²⁹ [Chapter 7, Page 147 of the UN Global Assessment Report \(GAR\) on Disaster Risk Reduction 2015](#)

Several city level standards, modelling and certification processes are now being developed to address these challenges:

- The UK's national standards body, the BSI, has published [PAS 182 Smart city concept model. Guide to establishing a model for data](#) to tackle the barriers to implementing smart city concepts, including interoperable systems and data-sharing between agencies. PAS 182 is aimed at organizations that provide services to communities in cities, and manage the resulting data, as well as decision-makers and policy developers in cities. The BSI is putting the concept forward for an ISO.
- The Open Geospatial Consortium (OGC) is committed to making quality open standards for the global geospatial community. These standards are developed through a consensus process and are freely available for anyone to use to improve sharing of the world's geospatial data. The OGC is involved in developing vendor- neutral open standards for communicating geospatial and temporal data for cities in areas such as Building Information Modelling (BIM) and interoperable underground infrastructure data.
- The Open Data Institute (ODI) has developed a 4 tier semi-automated open data online publishing certification scheme to assess the quality of open data publishing across a range of legal, practical, technical and social criteria. The ODI certification scheme is being used by a number of cities and national agencies to publish risk data.

 Number of properties at risk of flooding from rivers and sea, 2011	View certificate	Published By Environment Agency Issued over 2 years ago	GB final	▼
 Sunderland Flood Risk Zones	View certificate	Published By Sunderland City Council Issued over 2 years ago	GB final	▼
 Flood Warning Areas	View certificate	Published By Environment Agency Issued over 2 years ago	GB final	▼

Credit: Open Data Institute

- Leveraging its [ISO 37120 Sustainable Development of Communities: Indicators for City Services and Quality of Life](#), (see graphic below) the World Council on City Data (WCCD) in partnership with UNISDR is developing the ISO 37123 - Indicators for Resilient Cities. This aims to align the global indicators for the 10 Essentials with the current ISO and indicators from the insurance sector to create quality comparable city data to reduce risk, increase insurability and resilience at the local urban level. For the WCCD a key value of standardised city data that is published as open data is that it provides a common language or platform for convening wider groups of stakeholders (utility and telecommunications companies, technology and community groups) on priority local issues that have not traditionally engaged in urban risk management.



Credit: World Council on City Data (WCCD)

IMPLEMENTATION APPROACHES

- 1 Collect relevant data prospectively
- 2 Share data openly across levels of governance, stakeholders, businesses, and community.



Credit: Resurgence, Color Adjustment

PART 4



Credit: United Nations, Geneva, Color Adjustment

MANAGING OPEN INNOVATION PROCESSES WITH MULTIPLE CITY STAKEHOLDERS

The Sendai Framework for Disaster Risk Reduction makes multiple references to the need for innovation and the engagement of multiple stakeholders to reduce risk. The Framework can be read as a call for open and inclusive innovation for resilience.

The complexity, however, of urban areas and the diversity of actors in them, can present challenges for those who try to organize, convene, and collaborate across multiple sectors. In the context of urban resilience, open data based challenges can provide a strong foundation for cross-sector relationships to be built upon.³⁰ City governments need to understand that they will be most resilient when they connect and collaborate with local stakeholders and actively pursue a resiliency strategy which promotes knowledge and data exchange between governments, businesses, NGOs, and citizens. This shared knowledge and data becomes the basis for creating new and innovative solutions that contribute to a city's specific urban resilience and risk reduction goals.

Collaboration and stakeholder engagement needs to be taken beyond just knowledge sharing and data collection to spur innovation; the process for designing, implementing, and maintaining risk reduction programs and resilience initiatives should leverage these relationships over time. Additionally, city governments can create sustained, lasting partnerships with institutions that align with their resilience and open data strategies, such as think tanks, universities, developer and technological communities.

³⁰ For a checklist on strengthening cross-sector collaboration between the urban resilience and open data community, '[How can we improve urban resilience with open data?](#)' (p35) Open Data for Development, Open Data Institute, OpenNorth.

IMPLEMENTATION APPROACHES

- 1** Create or co-create an open and accessible platform to publish data as open data of relevance to its resilience needs. The platform should be consistent with its overall data strategy outlined in the Roadmap, be linked to city hazard maps and to implementation of the Essentials.
- 2** Combine a platform approach with creating spaces for open innovation such as dedicated data innovation labs and open data leader networks.
- 3** Create mechanisms to collaborate with citizens and other key stakeholders, online and in person, and provide or crowdsource the data needed to develop new solutions to specific resilience challenges.
- 4** Achieve a low barrier for participation in order to encourage as many diverse actors as possible (i.e. civil engineers, public planners, technology developers, community groups).
- 5** Innovation initiatives can on take many forms - hackathons, online and event based challenges and consultations.
- 6** City governments should consider partnering with larger technology and investment companies to ensure that promising innovations can be incubated, can develop business models and be scaled.

PART 5



Credit: United Nations, Geneva, Color Adjustment

MOVING BEYOND DATA: EFFECTIVE PUBLIC ENGAGEMENT & RISK COMMUNICATION

“There has to be a broader and a more people-centred preventive approach to disaster risk. Disaster risk reduction practices need to be multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective.”³¹

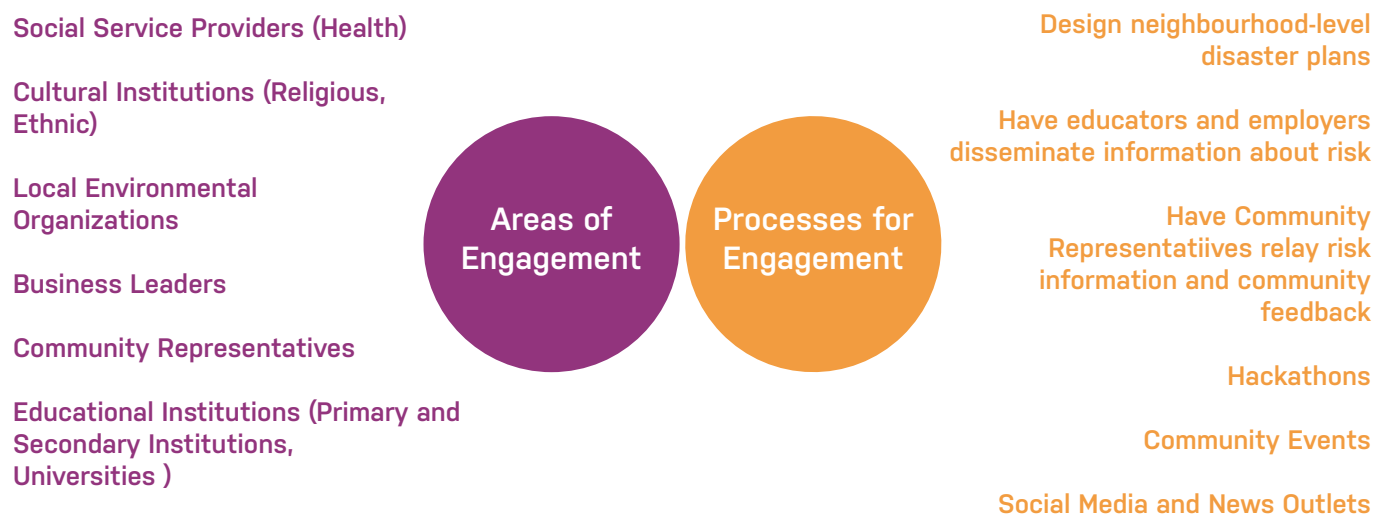
Resilient cities and communities are those in which citizens and residents are informed and aware of the risks which affect them and are armed with the information needed to respond to the shocks and stresses of urban life. Better informed residents will know how to act in times of crisis by being prepared for risks and aware of places of refuge for when they do occur. This poses challenges for the uptake of risk information arising from traditional catastrophic risk modelling approaches, which rarely engage local stakeholders. Open data based approaches can allow community groups to engage in collaborative risk assessment and monitoring through events such as community hackathons, or grassroots disaster risk reduction programmes.

In order to reach wider and more vulnerable groups in cities that are unlikely to participate in these community events, other forms of public engagement and risk communication are needed to increase community level preparedness.

³¹United Nations Sendai Framework for Disaster Risk Reduction.
Preamble. Section 7 Page 4.

The following model demonstrates possible groups to target for engagement, as well as different processes for engagement. City officials should disseminate information in a coherent manner to different demographic groups. For example, young adults may prefer electronic delivery while the elderly may require printed maps. The diversity of communities and languages in urban areas should also be taken into account, and where possible, information and events on disaster risk reduction should be developed in partnership with the groups city officials are seeking to engage with.

In situations when dealing with vulnerable groups that may be illiterate and distrustful of officials and organized institutions, the organisation and presentation of data - and the formats, channels and intermediaries through which it is conveyed - can be of critical importance. It is vital to work through existing community networks as well as support the formation of new networks.



IMPLEMENTATION APPROACHES

1 Innovate to increase the overlap between your city's risk expert and local community by:

Engaging with your local open data community to develop collaborative community risk mapping initiatives;

Investing in data visualisation to make risk information more accessible;

Working with community representatives as bridges between risk experts and communities.

2 Support two-way dynamic information flows between city officials and existing community networks by:

Encouraging citizens to voice their concerns and experiences with city officials; their insights could point to failing infrastructure which may put them, and others, at further risk.

Creating feedback mechanisms for citizens to share information and their opinions is pivotal;

Building capacity in community leaders to communicate risks; in times of crisis they can disseminate critical information and, over the long term, help to build disaster memory.

3 Support local communities of practice in risk communication:

Creating a local culture of open collaboration across sectors, communities and demographics helps city officials to make space for risk related dialogues to occur;

Creating physical spaces and events which allow prolonged collaboration can encourage groups to pilot projects, create joint research programmes and catalyse new initiatives to support future data collection and modeling platforms.

4 Engage in good practice media and risk communication strategies which involve:

Investing and supporting independent local media, as well as educating local journalists so they are more literate in disaster risk reduction. Their capacity to communicate risk during times of crisis can be life-saving. They need to have access to visually accessible information, and data to interpret and circulate to citizens;

Encouraging local media to move beyond 'messaging': their priorities should also include audience research, channel analysis and creating space for listening, and dialogue with communities at risk.

APPROACHES TO COMMUNICATING RISK

- 1 CONSIDER WHO IS AT RISK**

What demographic of people do you need to reach? What languages do they speak, where do they gather most of their information? What do people know or do not know about the risks they face?
- 2 ASSESS THE BEST CHANNEL FOR COMMUNICATION**

Consider news outlets, social media, fact sheets, community-based advocates, businesses, events.
- 3 LET CITIZENS KNOW THEIR RISK, WHAT THEY CAN DO NOW, AND WHAT IS REQUIRED OF THEM IN CRISIS**

Consider ways to include them in the process, this helps to grow their understanding of risks, and enables them to be a part of the solution.
- 4 CONSIDER THE POLITICAL DIMENSIONS OF MAKING CERTAIN RISK INFORMATION PUBLIC**

This may include factors such as reduced property prices in areas at risk, and be prepared for the dynamics that information release may generate.
- 5 ENCOURAGE COMMUNITIES TO DEBATE AND DISCUSS RISK MANAGEMENT AND PREPAREDNESS**

Helping people to talk to one another, to question the risks they face and what they can do about it will strengthen their understanding of disaster risk management.



Credit: UNISDR, Color Adjustment

RESOURCES

KEY FRAMEWORKS

[Sendai Framework for Disaster Risk Reduction](#)

[Sustainable Development Goals](#)

[The International Open Data Charter](#)

[Hyogo Framework for Action](#)

DATASETS

UNEP Environmental [Data Explorer](#)

European Data Portal's [Datasets](#)

Natural Earth's [GIS Datasets](#)

NASA's Socioeconomic Data and Application Center's (SEDAC) [Datasets](#)

OpenTopography's [Dataset](#)

ArcGIS Open [Datasets](#)

REPORTS

Arups' [Urban Mobility in the Smart City Age](#)

Arup and RIBA's [Designing with Data: Shaping our Future Cities](#)

OpenNorth and ODI's [How can we improve urban resilience with open data?](#)

UNISDR [Local Government Powers for Disaster Risk Reduction](#)

UNISDR [Global Assessment Report on Disaster Risk Reduction.](#)

Data-Pop Alliance [Synthesis Report: Big Data for Climate Change and Disaster Resilience](#)

GUIDES

The CitiesAlliance's [Data Toolkit](#)

European Data Portal's [Recommendations for Open Data Portals](#)

OpenDRI's [Resources](#)

[OpenGovGuide](#)

Smart Cities Council [Open Data Guide](#)
(Requires membership)

SunlightFoundation [Guidelines for Open Data Policies](#)

The World Bank's [Open Data for Resilience Initiative Field Work Guide](#) and [Planning an Open Cities Mapping Project](#)

[GeoSUMR](#)

RESOURCES

TOOLS & APPLICATIONS

UNISDR [Disaster Resilience Scorecard for Cities](#)

UNISDR [Quick Risk Estimation Tool](#)

[EcoCitizen World Mapping](#)

The European Commission's [Global Human Settlement Layer](#)

The Nature Conservancy's [Natural Solutions Toolkit](#)

OpenTopography's [Tools](#)

World Bank's Open Data [Readiness Assessment Tool](#)

ODI's [Open Data Certificate](#)

PLATFORMS

Open Data Platform [CKAN](#)

[Resilience.io](#)

[ArcGIS](#) Open Data Platform

Esri's [Green Infrastructure](#) Platform (US Only)

NASA's Socioeconomic Data and Application Center's (SEDAC) [Earth Observations](#)

[OpenStreetMap](#)

United States Geological Survey (USGS) [Earth Explorer](#)

Vizonomy's [Climate Risk Terminal](#)

UNISDR [Making Cities Resilience Campaign](#)

RISK COMMUNICATION

OECD [Trends in Risk Communications Policies and Practices](#)

NOAA [Risk Communication and Behavior: Best Practices and Research Findings](#)

University of Maryland's [Understanding Risk Communication Best Practices: A Guide for Emergency Managers and Communicators](#)

CERC [Crisis and Emergency Risk Communication Manual](#)

GLOSSARY

B

BIG DATA

Data that is large or complex and derived from digital sources such as satellites, sensors, mobile phones and social media production.

C

CLOSED DATA

Data that only its owners or people within an organisation can access, for reasons like privacy, commercial sensitivity and security.

D

DISASTER

A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

E

EXPOSURE

The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.

F

FAILURE CHAIN

A failure chain is a set of linked failures spanning critical assets in multiple infrastructure systems in the city. As an example – loss of an electricity substation may stop a water treatment plant from functioning; this may stop a hospital from functioning; and this in turn may mean that much of the city's kidney dialysis capability (say) is lost. This failure chain would therefore span energy, water and healthcare systems.

G

GEOSPATIAL DATA

Geospatial data, GIS data or geodata has explicit geographic positioning information included within it, such as a road network from a GIS, or a geo-referenced satellite image. Geospatial Data can be open or closed.

H

HAZARD

A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

O

OPEN DATA

Data anyone can access, use and share. It must: be accessible, which usually means published on the web; be available in a machine-readable format; have a licence that permits anyone to access, use and share it.

GLOSSARY

R

RESILIENCE

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

RISK ASSESSMENT

The process and outcome of compiling scenarios of natural hazards that could cause a disaster in the city, and the city's exposure and vulnerability to these.

S

SCENARIO

A comprehensive assessment of the severity, probability of a hazard and its total impact – the exposure and vulnerability of the city to loss of life, damage or other adverse impact in the resulting disaster. As a minimum cities will ideally have two scenarios – one for the "most probable" event and one for the "most severe."

SHARED DATA

Data that is shared with specific people and organisations for a specific purpose: to provide services, connect information, and contribute to research. Shared data can include licensed commercial data.

processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

V

VULNERABILITY

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

The Glossary is adapted from the Disaster Resilience Scorecard for Cities updated UNISDR Terminology 2017 and the paper How can we improve urban resilience with Open Data? by Open Data for Development, Open Data Institute and OpenNorth.

THE MAKING CITIES RESILIENT CAMPAIGN addresses issues of local governance and urban risk. The Campaign is led by the UNISDR but is self-motivating, partnership and city-driven with an aim to raise the profile of resilience and disaster risk reduction among local governments and urban communities worldwide. www.unisdr.org/campaign/resilientcities

RESURGENCE supports cities and communities to innovate through open data and to use effective risk communication strategies to protect their communities and assets from climate related stresses and shocks. www.resurgence.io/

RESILIENCE BROKERS is an organisation set up by the Ecological Sequestration Trust to support demonstrations of the transition to resilient development paths in 200 city regions, globally, by 2023. They champion a holistic approach to systems change that is driven by the power of collaboration, innovation and disruptive technology. Resilience Brokers act as facilitators in a neutral space supporting cities to build on their existing strengths and providing the tools and support they need to tackle global issues. www.resiliencebrokers.org

GEOINFORMATION FOR SUSTAINABLE URBAN MANAGEMENT AND RESILIENCE (GeoSUMR) promotes the use of geospatial tools and information by decision-makers in second-tier cities in the developing world in order to improve the efficiency and sustainability of urban infrastructure and service delivery through the use of an integrated approach to planning. www.geosumr.com

OpenNorth is Canada's leading not-for-profit organization specialized in open data, open government, community engagement, open smart cities and civic technology. OpenNorth connects the global open data and open government movements to national contexts and local ecosystems; enhancing effective knowledge sharing, collaboration, and interoperability. www.opennorth.ca/

Esri is a global leader in Geospatial Data And Geographic Information Systems (GIS). Founded to help solve some of the world's most difficult problems, Esri supports their users through a commitment to science, sustainability, community, education, research, and positive change. www.esri.com

