Quantified Cities Movement
A Framework For Convergent Risk-Informed Decentralised Disaster Risk Reduction

Sarbjit Singh Sahota
Emergency Specialist Disaster Risk Reduction Section, UNICEF India
Email: sssahota@unicef.org

Siddharth Benninger
Centre for Development Studies and Activities (CDSA), Pune, India
Email: siddharth.benninger@gmail.com

Abstract

Rapid and uncontrolled urbanization the world over sends a clear message that cities and city governments will have to prepare themselves for managing resources, providing equitable delivery of services and ensuring safety of citizens, businesses and critical infrastructure as well as security of resources such as water, food, and livelihoods. The United Nations projects a population increase of 41% (41.86 million) between 2014 - 2030 in the 9 most populated urban agglomerations in India (World Urbanization Prospects, 2014). During the period of 2014-2050 India is expected to account for approximately 16% of the world's urban population growth (World Urbanization Prospects, 2014). City governments will fight a losing battle unless the ongoing approaches and frameworks in urban management, policy and planning are changed and/or improved. The economically weaker sections, children, the elderly, women and persons with disabilities will bear the brunt of the lack of adequacy, safety, security and equitability of service delivery and resource distribution. The situation will be further exacerbated in the event of a disaster or civil strife as well as due to long-term stresses such as climate change and environmental degradation. There is a need to formulate a sustainable, inclusive, scalable and replicable real time urban monitoring framework in order to ensure increased resilience for all settlements. All aspects of urban and rural systems, urgently need data and information ecosystems to drive sustainable and timely action. The Quantified Cities Movement is a monitoring and planning framework that improves urban and regional planning and enables settlements to be resilient by continuously providing them with near real-time information. In various contexts, we have rolled out QCM to build transparency and accountability by facilitating the participation of various stakeholders in the process of disaster risk reduction at the local level. This system enables monitoring for gaps in preparedness, response and recovery, and promotes resilience activities and increased local level understanding of urban stresses and disaster risk. This web-based platform and associated IT ecosystem is replicable and scalable across settlement hierarchies and government jurisdictions. The system enables two-way communication where all stakeholders can be alerted to situations reported on the ground.

Introduction

The current settlement planning arrangement is not structured to accommodate citizen-centric participatory resilience planning and action. There is a need for a framework which is not "top-down heavy" but rather bottom-up to inform planning and action with the insights of the citizens as well as experts. The development planning process is rarely informed by the underlying and primary risks that citizens face on a day-to-day basis. Most settlements do not possess systems that enable granular, real-time and location-based monitoring of local risks and hazards. The lack of evidence based, informed decision-making presents none or very limited opportunities to cost-effectively assess the situations of environmental/public health, disaster risk, deficit in service delivery systems, and lacunae in quality of life of the most vulnerable.

Currently, there are large vulnerable sections of population living in unplanned, unhealthy and malfunctioning cities and settlements. The absence of a reporting framework and mechanism, and lack of capacities of various stakeholders, including citizens, present a major impediment to local area preparedness and response in the case of a disaster to take anticipatory preventive and mitigation actions. In many settlements, the current management and planning arrangement is not adequately structured to accommodate or integrate issues such as efficient systems for delivery of social inputs to all sections of society, disaster risk reduction and preparedness, climate change mitigation/adaptation, environmental risk assessment and quality-of-life indicators, rights of vulnerable sections of society (CRC, CEDAW and CRPD)[1], heritage preservation and conservation as well as environmental protection and conservation.

There is a lack of a standardized system of data collection, norms and standards, reporting or feedback loops for settlement resilience planning and management in the current settlement management and planning framework. The sheer size of population and physical scale of cities present a challenge in collecting high resolution, granular, accurate, timely and relevant data for action. Indicators that must focus on hazards and resilience

1 CRC: Convention on the Rights of the Child. CEDAW: Convention on the Elimination of All Forms of Discrimination against Women. CRPD: Convention on the Rights of Persons with Disabilities.

issues that should be integrated in the planning process are not identified or clearly defined. A wide range of quality standards and norms[2] published by various government agencies[3], at various levels, is not followed and tracked. There is a lack of scientifically collected and processed data (insight). Since scientifically collected and processed data ensures informed and objective decision making for disaster risk reduction policies and plans, most outcomes are measurable or at least tracked through an objective and participatory process. Encouraging citizen participation in the disaster risk reduction process is the most important step in ensuring healthy cities.

2 URDPFI norms, Ministry of Urban Development, Government of India (http://moud.gov.in/URDPFI).

3 Air, Water and Noise quality norms published under various acts, Maharashtra Pollution Control Board, Maharashtra State (http://mpcb.gov.in/index.php)

What is the Quantified Cities Movement (QCM)?

The 'Quantified Cities Movement' ("QCM") ecosystem comprises a mobile application accessible to citizens, an associated website for data visualization, infrastructural elements, other software and specially developed algorithms, to enable the collection and processing of data relating to inter alia quality of life indicators, sustainable development indicators, disaster management indicators and climate change indicators. The following pages provide a broad outline of the QCM ecosystem, its various elements and how the ecosystem can be used by various stakeholders.

How does QCM work?

QCM enlists volunteers to monitor their neighborhoods in cities or villages (in the case of rural settlements), for resilience planning and action. As illustrated in Figure 1, volunteers submit reports of the ground situation to the QCM dashboard that can be accessed by various government departments, elected representatives, and civil society organisations. This can be raw data or processed data in the required form of tables, graphs, reports and maps. All stakeholders can access maps, graphs and reports in order to make an informed decision for action in a given situation. In certain cases, there is potential for stakeholders to suggest and vote for solutions.

Various stakeholders deal with the data in different ways. Government agencies and departments react to grievances and emergencies, elected representatives look for solutions or propose laws that will improve the city, newspapers report the problems to a wider audience and discuss

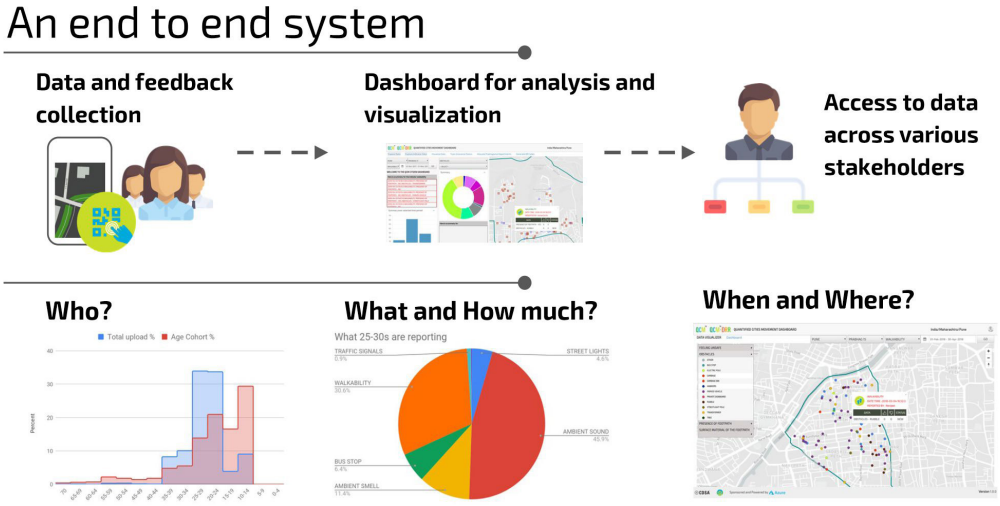

Figure 1. An overview of how QCM works

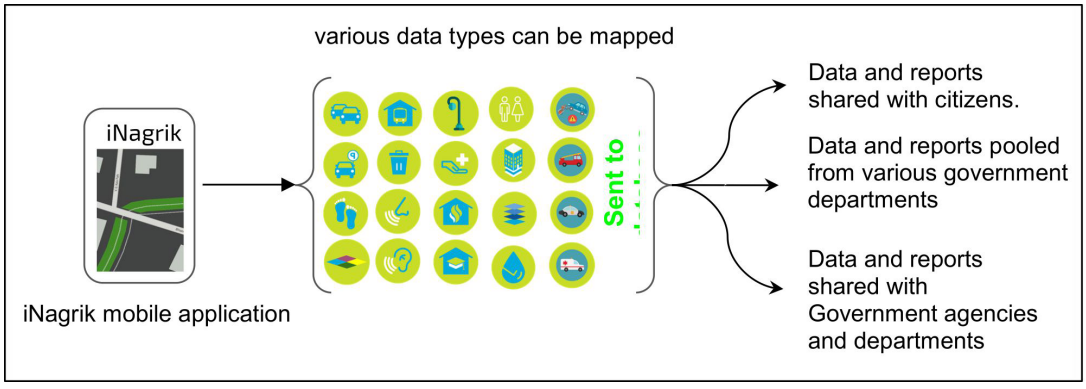

Figure 2. Data collection and scalability

the issues and citizens, volunteers and various civil society organizations report issues and suggest solutions.

With the help of the iNagrik mobile application (Figure 2), various government agencies and departments can map, monitor and manage assets, react to grievances and emergencies, and document solutions or propose new initiatives that will improve internal systems for service delivery, infrastructure management and DRR planning.

What are the elements of the QCM ecosystem that stakeholders will use?

iNagrik mobile application: iNagrik is at the heart of the QCM framework (Figure 3) and enables citizens to report, receive, and share issues and solutions.

The application enables users to upload and update data for any physical asset including but not limited to roads, buildings, social infrastructure, footpaths, and transport infrastructure. The upload is geotagged and time-stamped ensuring validation of the uploaded data. The spatio-temporal mapping enables duty-bearers (e.g. line-departments) to visualize and track on the ground situations. iNagrik can be enabled for various languages and modified according to the needs of line-departments/institutions and other stakeholders.

Figure 4 (Left). An urban pulse point is a QR code linked to a site of interest.

Pulse Points

Urban Pulse Points are Quick Response (QR) codes through which users can scan assets, monitor and take user feedback from amenities such as public toilets and bus stops. Figure 4 is an actual pulse point used for heritage documentation, information and feedback.

The QCM data collection infrastructure enables various stakeholders to upload a wide range of reports. In Figure 5, citizens can report for preparedness and response to enable DRR.

QCM dashboards: The dashboards are designed to provide information and analytics to departments. Features can include infrastructure listing, spatial distribution and frequency distribution of a variety of data, and the ability to query data over space and time.

The dashboards give access to analytics and trends regarding status of various types of infrastructure. Departments can

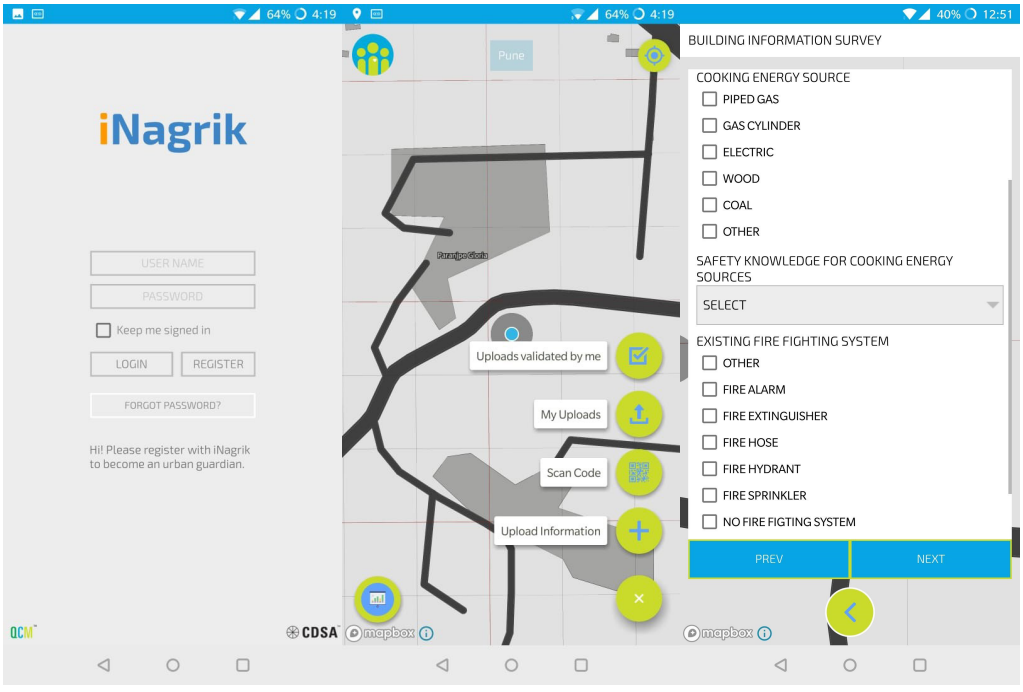

Figure 3. iNagrik mobile application

Citizens reporting local area problems with services and infrastructure	→	Reports are instantly shared with the DDMA, and the elected representatives
Citizens reporting local area hazards and emergencies.	→	Reports are instantly shared with emergency services, DDMA, other citizens and the elected representatives
Citizens participating for local surveys and feedback	→	Reports are instantly shared with the departments, other citizens and the elected representatives
Citizens receive local area risk and hazard information	→	Information on local risk profiles, emergency services and citizen safety services is shared with citizens
Citizens receive disaster preparedness information	→	Links to helpful websites, toolkits and handbooks are instantly shared with the citizens and the elected representatives

Figure 5. Types of citizen reports and two-way communication that can be enabled.

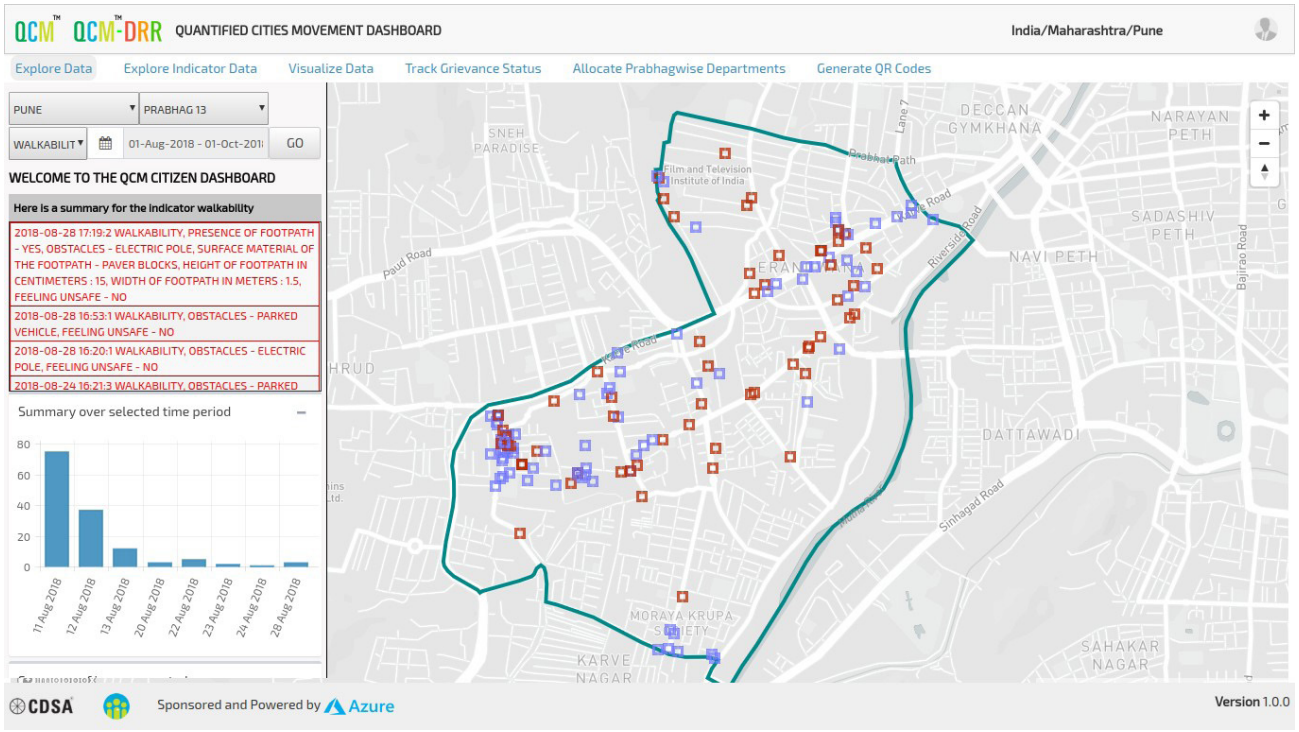

Figure 6. Map of a ward showing the clustering of various uploads regarding street issues.

track trends (Figure 6 and Figure 7), to improve service delivery and efficiently allocate resources to ensure continuity in access to services.

Dashboards have been made for various government departments to deal with grievances and emergencies (enabling Accountabilities to Affected Population) as well as monitor timely access to amenities and services. The system also enables rescue services and security services to track incident reports as shown in Figure 8.

Mapping community infrastructure: The QCM visualization interface (Figure 9) provides a three-dimensional model for administrators and planners to view priority areas for disaster risk analysis and compare data.

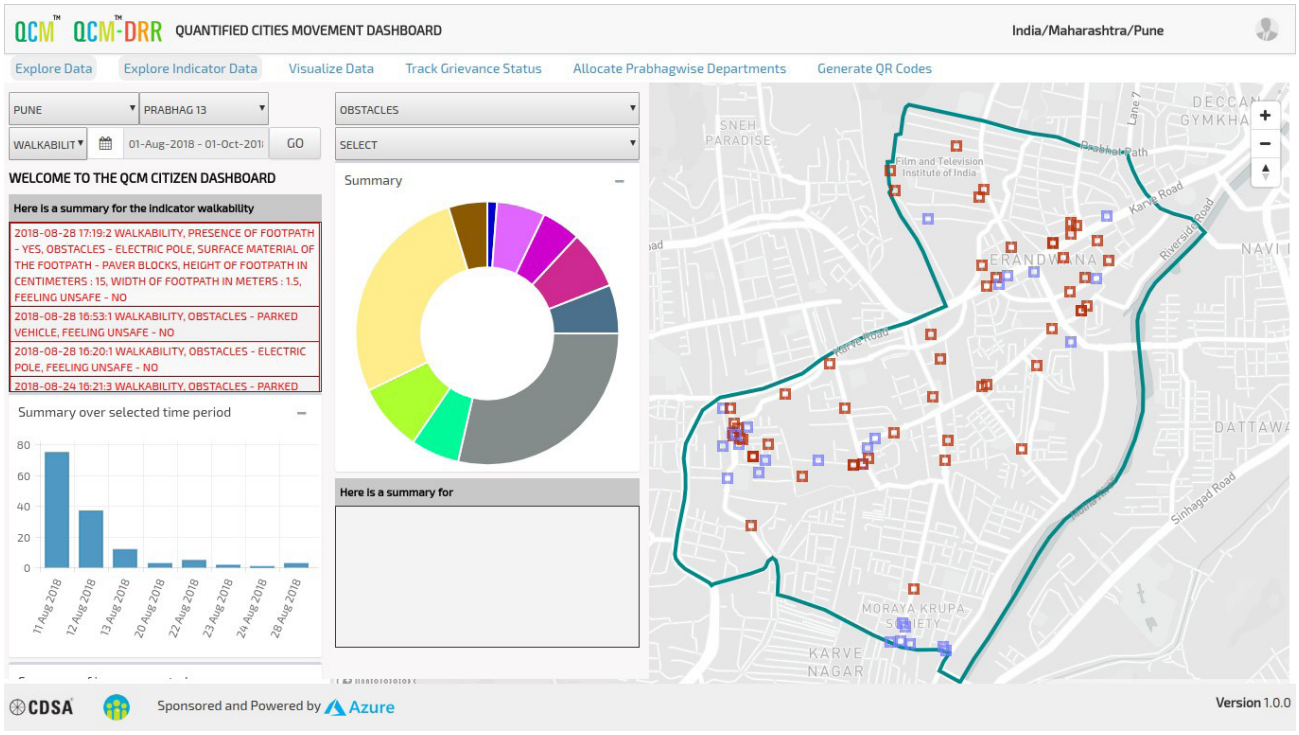

Figure 7. Map of a ward showing the clustering of street issues reported by citizens along with percentage breakdown for types of issues reported.

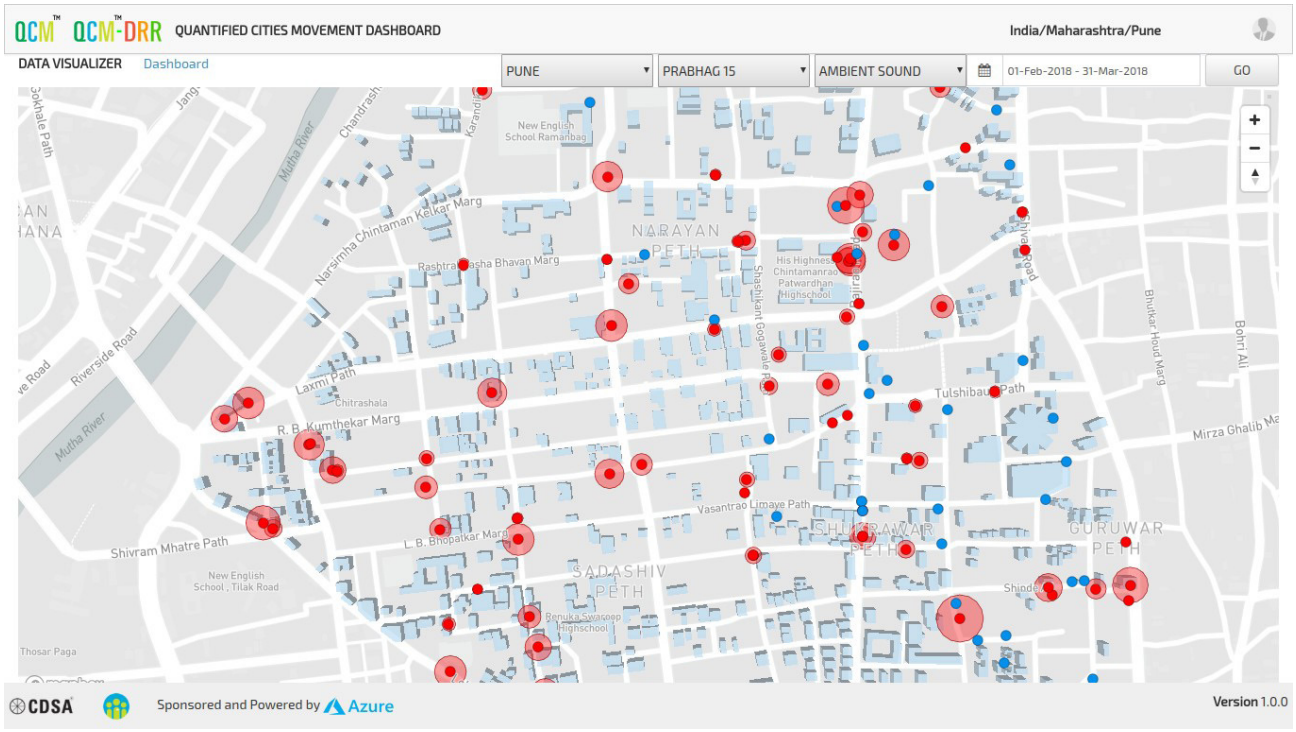

Figure 8. Map for Emergency tracking and study.

Infrastructure Location: Various types of infrastructure can be mapped through the system, based on building footprint, plot number and survey numbers. This data must be provided by the department and can establish the location of the asset. This information is important as the data for the unique location can be continuously updated and maintained.

Infrastructure area and population: Basic data regarding the infrastructure, such as built-up area, capacity, population base can be mapped (Figure 10) and fed into the ecosystem, which can be

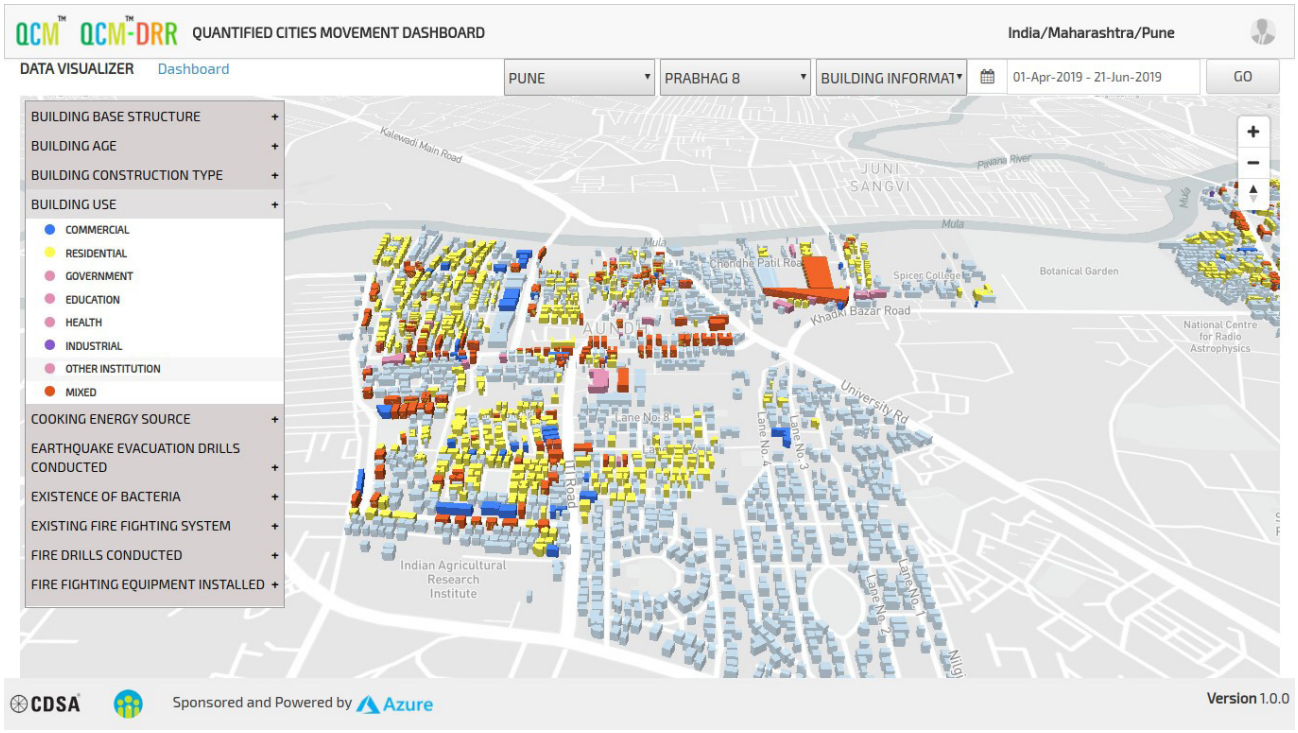

Figure 9. Mapping city land use.

Figure 10. Mapping asset location, area and population.

accessed and used by the department. Storing such data is useful for planning and verifying infrastructure and amenity requirements for a given asset as well as enabling a quick census.

Infrastructure plot details: Important details about the infrastructure can also be updated (Figure 11). Details such as housing types, tenure type, progress of construction, property value, among other things, can be updated and mapped. Using this data, the department can measure property values, track activities linked to tenure types and status of project implementation.

Mapping preparedness: The department can decide on which type of infrastructure and amenities need to be mapped. Asset infrastructure and amenity status can be continuously updated and tracked. This enables the department to prioritize infrastructure maintenance and retrofitting. The system also enables inventorying of various elements. Various activities linked to a house, for example, can also be tracked. Figure 12 illustrates whether earthquake evacuation, firefighting and flood evacuation drills have been conducted at the location. This data is invaluable in case of a disaster as well as for disaster preparedness and resilience activities. The data can be shared with the urban local body and state authorities such as the disaster management authority of the state for improved collaboration.

Figure 13 illustrates how land use is tracked and, more importantly, how water infrastructure for a particular use is mapped through the system. Various

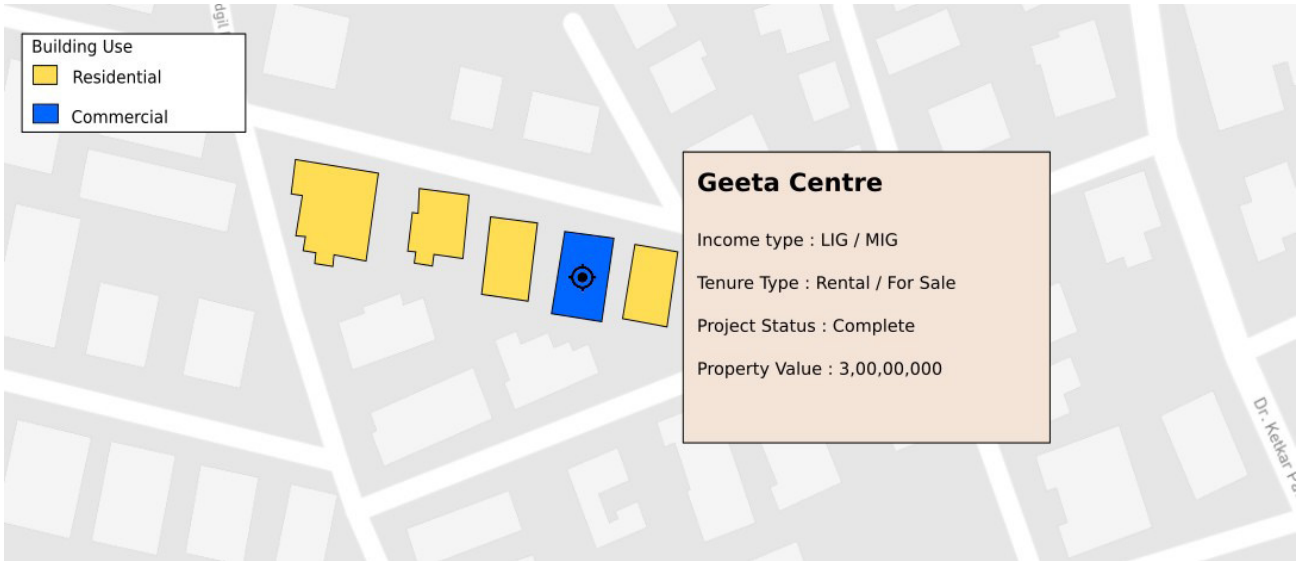

Figure 11. Mapping asset plot details and status including value.

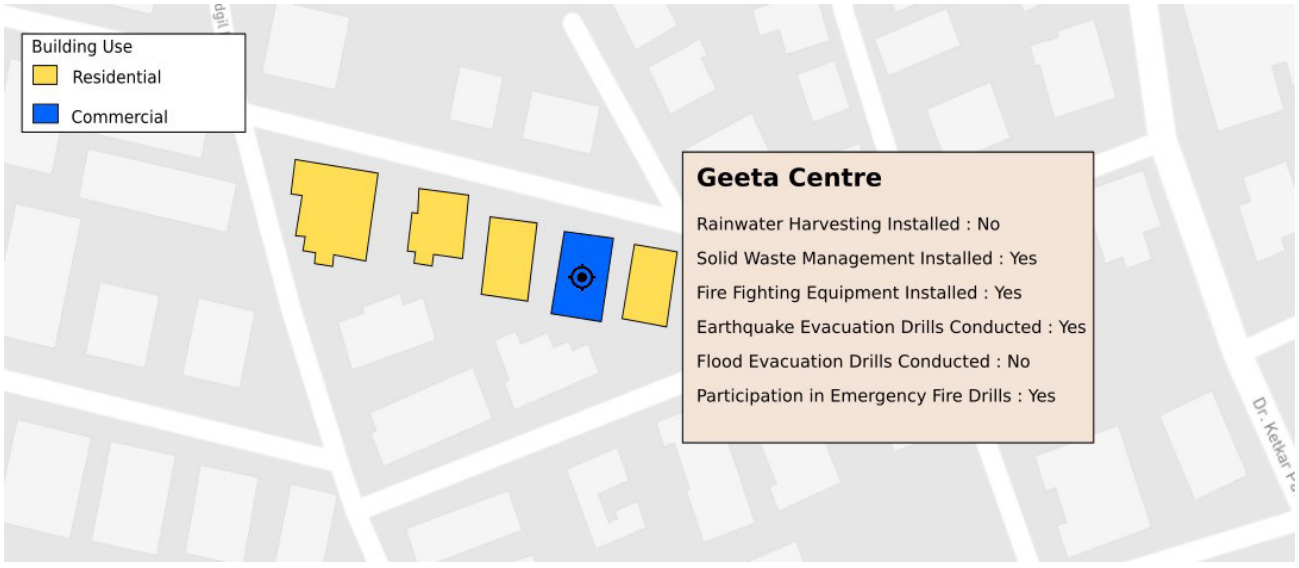

Figure 12. Mapping preparedness activities.

departments can share and cooperate to track assets. In the figure below, water sources, total water holding capacity, and availability for Geeta Centre have been mapped. This information can be shared with water supply and fire departments as well as the DRR planning department.

Sorting: Data sorting and querying is an important function that the QCM ecosystem provides. These functions enable the user to sort assets by standardized data. Any asset that has been tagged with a particular type of data can be queried and sorted for the same. Such a system enables the department to identify gaps (Figure 14), differences across variables such as total built area, tenure, land values, density, and infrastructure.

Comparing against quality standards: By engaging citizens, scientists and surveyors in reporting neighborhood level stress and risk, QCM facilitates best practices in urban an rural policy and planning, improving participation and increasing the availability of evidence. This process empowers all citizens, surveyors and academicians to collect data, analyze data, and map stresses identified through comparison with legislated quality standards, and also suggest solutions.

Benchmarking and comparing against baselines: Due to the potential of continuous and timely data collection, the ecosystem presents great opportunities for baseline studies and benchmarking. Stakeholders can compare the current situation to baselines and benchmarks in order to monitor marginal changes

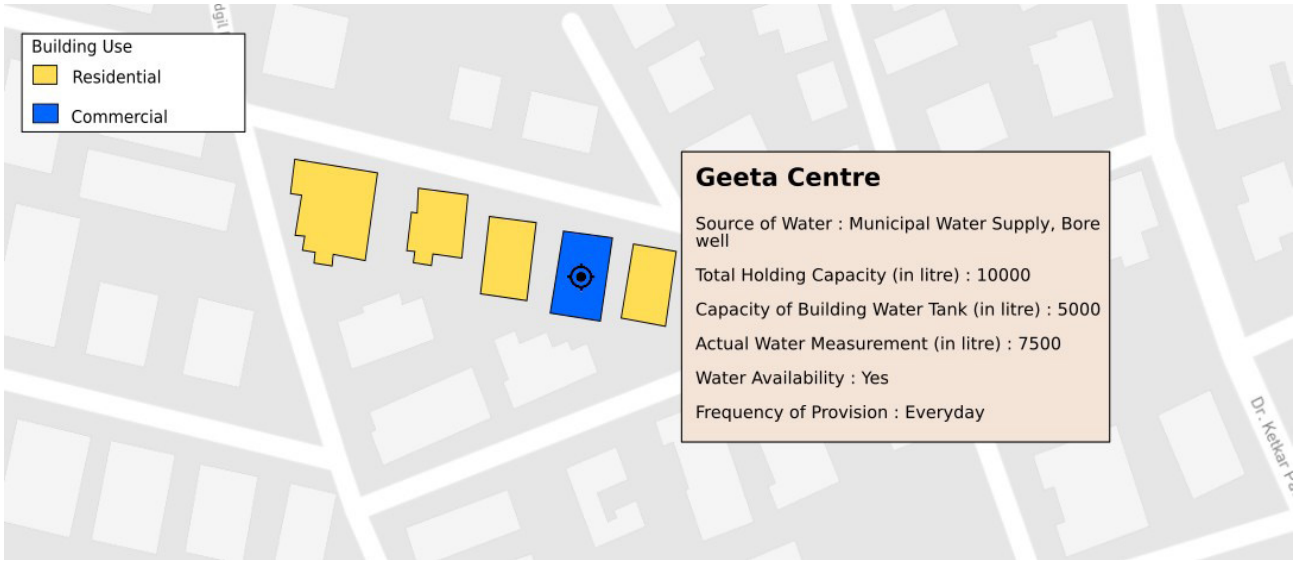

Figure 13. Mapping asset amenities such as water infrastructure and elements.

Figure 14. Sorting assets by location, area, value as well as infrastructure and elements.

for various indicators including but not limited to quality of life, climate change, disaster risk reduction and resilience.

Comparisons between wards and between cities: For standardized datasets, stakeholders can compare various indicator levels between wards and administrative precincts or even cities.

Use Cases

Example 1.

The Alliance for Resilient Cities (ARC)

ARC is being implemented in Pune, India. It is an initiative of the Centre for Development Studies and Activities and the Pune Municipal Corporation. It is being supported and mentored by the UNICEF DRR cell in New Delhi. The Alliance enables colleges, research institutions and the local governments to carry out local area research to achieve the Sustainable Development Goals by enabling students (in photograph) to collect data using the QCM framework. The data is sent to all the alliance members for use in research and policy creation (Figure 15).

Example 2.

The Karnataka Migrant Tracking and Social Protection Framework. (KMTSPF)

KMTSPF was initiated by the Ministry of Panchayati Raj of the Government of Karnataka and supported by the UNICEF Hyderabad office in 2020 until the end of 2021. The system was implemented to track the needs of returning migrants during the COVID pandemic. The framework used a customized instance of the QCM framework to enable village officials in all the villages of Karnataka State to report migrant needs, which included health care, social protection, education, livelihoods and food security. Village officials would carry out weekly surveys to report the ground situation to the District and finally the State functionaries.

Figure 16 illustrates how the system enabled government functionaries to identify the location and breakdown of skilled workers who could find gainful employment after returning to their villages during the COVID pandemic.

Figure 17 below showed the extent and gaps in the provision of social protection that is provided by the state government to its citizens. The Arogya Karnataka Card is an important document that provides important health coverage to the holders of this card. In this case, the government of Karnataka could pinpoint the gaps in the provision of social protection and organize efforts to reach the people in need due to the availability of location and time data, which was enabled by implementing the QCM framework.

Conclusion

Internet connectivity, processing power and storage capacities have been continuously improving over the past decades.

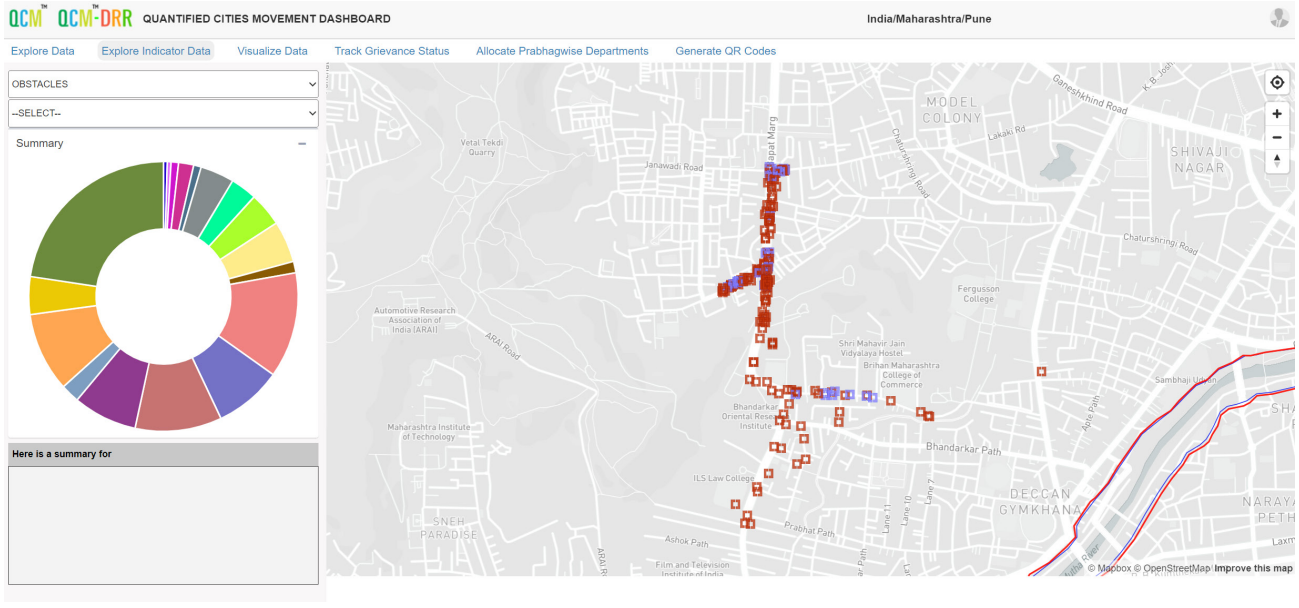

Figure 15. Student reports informing authorities whether the streets are safe for children, the elderly and persons with disabilities.

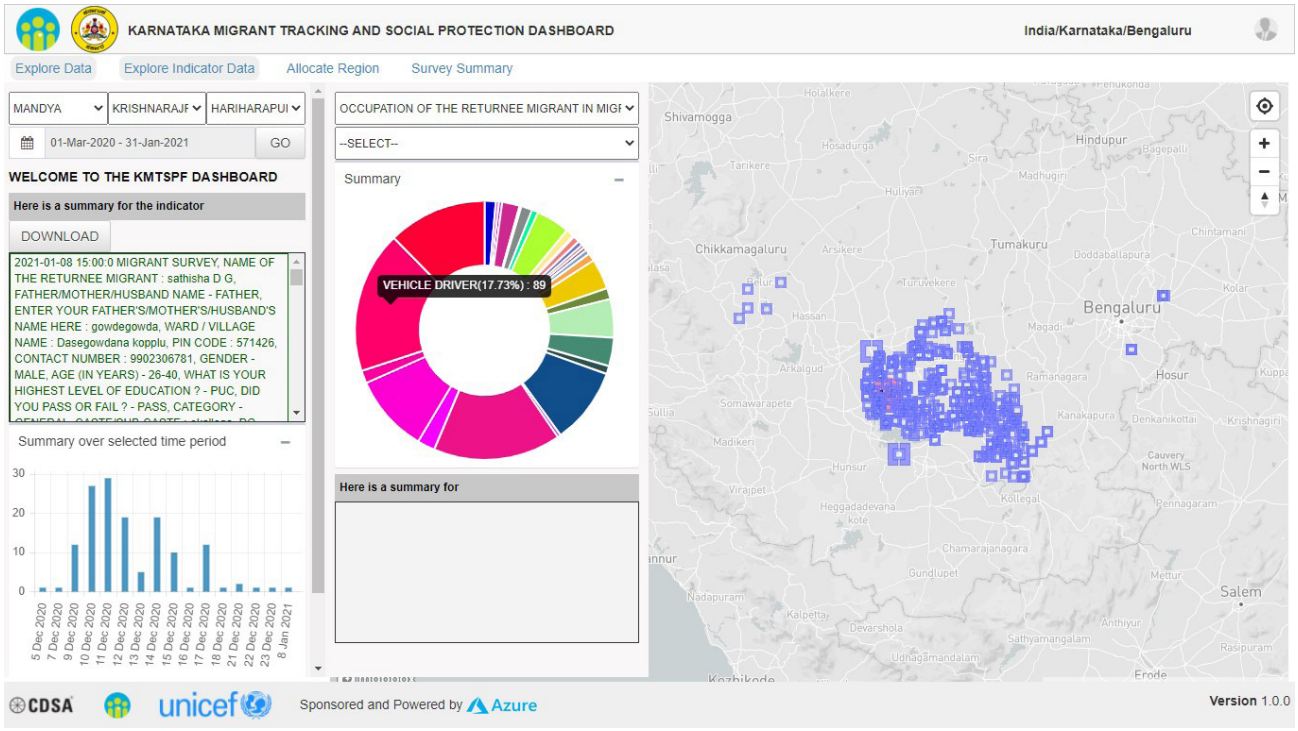

Figure 16. Reporting on skills of reporting migrants to match livelihood opportunities at the local level

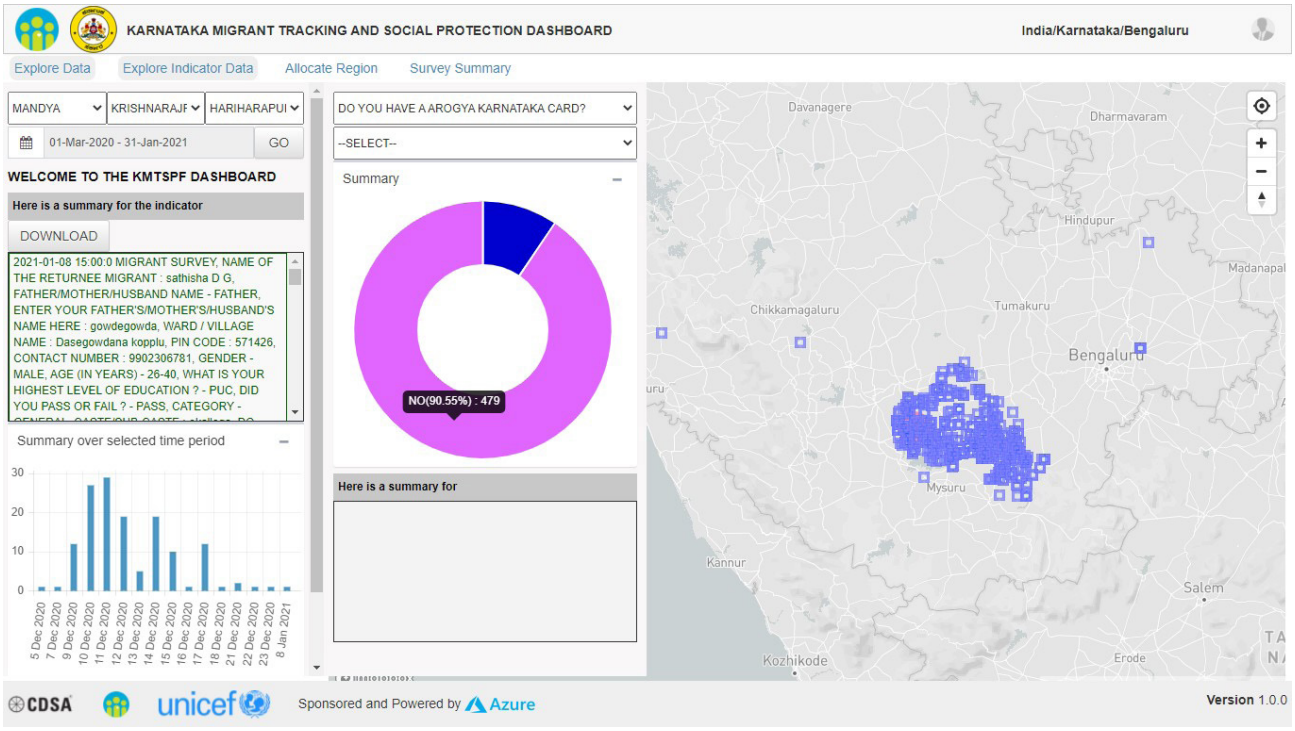

Figure 17. Reporting on skills of reporting migrants to match livelihood opportunities at the local level

Coupled with this, Internet of Things (IoT) frameworks are being installed for varied uses (refer to the Asia Pacific Tech Monitor Oct-Dec 2021 issue). The use of smartphones is expected to rise to 94% in 2030 from 68% in 2020. With this increase in adoption of communications technology at the household level, it is imperative that smartphones become enablers of disaster risk reduction. IoT devices and data can be linked to the Quantified Cities Movement (QCM) framework, presenting an opportunity for the creation of a worldwide platform for disaster risk reduction and resilience.

The system is a great framework for monitoring the achievement of Sustainable Development Goals (SDGs) as various surveys and data can be integrated and layered and interfaced in the system. With the help of youth alliances, NGOs and community-based organisations, various types of data can be collected at the grassroots level and pushed to UN organisations and local governments. This data can be compared against SDG targets to monitor and manage inputs to achieve the SDGs.

QCM readily becomes a platform for collaboration and mapping accountabilities and needs of various vulnerable groups. QCM has the capabilities of two-way communication, enabling authorities to alert selected groups about risks, various social protection programmes and livelihood opportunities.

Once such a system is installed, it ensures improvement in the speed at which data is collected, situations are monitored and local governments can respond to emergencies and make short and long-term investment plans for disaster mitigation, prevention, recovery and preparedness. It becomes a legacy system for enabling time series analysis and a repository of time series data. The system provides an opportunity to gather granular as well as big data and, in turn, improve and enable Artificial intelligence systems for urban monitoring and management.

QCM seamlessly enables households to plug in to a social protection and disaster risk reduction system that can enable preparedness, response and recovery in the event of any disaster. The QCM framework provides an opportunity for evidence-based and risk- informed planning of settlements as well as regions. Such a system should be treated as necessary infrastructure for all settlements. By institutionalizing and deepening such a system, local and state governments enable the creation of a much needed, real-time network to protect against loss of life and property.