Harnessing the Power of Data for Mainstreaming Urban Resilience

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Abstract

The rapid pace of urbanization in India demands that cities use data in a strategic manner to ensure sustainable and resilient development. Through the research conducted by the Urban Resilience Unit at National Institute of Urban Affairs the authors suggest that cities need support with decision-making and using data effectively and highlight the value of decision frameworks and data observatories to support Indian cities prepare for their urban future. This requires an intervention at the city level to facilitate the use of information for decision support and institutionalize urban data observatories. Through this paper, the authors highlight global case studies in which data observatories have facilitated smart decision making to reduce citywide and community risks to shocks and stresses. The authors also discuss the initiatives being taken at the national level by the Indian Government and propose options for implementing urban data observatories as a part of the ongoing national urban missions

1 India's Urban Future

India is moving towards an urban future. According to the McKinsey Global Institute [SVD+10], urbanization rates in India suggest that cities will need to accommodate more than 200 million additional people by 2030 [Gov11]. Yet, the status of cities indicates that India needs to be better prepared to accommodate this expected growth. For example, several cities struggle to provide basic

services to all their residents, and many are not able to maintain their existing natural resources [Sin03]. Currently, the deficit in urban infrastructure spending is more than Rs. 7,355 per capita (McKinsey Global Institute 2010), which has resulted in inadequate maintenance of existing infrastructure and gaps in new infrastructure development to keep up with the already growing urban population.

Furthermore, urban areas are already prone to a variety of acute shocks and stresses like urban flooding, cyclones, heat waves, traffic jams, air pollution and disease outbreaks placing both citizens and infrastructure at risk. Based on the vulnerability maps recently launched by the Ministry of Housing and Urban Affairs, India, more than 50% of smart and AMRUT cities are either at very high or high risk to hydro-meteorological hazards especially floods and cyclones [BMP19]. According to a recent study, without better planning and disaster preparedness, trends like climate change will cost the Indian economy Rs. 8.42 lakh crore by 2050 if emissions continue at their current rates [MBC$^+$18]. In order to address the above challenges and plan for long-term development of urban areas cities should start making informed decisions and include environmental, social and economic risks in both design, construction and management of their public infrastructures and services.

2 Data Informed Decision Making

Around the world, planners, policy makers, civil society groups and other stakeholders use data to help them make informed decisions that have positive impacts on their city. Data can enable stakeholders to be better prepared against shocks and may also support them in allocating resources in preparation for growth and alleviate stresses within a city. For example, the city of Rio de Janeiro in Brazil has worked with IBM to set up a data operations center to mitigate the impacts of shocks like landslides and floods in informal settlements. The operations center collects and visualizes data from government agencies to map vulnerable areas. Then, by integrating weather forecasts, the government has been able to issue warnings to citizens in risk prone areas about impending flooding and landslides. The operations center has also bridged the information gap during response and recovery, allowing response teams to coordinate to mitigate damages during shocks like a building collapse in time.

Other stakeholders are also able to use data to create a positive impact: researchers at Newcastle University are collating data from more than 100 sensors across the city of Newcastle, UK to understand urban flood management and the impact of extreme weather events. They have set up a Newcastle Observatory to visualize flooding and drainage data to conduct research on these events. Another example of data informed decision-making is in Nairobi's largest informal settlement, Kibera. Civil society groups worked with resident volunteers to map the social infrastructure across the settlement. The community was able to collect information about the state of water, health and education infrastructure within the settlement. Elected representatives for the area have used the data collected about sanitation and education infrastructure to allocate finances for more latrines and hire more teachers in the local schools [Hag17].

This multistakeholder approach for using data to alleviate shocks and stresses has also been implemented globally through the 100 Resilient Cities (100RC)

program to build resilience in 100 cities. Across its network of cities, 100 RC has enabled the development of more than 80 resilience strategies with more than 3,000 initiatives to push the resilience agenda forward [10019]. These strategies and projects were conceived with the support of governments, businesses and local communities and they utilized a wealth of city data that these groups provided. For example, through mapping of social assets like schools, Paris was able to determine that schoolyards represented more than 70 hectares of paved surface in the city. As the city has experienced dangerous heatwaves in the past, city officials, with community support, were able to use this information to allocate funds and resources to greening these spaces to strategically cool the city and provide public play spaces for the community [10019].

To manage the impacts of urban growth and safeguard city investments from physical, economic, climate and social risks, there is an urgent need for cities to adopt data informed approach to planning. The above examples demonstrate the value addition of using data strategically with a multi-stakeholder and multi-sectoral approach. The stakeholders in these cities were able to use the data to enable them to make effective decisions about resource allocation, infrastructure projects, and disaster risk reduction. These decisions ultimately mitigate the impact of shocks and ease stresses, building the resilience of cities.

3 Indian Context

Indian cities require risk-informed investments and evidence-based planning. Unfortunately, city managers are not using data effectively to aid their decision-making due to several constraints. Firstly, policy makers do not have access to data that they need. Secondly, different departments collect urban data across city, state and national government agencies using different methodologies, at different resolutions and at different time periods. Thirdly, data are also not collected a timely manner to inform day-to-day decision-making [UNH15].

For example, in Delhi, there are around 18 separate agencies spanning across city, state and national governments that are responsible for various aspects of environmental management of the city and its surrounding. Data collected by one department is usually not made available to another department easily, thereby leading to uninformed decision making. There are also limitations with tools available to assist decision makers with visualization of data. Without visualizations, policy makers may not be able to recognize spatial and temporal trends, resulting in inaction or delayed action [UNH15]. The fragmented data landscape and lack of adequate analytical tools also makes it even more challenging to identify cross-sectoral linkages.

4 Informed Decision Making through Data

The importance of data driven governance as an opportunity to create a more sustainable and resilient urban future has been actualized through both national initiatives (Smart Cities Mission) and international agendas (Sustainable Development Goals). The Ministry of Housing and Urban Affairs (MoHUA), Government of India will be launching "DataSmart Cities" initiative to help 100 Smart Cities promote data for better governance and innovation. The initiative aims to

develop applications which can guide Smart Cities in achieving data driven governance through data management, information sharing and knowledge exchange. This will lead to increased transparency in governance and foster innovation within service provision [Gov18].

As a part of this proposed initiative, City Data Officers (CDOs) will be provided to each city to help them establish a City Data Alliance, which will include relevant stakeholders (including, government, business, academia, citizens and NGOs). In addition, the CDO will work with the stakeholders in managing and maintaining their data in compliance with the National Data Sharing and Access Policy. The city government and their stakeholders will be able to choose to make either parts or all of their data available on a city specific open government data portal using an India Urban Data Exchange (IUDX) platform. This is expected to "facilitate easy and efficient exchange" of information across various departments and institutions for their respective decision making purposes [Gov18].

Cities are also working on benchmarking themselves against targets set by international agendas like the SDGs and national indices like the Ease of Living Index. The SDG targets and indicators help monitor a city or country's progress in achieving sustainable development [Nit18]. Similar to SDG targets, the MoHUA (Government of India) has released The Ease of Living Index as a metric for Indian cities to assess how liveable they are. Cities evaluate their rating based on a series of 78 indicators measuring institutional, social, economic and physical characteristics on an annual basis. However, cities need to take a holistic approach to data collection and visualization. The data being collected must be functional for decision-making purposes to help improve the condition of the city. For example, many of the SDG indicators are meant to be monitored at a state or country level and the indicators still need to be contextualized for the city scale. The data for each indicator also needs to be available at the city scale. There are also challenges related to the frequency of data collection: much of the data is being collected at a frequency that is too low for day-to-day decision-making. Different information needs to be captured at useful time frames to enable its utility. Finally, to understand how the data can be used for decision-making, cities need to move beyond just collecting the data and need tools for spatial and temporal trend visualizations. This will allow city managers to use the data for informed decision making.

5 Urban Resilience Unit Initiative: Implementing Data Observatories in Indian Cities

The Urban Resilience Unit at the National Institute of Urban Affairs is an initiative supported by 100 Resilient Cities – pioneered by the Rockefeller Foundation. The Unit is working to mainstream urban resilience in Indian cities through data informed decision making by developing decision frameworks and purposing that Indian cities implement urban data observatories.

An urban data observatory is a platform that serves as a repository for accurate and frequently updated city specific spatial and non-spatial data that will serve as a decision support system. The observatory adopts a multi-stakeholder and multi-sectoral approach, collating and visualizing data from

various government and non-government agencies. This will help eradicate data gaps that currently plague decision makers. Decisions makers will be able to use the data observatory to visualize trends, analyses data and build scenarios to help stakeholders solve complex urban problems.

5.1 Operationalizing the Data Observatory

The data observatory will eradicate the challenges that decision-makers currently face in utilizing data to take action and solve challenges. The Urban Resilience Unit organized an expert consultation with decision makers from local governments, businesses, research and educational institutions and civil society to understand in more detail, the challenges they face in using data for effective decision-making.

One of the primary challenge that plagues decision makers today is the ambiguity around protocols regarding the quality, collection, sharing, storage, format and ownership of data. Many of these factors constrain stakeholders from using data as decision support and for research purposes. Currently, no formal mechanisms exist to enable data sharing between data producers and users and many government agencies are reluctant to share data with the public. There are also no standards for sharing data to ensure quality control or monitor the usage of sensitive information. Finally, data sets that are currently available and verified are often accessible in an impractical format or at frequencies that are not suitable for analysis: for example, tabular data is uploaded as a jpeg or pdf, and therefore cannot be used in database management systems for analysis.

The data observatory addresses these challenges as a common platform for data, which is accessible for all stakeholder groups. The observatory operations will require an operational team that will be led by a Chief Data Officer and will include of data scientists, IT programmers and urban planners. The team will have three main roles: center operations + maintenance, data processing and innovation. Through these roles, the team will ensure quality control of data as it is uploaded to the observatory. The team will be responsible for cleaning and filtering the data for errors, ensuring the formats are compatible for spatial and temporal analysis and maintaining the metadata of the data sets. The team will also be responsible for ensuring sensitive information is not made public and that data will be compliant with data protection laws, including recommendations in the "A Free and Fair Digital Economy: Protecting Privacy, Empowering Indian" report by Committee of Experts under the Chairmanship of Justice B.N. Srikrishna.

The team will also be responsible for conducting trainings and data sensitization workshops with stakeholders, to raise awareness about the importance and value of an open data culture. This would include workshops around methodologies to ensure transparency regarding data sets on the observatory.

5.2 Platform for Stakeholder Engagement

Another key finding from the consultation with stakeholders around data and decision-making was the need for a multi-stakeholder and collaborative approach to data. Stakeholders are critical to the success of the data observatory. Much of the urban data generated comes from citywide stakeholders on a daily basis but currently no formal platform for such multi-stakeholder engagement exists.

To ensure that decision makers can make the most effective decisions, it will be necessary that all stakeholders are associated with the observatory.

As seen in 1, the observatory will be a platform that will have a symbiotic relationship with its stakeholders: their contribution in terms of city data will allow decision makers and government agencies to fill data gaps and understand the landscape holistically. Also, stakeholders will have access to data, which they can use to inform their decisions: Citizens will benefit from more access to information about service availability, transportation and disaster risk, for example. This will lead to more accountability in government provision of services. Furthermore, the observatory increases the opportunities for public engagement between government and citizens.

Figure 1: Stakeholder contribution and participation in the data observatory is critical to its success

City governments, as one of the main decision makers, will greatly benefit from the collation of data across sources. They will have tools to enable the creation of evidence-based policy making and decision support for complex problems.

The business community stands to benefit from the data observatory, as they will have a better understanding of city services, energy provision, infrastructure, environmental data and disaster risk. These topics can be used in business planning and for starting conversations with the government to create a more opportune business environment.

Students, professors and researchers stand to benefit from a variety of data about the city that they may previously have been unable to access. Furthermore, educational institutions are a source of rich data collected during studios and theses that can be integrated into the platform

5.3 Decision Framework

The final challenge that stakeholders currently face in using data is maximizing the potential of data for decision-making. Decision makers at the workshop were unable to define decision questions and mostly discussed the use of data for diagnostic purposes but not decision making.

The Urban Resilience Unit is developing a decision framework to help cities make decisions to reduce the risks of shocks and stresses. The decision framework is multi-sectoral and takes a holistic approach to challenges within cities. The Unit has conducted research on more than 600 indicators to develop this framework. As seen in 2, it consists of five broad themes: Basic Services, Infrastructure, Social Infrastructure, Natural Systems and City Planning Systems. Each theme is broken down into sub themes, which have a series of indicators and decision questions to help measure a city's performance across time and space.

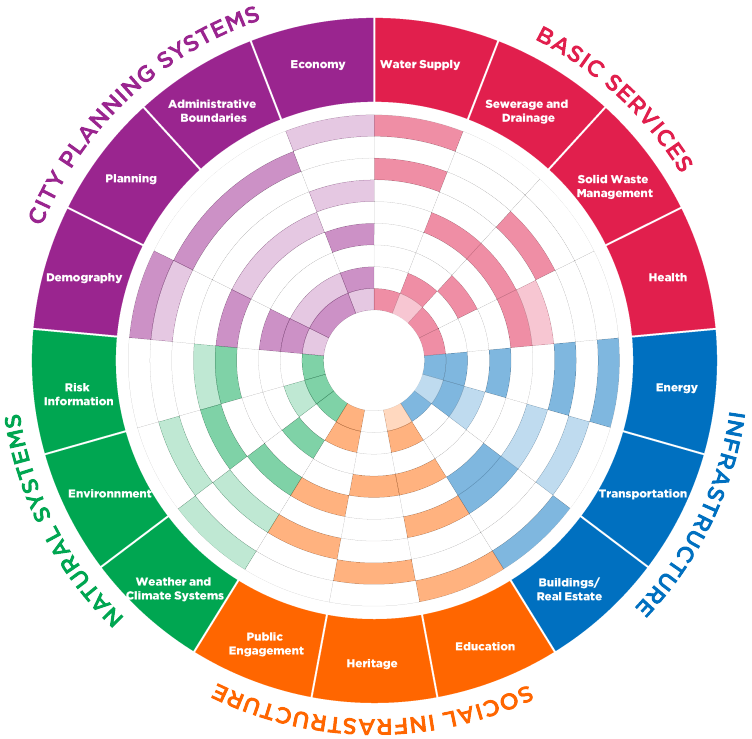

Figure 2: The Urban Decision Framework is comprised of themes that will help guide cities towards developing decision questions to address acute shocks and chronic stresses

This framework will support cities in understanding how to operationalize data while using the data observatory. This framework has been developed considering the cross linkages between themes and sub themes. For example, if the city has adequate infrastructure catering to improved economic opportunity, it is likely that is has strong urban planning and implementation systems. Therefore, as cities use the framework and identify areas for improvement,

strategic decisions can enhance the strength of multiple systems. It is designed to enable decision makers prioritize city needs and develop targeted and risk-informed policies. As cities use the framework, they can identify areas for resilient infrastructure development, improvement in service provision, alleviation of stresses and mitigation of shocks.

A series of use cases are being developed for the 17 sub themes to highlight how the framework will support decision-making and can help stakeholders answer key questions about their city. 1 to 5 are below and highlight examples of use cases for the themes of water, health, buildings and real estate, environment, and transportation.

Along with developing use cases, the Urban Resilience Unit proposes to work with cities to identify the specific datasets which are required to help answer take these decisions and address challenges. This would include identifying the source agency, the scale/resolution at which the data is required, the frequency the data must be collected, and visualization and models that are necessary to utilize data effectively for problem solving:

6 Conclusion

Data will support cities to embody the characteristics of resilience to enable them to cope with a variety of shocks and stresses. These characteristics of resilience are that systems are reflective, resourceful, inclusive, integrated, robust, redundant and flexible [ARU14]. Used effectively, data will ensure that city systems are reflective, so that decisions are made based upon holistic understanding of the needs and gaps they are meant to solve the urban challenges. Data can also help a city be resourceful, helping planners understand how assets and resources are distributed spatially and how they can be used more efficiently and for different needs. Data can help a city be inclusive and integrated if it is collected from different stakeholders. It can also help devolve governance and empower stakeholders to take informed decisions within their own institutions, reducing the burden on ULBs. Data can also help cities incorporate the risk of priority shocks, enabling them to design infrastructure and networks with spare capacity and specific designs to offset disasters, helping the city infrastructure and services be both robust and redundant.

Indian cities must act now to prepare for its urban future and the use of data for informed decision making will be imperative in ensuring that cities grow in a sustainable manner with the ability to thrive despite social, economic, physical and climatic risks. The value of data can only be unlocked when it is used holistically and with the correct decision support and visualization tools so that decisions affecting the city can be taken based on evidence. The Urban Resilience Unit's strategy to develop data observatories is an initial effort to support cities in both collecting, visualizing and analyzing data through a holistic, multi-sectoral and multistakeholder approach. The decision framework, based on indicators and research about on the ground challenges cities face, will support stakeholders in using data to take informed decisions, enabling transformative change and creating a resilient urban future.

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Table 1: Use Case to highlight how the framework and data observatory can help city stakeholders take informed decisions related to water service provision

Stakeholder	**Problem**	**How Data Can Be Used**	**Changed Scenario**
Municipal Commissioner	The city's water distribution systems are stressed and the city faces the challenge of increasing water scarcity, poor cost recovery and high distribution losses. The municipal commissioner wants to improve their service delivery by using data.	The commissioner uses the observatory to determine water levels across the city with sensors providing information. This helps identify leakages in the distribution channels. Maps from the observatory also highlight which communities have less access to municipal water supplies.	The municipal commissioner is able to understand where leakages are occurring and which communities are deprived of clean drinking water. She is able to take better actions that make service delivery more efficient with better distribution channels and cost recovery systems.
Businesses	Business productivity suffers when water cuts occur and complaints are not being addressed in a timely manner.	Businesses entities provides data on their water demand and supply on a daily basis. The observatory is able to collate and process this information and provides it back to all stakeholders.	Business community starts to get early information about possible supply and the gap in their demand. Businesses start to plan in advance on both adaptation and mitigation measures.
Citizens	Citizens are facing water shortages frequently and in some slums, municipal water is not available. This has resulted in poor spending more on accessing water from tankers. Evidence of poor health outcomes exists in these areas due improper water storage.	Citizens upload their water complaints through a single window platform to the data observatory. The complaints are monitored regularly by urban managers and effective actions in critical areas are planned in a timely manner.	Residents have improved access to reliable and safe water supply. Strategic engagement leads to reduction in complaints.

Table 2: Use Case to highlight how the framework and data observatory can help city stakeholders take informed decisions related to disease outbreak in the city

Stakeholder	**Problem**	**How Data Can Be Used**	**Changed Scenario**
Municipal Corporation Officers	ULBs do not have resources to report incidence of disease in slums on a daily basis, leading to an under reporting in some cases of water and vector borne disease and their treatment.	Mobile based reporting by the anganwadi workers to the observatories provide hourly report to public health officers. Also, they can map areas that have water logging and provide advisories to select communities	The city is able to increase health and sanitation services especially for poor and vulnerable. Fogging is also carried out only in strategic locations on a priority basis.
Hospitals and Healthcare Providers	Health care providers usually do not know how many cases of specific diseases will occur. Thus they would not have adequate stock of essential medicines in cases of epidemic.	Health data about incidences and causal factors are shared by health care providers to observatories inturn they get predictions and projections to help plan for any adversities.	There is enough storage for required medical supplies and treatment material. Hospitals can also plan and sometimes prevent the diseases before they turn to an epidemic.
Citizens	Water borne disease disproportionately affects the urban poor as they do not know about symptoms and do not seek treatment early.	The observatory can be used to promote materials that help raise awareness about water and vector borne diseases only in selected areas thereby maximizing their communication budget and minimizing the impact	There are fewer occurrences of water borne disease in the city, especially in slums. When disease does occur, citizens get checked and treated in time.

Table 3: Use Case to highlight how the framework and data observatory can help city stakeholders take informed decisions related to real estate and housing in the city

Stakeholder	**Problem**	**How Data Can Be Used**	**Changed Scenario**
Development Authority/ City Planners	Planners in the city want to rehabilitate residents living in informal settlements in environmentally sensitive areas in-situ. However, they do not have strategic information on where to locate to have mutuall benefit the stakeholders.	NGOs working in slum communities regularly upload demographic characteristics along with settlement status and user need to observatories which is used to determine the housing needs for rehabilitation.	The city is able to provide families living in informal settlements within proximity to their livlihood and their critical needs are addressed within the new housing
Policy Makers	Many houses are built as affordable housing in the city are unoccupied or rented to tenants who were not the original benefactors.	NGOs and educational institution reports on the staus to the observatory for policy makers to understand the challenges and device contextual solutions	Policy makers are able to rectify flaws in older designs to ensure new settlements meet the socio-economic needs of the residents.
Citizens	Many migrants move to the city without an understanding of which areas are at risk to shocks like landslide leading to high impact in case of extreme events	The observatory displays risk maps for relevant disasters and shocks in the city. New migrants are able to identify areas that are prone to disasters and are able to select housing options in safer areas.	Residents incur fewer losses from disasters as relatively few people live in risk-prone areas. Lives and investments are secured.

Table 4: Use Case to highlight how the framework and data observatory can help city stakeholders take informed decisions related to environmental issues in the city

Stakeholder	**Problem**	**How Data Can Be Used**	**Changed Scenario**
Municipal Commissioner	The city faces severe heat stress in the summer months due to urban heat island. The city wants to address this through greening initiatives but does not know the best areas for intervention.	On the data observatory, city managers can analyze land cover, land use data, daily temperatures and urban heat island imagery to determine where the hottest pockets in the city are as well as open spaces for greening efforts.	In urban heat islands that have space for greening, the city has taken efforts to plant trees to reduce UHI in the area.
Researchers / Educational Institutions	Air pollution is very high in the city but the causal factors are unknown. Researchers want to identify the main contributors to air pollution to take necessary mitigation action.	Researchers have access to levels of various pollutants around the city, meteorological data and information about industry and traffic congestion to determine the biggest contributors of pollution in the city.	Research on the main contributors to the city's air pollution is available to the city to take strategic mitigative actions
Citizens	The city is prone to flooding during high rainfall events. Communities do not know where it will flood and are therefore underprepared.	Data from the observatory informs the public about flood warnings, allowing for better preparation. Information is also available to help citizens learn what to do during a flood to protect themselves and their families.	Residents incur fewer losses from disasters as relatively few people live in risk-prone areas. Lives and investments are secured.

Table 5: Use Case to highlight how the framework and data observatory can help city stakeholders take informed decisions related to transportation challenges in the city

Stakeholder	**Problem**	**How Data Can Be Used**	**Changed Scenario**
Municipal Corporation Officers	Motor vehicle collisions are a leading cause for injuries and loss of life. The city is responsible for providing safe streets for its residents and officers want to reduce the number of accidents.	By observing camera and sensor data, traffic and pedestrian flows are mapped and visualized on the data observatory. These are overlaid with data regarding locations of traffic accidents and timings of the accidents to create design interventions for risk prone intersections and streets.	The city has identified the top 10 accident prone areas in the city and has been able to redesign the streets and intersections to reduce the number of accidents and collisions.
Businesses	Businesses suffer loss of productivity due to high congestion in the city. Their logistics and shipping are also delayed considerably.	On the data observatory, businesses can query and determine which streets are the most congested at different times. They use this data to change the timings of their shipments and logistics as well as plan alternative routes.	Business productivity improves and costs of shipping and logistics are reduced.
Civil Society / NGOs	In many communities, public transportation access may be low and may not be routed for the desired destinations of the community. Citizens thus rely on more expensive or time-consuming modes of transportation.	With the data observatory, NGOs and researchers can see the public transportation routes in the city to determine the unserviced areas. NGOs specialized in transportation help design efficient routes to the transportation authority.	The city makes revisions to the bus routes to reach the maximum number of users.