

# Smart City Resilience

## Learning from Emergency Response and Coordination in Japan

### Executive Summary

Cities worldwide are placing increasing importance on building up resilience to natural disasters, such as extreme weather, flooding, heat and water stress, caused by climate change. Confronted by a natural disaster, smart cities can use sophisticated ICT infrastructure and analytical capabilities to enhance and coordinate the information flow between multiple public agencies, such as transport authorities, emergency services and energy providers, and citizens. With the help of mobile networks, a city municipality can reach the majority of its citizens at short notice.



Cities can learn from the experience of Japan, where the federal government launched an emergency warning system in February 2007, providing its municipalities with a plan and a solution to respond to natural disasters. The system was put to the test in the aftermath of the 9.0 magnitude earthquake that hit the country on the 11th March 2011, followed by a 9.3-meter high tsunami, only minutes after.

The impact of the tsunami was devastating, causing significant number of human casualties and severe damage to towns and cities in the north east of the country. More than five million people were stranded at their place of work and elsewhere in Tokyo metropolitan area. However, the warning system prevented the tsunami having an even greater impact: The Shinkansen bullet trains automatically stopped when the first tremors from the earthquake were felt. No trains derailed and no elevated bridges collapsed. Japan's recovery system, which dispatched nearly 28,000 members of the National Police Force, Fire and Disaster Management Agency and created more than 328 shelters, also helped the country recover from the disaster.<sup>1</sup>

### Crisis Planning, Coordination Preparation and Recovery

Cities across the world are attaching greater importance to planning, preparing and reacting to the growing number of natural disasters, such as extreme weather, flooding, heat and water stress, caused by the changing global climate. A 2010 study by the OECD estimated that in major coastal cities, such as Miami, New Orleans, Tokyo and New York, as many as 150 million people - close to four times the current 40 million - will have to rely on flood defences for protection by 2070<sup>2</sup>. The study also estimated that flooding could cause trillions of dollars of damage to these cities between now and 2070. In its C40 Climate Action in Megacities report<sup>3</sup>, engineering consultancy Arup identified 19 cities that have allocated funding for studies assessing the impact of climate change and associated risks. By 2011, 12 of these cities had gone as far as developing climate change adaptation plans, according to Arup.

An island nation located in a volcanic zone on the so-called Pacific Ring of Fire, Japan is prone to extreme weather and

natural disasters, especially earthquakes and tsunamis. Japan's city municipalities, which act as central coordination points for the implementation of disaster prevention and recovery, have a direct responsibility to carry out emergency response operations. In the wake of the major earthquake and tsunami that hit Japan in March 2011, for example, the Tokyo Metropolitan Government provided guidance on recovery measures to various stakeholders, including citizens, businesses, communities and rescue emergency support services, such as fire brigades and ambulances within its territory. It also distributed information about the impact of the earthquake and tsunami, and locations of emergency shelters.

Opened in 1991, the Tokyo Metropolitan Disaster Prevention Centre<sup>4</sup> is the central liaison facility for disaster management organizations under

<sup>1</sup> <http://www.bousai.metro.tokyo.jp/english/e-knowledge/center.html>

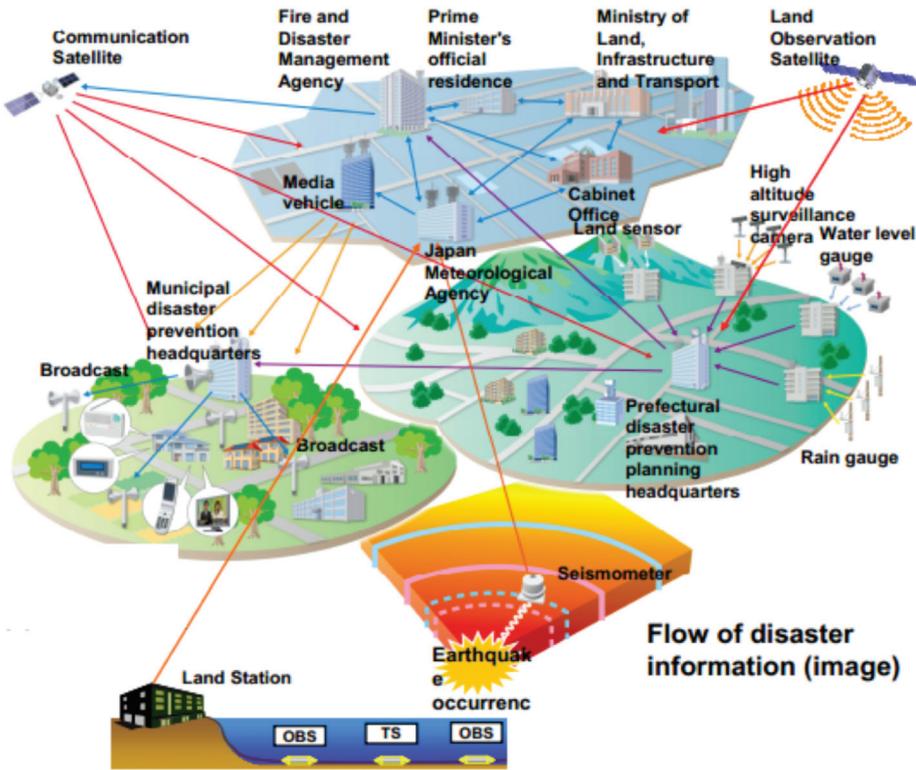
<sup>2</sup> <http://www.oecd-ilibrary.org/docserver/download/5km4h6wb434.pdf?expires=1357821256&id=id&accname=guest&checksum=CB882CD54FAAD164173E95EABC9EE43> and [http://www.rms.com/publications/OECD\\_Cities\\_Coastal\\_Flooding.pdf](http://www.rms.com/publications/OECD_Cities_Coastal_Flooding.pdf)

<sup>3</sup> [http://www.arup.com/-/media/Files/PDF/Publications/Research\\_and\\_whitepapers/Arup-C40ClimateActionInMegacities.aspx](http://www.arup.com/-/media/Files/PDF/Publications/Research_and_whitepapers/Arup-C40ClimateActionInMegacities.aspx)

<sup>4</sup> <http://www.bousai.metro.tokyo.jp/english/e-knowledge/center.html>



Exhibit 1. Flow of information when the emergency warning system is mobilised.

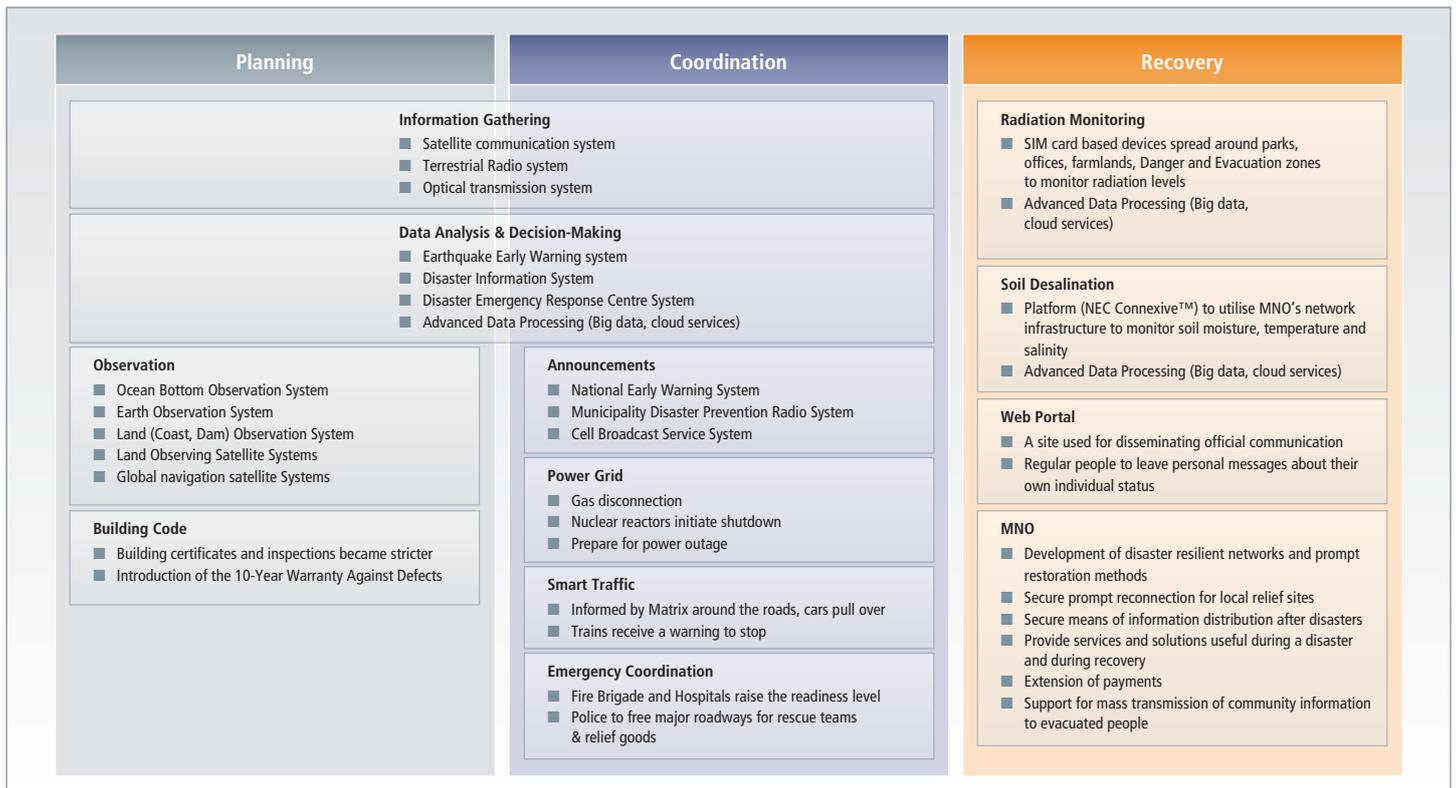


Source: NEC



Japan's comprehensive emergency warning system, developed by the Japan Meteorological Agency, (see Exhibit 2) highlights how smart cities can, during the coordination phase of a natural disaster, continually capture data from observation systems and feed it in to data processing platforms. These platforms can then quickly generate accurate information to be transmitted to both individuals and companies, while helping to prepare the emergency services (police, fire brigade, hospitals). The backbone of any comprehensive smart city disaster solution is information and communications technologies (ICT) run by technology vendors and telecoms operators, overseen by the operational management of a public agency.

Exhibit 2. Disaster recovery solution developed by the Japan Meteorological Agency



Source: GSMA analysis based on information from NEC Disaster Solution



In the recovery phase, the backbone ICT infrastructure needs to be assessed to determine if any repairs and restoration are necessary. For example, Tokyo Metropolitan Government has a manual covering a range of measures and tasks that have to be completed<sup>6</sup>. Japan's mobile operators also have a recovery strategy for mobile infrastructure that applies to different disaster scenarios. This strategy, which was deployed in the aftermath of the March 2011 earthquake<sup>7</sup>, includes the following elements:

1) Improve disaster resilience of the networks and establish restoration methods<sup>8</sup>:

- In preparation for wide area disasters, key network functions are distributed across several regions. After the 2011 earthquake, NTT DoCoMo also decided to construct 100 highly-resilient "Large Zone" stations, separate from the ordinary base stations, that will be able to provide mobile coverage to 35% of the population in the event of a wide-area disaster or power outage<sup>9</sup>.
- Networks are equipped with backup 24-hour storage batteries and access to alternative power sources such as solar and wind, to ensure they can operate even after long-term power outages.

2) Improved reconnection and re-establishment of coverage for local relief sites:

- Involves the installation of temporary base stations with both satellite and wireless communications.

3) Establish secure means of information distribution after the disaster:

- Measures to address communication needs directly following a disaster, such as the distribution of satellite phones and the construction of satellite mobile base stations and emergency microwave facilities, which would help prevent network congestion.
- Measures to address changes in customers' needs, such as shifting from using voice to e-mail and internet for accessing information.

4) Provide services and solutions useful during a disaster and during recovery:

- Support for local governments, medical care, schools etc. through the deployment of base stations, mounted on vehicles, and the transportation of fuel and relief goods to the sites.

Following a natural disaster, it is important to review a city or region's resilience strategy to identify any vulnerabilities and gaps. During the earthquake in Japan in March 2011, for example, people wanted to get general information from a single source. While many people used the micro-blogging service Twitter to inform friends and relatives about their own condition, large groups of affected citizens did not have Twitter accounts.

To address this challenge, in September 2012, the Japanese government started a month-long pilot of a new central web portal that could communicate critical information during an emergency, collected from a large number of

governmental agencies, to improve citizens' safety in the wake of a natural disaster. The information provided by the portal covers power outages, weather forecasts and systems, transportation blocks and diverted routes. The web portal also offers Twitter-style functionality, so that all citizens could use it to leave personal messages. These services have now been integrated into the main web site on a permanent basis.

**Importance of Big Data in Crisis Response**

Cities' ability to process, store and share vast amounts of data (big data) is crucial for building up their resilience and preparedness for natural disasters. In Japan, for example, the government has implemented a coordinated data distribution project for the monitoring of radiation, where SIM-enabled devices located in farmlands, parks, offices and danger and evacuation zones use the mobile networks to transmit measurements of radiation. Municipalities then use this data to keep the public away from the areas where high radiation has been detected.

Similarly, tsunamis can increase the salinity of soil, making it unsuitable for agriculture. NEC is currently sponsoring a new technique that can reduce the length of desalination treatment from two years to four months by storing, sharing and analysing soil moisture temperature and salinity levels.



<sup>6</sup> <http://www.bousai.metro.tokyo.jp/english/e-tmg/restoration.html>

<sup>7</sup> For further information about the role of mobile in Disaster Response, see the GSMA site: <http://www.gsma.com/mobilefordevelopment/programmes/disaster-response/programme-overview>

<sup>8</sup> NTT DoCoMo Annual Report 2011

<sup>9</sup> [http://www.nttdocomo.co.jp/english/corporate/ir/binary/pdf/library/presentation/110428/notice\\_110428-2\\_e.pdf](http://www.nttdocomo.co.jp/english/corporate/ir/binary/pdf/library/presentation/110428/notice_110428-2_e.pdf)

### Smart City Resilience: Conclusions

A city's ability to respond effectively to natural disasters heavily depends on its uses of ICT infrastructure, including mobile networks<sup>10</sup>, to efficiently receive, process, analyse and re-distribute data, and mobilise various city services. Municipal and national governments in the USA, Taiwan, Azerbaijan and other countries around the world have learned from Japan's approach in the aftermath of the 2011 earthquake and have used it as a blueprint for their own warning and recovery systems. Here are some of the key lessons for cities globally from Japan's emergency warning system:

- In Japan, the national emergency solution is developed by the central government, while the cities become the central coordination and response units when a disaster strikes.
- A detailed step-by-step guide for every second prior- and post-disaster needs to be put in place. This guide outlines where and when all the necessary activities need to occur, and assigns all the required responsibilities.
- Mobile operator participation is crucial throughout the entire process of city crisis planning, coordination and recovery. Mobile networks need to be beefed up to connect all stakeholders, including police, hospital and nuclear plants, to complement existing proprietary networks. Mobile networks also need to be used to connect a wide range of sensors, in order to monitor land and ocean changes, and accurately measure crucial parameters, such as wind speed, waves, radiation, and salinity. Mobile connectivity needs to be combined with different types of observation systems and global satellite systems.

■ A city's ability to collect, process, analyse and distribute information from various sensor networks and the entire urban ecosystem is crucial for resilience. This ability depends on effective partnerships between technology vendors, software companies, integrators and telecom operators. Once the infrastructure required to process, store and share large volumes of data has been built, it can also give rise to new business opportunities for many stakeholders, including mobile operators and technology companies, who can use cloud services, data analytics and business intelligence to create new services and applications for consumers and enterprises.

### Partner Background

#### Japan Meteorological Agency

The Japan Meteorological Agency (JMA) is a governmental agency responsible for implementing the following services, in compliance with the Act for Establishment of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the Meteorological Service:

- Prevention and mitigation of natural disasters
- Safety of transportation
- Development and prosperity of industry
- Improvement of public welfare

<http://www.jma.go.jp/jma/indexe.html>

#### NEC

NEC Corporation is a provider of Internet, broadband network and enterprise business solutions. It delivers tailored solutions in the key fields of computer, networking and electronic devices, by integrating IT

and networking solutions, and cloud data analytics. NEC has supplied Japan with nine Ocean Bottom Observation Systems (OBOS) that connect 5,000km of submarine cable, 150 undersea seismometers, and seismometers in strategic locations in building foundations and other structures across the cities. NEC is also providing a complete disaster prevention system and network solution.

#### Mobile Network Operators

There are three major mobile network operators in Japan: NTT DoCoMo, Au and Softbank, which together have approximately 128 million mobile subscriptions, approximately 98% of the market.

[www.nttdocomo.com](http://www.nttdocomo.com)

[mb.softbank.jp](http://mb.softbank.jp)

[www.au.kddi.com](http://www.au.kddi.com)

#### The GSMA Connected Living Programme

The GSMA's Connected Living programme is a market development initiative with a mission to help mobile operators accelerate the delivery of new connected devices and services. Its target is to assist in the creation of 700 million new mobile connections, whilst stimulating a number of service trials and launches in the automotive, education and healthcare sectors. The Connected Living programme is also working with the city of Barcelona, the Mobile World Capital, to develop and showcase smart city services. Our work focuses on the adoption of mobile-based solutions and services to ensure that the cities of the future are safe and healthy places to live and work.

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[www.gsma.com/connectedliving/smart-cities](http://www.gsma.com/connectedliving/smart-cities)

<sup>10</sup> <http://www.gsma.com/mobilefordevelopment/programmes/disaster-response/disaster-response-resources>



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au