Training Materials

For Implementing Smart Cities in Asia and the Pacific for Inclusive, Resilient, and Sustainable Societies

Water-related Disaster Risk Reduction and Smart Cities

United Nations Centre for Regional Development (UNCRD)

Training materials issued without formal editing
FOR TRAINING PARTICIPANTS ONLY

August 2022

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This training material has been prepared by Ms. Marisha Wojciechowska-Shibuya) for "The Capacity Building Programme for Implementation of Smart Cities for Inclusive and Sustainable Society in the Post-COVID-19 Pandemic Era". The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

Smart City Programme in Asia and the Pacific

A Training Tool for Cities in the Context of Water-Related Disasters Disaster and Climate Change

By Marisha Wojciechowska-Shibuya

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Foreword

At this moment (early September 2022), a third of Pakistan is reportedly under extreme monsoon floodwaters, incurring countless suffering and loss. This event, just one among an increasing number of severe water-related disasters, serves as a stark reality check in the brunt of increasing climate change events. In the face of such climate change impacts, this report seeks to shine a light on the promises wielded by smart city technologies. With nearly half of people in Asia-Pacific now residing in cities, cities lie at the helm of the efforts that are critically needed to shield vast swathes of people and economies from the might of severe water-related disasters. Cities wield a vast number of resources within their midst, which if harnessed with vision, will and innovation, can open creative new pathways to handle these changing times.

As this training module outlines, with the advent of hi-speed internet networks, AI and the Internet of Things, to name a few recent technological developments, smart city technologies can help a city to be better prepared as they can provide more accurate and localized monitoring and forecasting capacities. It ensues, that these technologies can also facilitate better communications and enhance coordination in times of disasters. Thus, as these technologies can help build up a city's resilience, the smart city concept carries with it the hope of saving more lives and reducing economic losses.

At the current moment, however, across our vast region, we are witnessing too few smart city initiatives as applied specifically to water-related disasters. To be sure, climate change, and more extreme weather events are increasingly bearing down upon us. May this training programme, deftly conceived by the United Nations Center for Regional Development (UNCRD) and their partners, serve as a rallying call for concrete action. And collectively, may we rally to our region's cities to bid them with more knowledge and means so they may harness the power of smart technologies. And that we may all be better protected when a water-related disaster comes barreling down at our cities' doors.

Acknowledgements

This training module is the fruit of the following institutions and people who spearheaded its creation, namely:

- United Nations Center for Regional Development (UNCRD): Kazushige Endo, Ganesh Raj Joshi, Taeko Yokota and Nana Urakami
- National Graduate Institute for Policy Studies (GRIPS): Kenzo Hiroki
- Ministry of Land, Infrastructure, Transport and Tourism (MLIT) Japan
- Marisha Wojciechowska-Shibuya, the international consultant who drafted these contents

Abbreviations and acronyms

AI: Artificial Intelligence
COP: Conference of the Parties
DRR: Disaster risk reduction
GLOF: Glacial lake outburst flood
GRIPS: National Graduate Institute for Policy Studies
HELP: High-level Experts and Leaders Panel on Water and Disasters
ICT: Information and communication technology
IoT: Internet of Things
MLIT: Ministry of Land, Infrastructure, Transport and Tourism
PPE: Personal protective equipment
R&D: Research and development
SDG: Sustainable development goal
UNCRD: United Nations Center for Regional Development

Executive Summary

Natural disasters have risen globally in recent years, both in frequency and intensity, and the vast majority of these disasters have been water-related. The Asia and the Pacific region is one of the most disasters-affected regions of the world. With the Smart City concept, cities in Asia can harness these technologies to build smart urban resilience to improve safety, security and the resilience of their communities. In this context, under the Smart City Programme, this training tool seeks to assist member countries in building their cities and communities to become more safe, resilient, and sustainable in the face of water-related disasters.

After a quick review of recent data on water-related disasters and climate change trends, definitions of resilience and the smart city concept are discussed in the context of disaster risk reduction. In a bid to offer to new perspectives in disaster risk reduction, specifics on disaster risk reduction and ICTs, namely through the advent of hi-speed internet and the Internet of Things, are discussed as emerging and powerful tools for municipalities to consider. A build back better approach in the context of climate change calls for forecasting in terms of future risk predictions, not past ones. Smart water technologies provide an efficient means for water supply and sanitation utilities to monitor and assess damage during disaster episodes. As cities are inevitably nestled within the wider context of their hydrological basins, the basin approach is offered as another angle through which to build more robust disaster risk reduction systems for cities. In closing, some smart cities best practices are offered as leads to further explore the application of the concept.

Introduction

Key points:

- The frequency and intensity of natural disasters have risen globally in recent years.
- The Asia and the Pacific is one of the most disasters-affected regions in the world. People living in Asia and the Pacific region are four times more likely to be affected by natural disasters compared to people in Africa, and 25 times more likely than those in Europe.
- As most of the mega cities in Asia and the Pacific are located along a coastline, they are at high risk of global warming and sea level rise.
- The Smart City concept seeks to make cities and communities more robust, resilient, and sustainable.
- As most of the natural disasters are water-related, a trend forecasted to increase in frequency due to climate change, building climate and disaster resilient urban infrastructures and services could provide the best solutions to adapt to natural disasters, global warming, sea level rise, and other climate change impacts.
- There is a basic truth in water disaster management: water is local.

During the past decade, water-related disasters have not only struck more frequently but have also been more severe. Extreme events have dominated the disaster landscape in the 21st century, a trend that can be linked to the rise in weather-related disasters.

Some 4.5 billion people were affected by disasters between 1998 and 2017, 96% of which were weather-related. Global annual economic losses from natural disasters are estimated at between 250 billion to 300 billion US dollars. Although death tolls of disasters have been contained due to global efforts and advancement of science and technology, the number of affected people and, particularly, the economic losses due to disasters have been skyrocketing.

About 90% of financing for disasters risk reduction worldwide is directed at emergency response and reconstruction/rehabilitation, and is increasing year by year, while the amount disbursed for disaster prevention and preparedness is limited to about 10%.

As a majority of the developing countries lack the state-of-the art early warning system, strong enforcement of building codes, integrated land-use and urban planning, and climate and disaster resilient infrastructure and services, cities in developing countries are highly vulnerable to disaster risk. The Asia and the Pacific is one of the most disasters-affected regions in the world. Studies reveal that people living in Asia and the Pacific region are four times more likely to be affected by natural disasters compared to people in Africa, and 25 times more likely than those in Europe[1]. Since 1970 two million people have been killed, and almost US$1.15 trillion of the economic losses have occurred in the region, which amounts to almost 40% of the global total[2].

[1] The rise of natural disasters in Asia and the Pacific: Learning from ADB's experience Mandaluyong City, Philippines: Asian Development Bank, 2013

[2] UN ESCAP, 2015: Overview of Natural Disasters and their Impacts in Asia and the Pacific, 1970 –2014, ESCAP Technical Paper, pp-30.

As most of the mega cities in Asia and the Pacific are located along a coastline, they are at high risk of global warming and sea level rise. According to the report "*The Future We Don't Want*", over 800 million people living in 570 coastal cities will be at high risk of sea level rise and coastal flooding[3]. In a business as-usual scenario, the global economic losses from coastal flooding may exceed US $1 trillion annually by 2050 unless the major coastal cities prepare for it[4]. Similarly, Asia and the Pacific is vulnerable to climate change impacts. Scientists have warned that South Asia could lose about 1.8 % of its annual GDP due to climate change impacts by 2050[5], and progressively reach up to 11% by the end of the century, under the business-as usual scenario [6]. The global climate change vulnerability index already indicated that seven major cities globally classified as an "*extreme risk*" are in Asia, and these include Dhaka, Manila, Bangkok, Yangon, Jakarta, Ho Chi Minh, and Kolkata[7].

The Smart City idea has become a popular solution worldwide to make cities and communities more robust, resilient, and sustainable. Smart urban resilience is an essential component of the smart city that helps to improve safety, security, and resilience of the cities and communities. Building climate and disaster resilient urban infrastructures and services could be the best solutions to adapt to natural disasters, global warming, sea level rise, and other climate change impacts.

Since over 90% of natural disasters in the world are water-related, including floods, droughts and storms, it is critical for the cities in Asia and the Pacific to build the capacity to be more resilient to the natural disasters which are increasingly frequent with the impact of various global changes, particularly climate change.

And there is a basic truth in water disaster management: water is local. While there can be national policy and investment frameworks, regional cooperation and global dialogue, the fact of the matter is that water is a local issue. Water-related disasters are local events. A flood, a cyclone, a landslide occurs within a definite space. They require readiness and resources to be prepared for at the local level, with municipalities certainly a key actor on the frontlines of DRR and management.

The major objective of this smart city development project is to improve the quality of life of urban dwellers by making cities more safe, efficient, resilient, and sustainable by improving the capacity to address water-related disasters and the impact of climate change, especially focusing on preparedness.

Module 1- Water-related disasters and climate change in cities

[3] C40, 2019: The Future We Don't Want - How climate change could impact the world's greatest cities.
[4] Hallegatte, S., C. Green, R. J. Nicholls and J. Corfee-Morlot. 2013: "Future Flood Losses in Major Coastal Cities". Nature Climate Change 3: 802–06. DOI: 10.1038/NCLIMATE1979
[5] ADB, 2014: Assessing the Costs of Climate Change and Adaptation in South Asia.
[6] ADB, 2015: Southeast Asia and the Economics of Global Climate Stabilization.
[7] https://www.adb.org/sites/default/files/evaluation-document/36114/files/rise-natural-disasters-asia-pacific.pdf

Educational aim: This module discusses the potential threats of water-related disasters and the impact of climate change to the modern cities. The module provides a broad picture of water-related disasters, their costs in human and economic terms, and the forecasted trends in climate change impacts for cities in the Asia-Pacific region, based on the latest data.

Key learning points:

- Water-related disasters, such as floods, droughts, storm surges and tsunamis account for 90% of all disasters in terms of number of people affected. This number is increasing.
- The impacts of climate change are predominantly felt through water. Nine out of ten natural disasters are water-related.
- Worldwide direct economic losses caused by disasters are significantly increasing, and the number of people affected by disasters is on the rise. The economic damages of water-related disasters alone over the past 20 years amount to about 1.8 trillion US dollars.
- Asia and the Pacific is the most disaster-affected region in the world.
- Cities are particularly vulnerable to climate change – both because extreme weather events can be especially disruptive to complex urban systems, and because so much of the world's urban population live in low-lying coastal areas, particularly in Asia.
- Cities in Asia of course face their own set of climate change impacts depending on their local environmental features, with some more at risk of floodings and others of storm surges, or tropical cyclones for instance.
- Future water-related risk reduction should be based on the future risk prediction under climate variability scenarios.

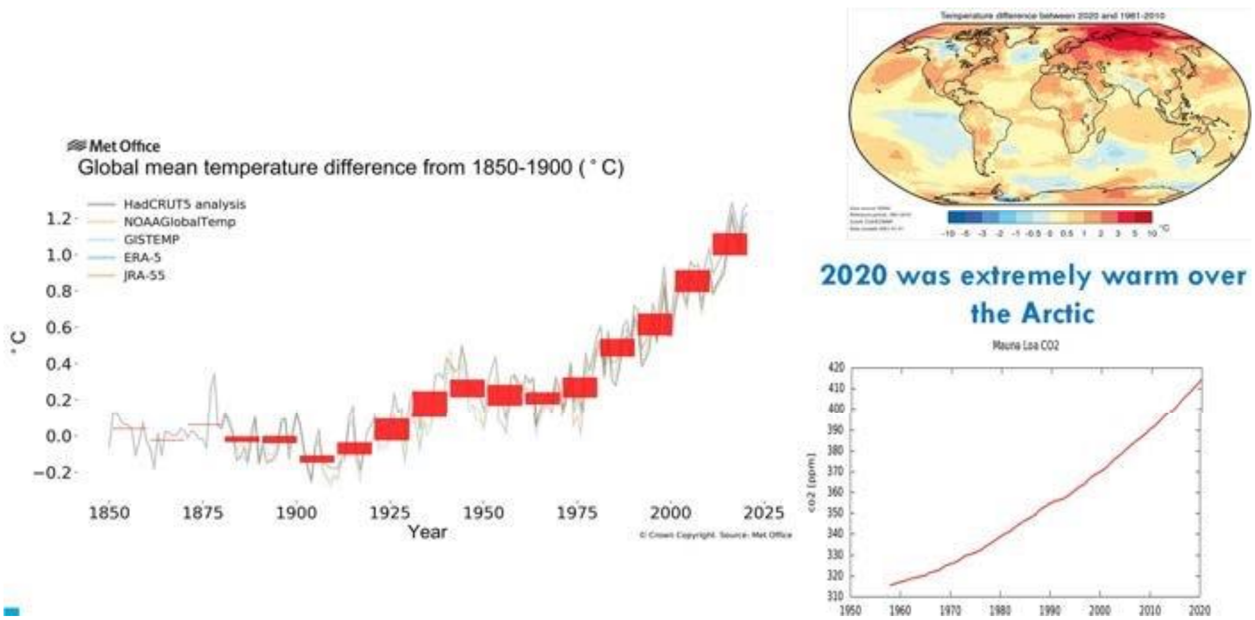
In terms of temperature and CO_2, 2011-2020 is the warmest decade on record, and 2020 was extremely warm over the Arctic, with the concentrations of the major greenhouse gases continuing to increase. With regards to ocean heat, sea level and pH, there is a record high ocean heat at various depths, the rate of sea-level rise is increasing, and ocean acidification is increasing. In the cryosphere, the Arctic sea-ice extent has declined in all months, vast areas of open oceans have now been observed in the Arctic, and the glaciers of Greenland and Antarctica are losing ice. Around 4.5 billion people worldwide between 1998 and 2017 have been affected by disasters, 96% of which have been water-related[8].

The projected impacts of climate change forebear the occurrence of disasters, such as: enhanced sea level rise and more pronounced hydro-meteorological extremes, a higher frequency of intense storms, locally more intense rainfall, higher river discharge extremes, as well as longer dry periods and droughts that can lead to deterioration of already scarce water resources. Some regions are even experiencing new forms of disasters, such as droughts, in areas not accustomed to such events.

[8] Extracted from WMO Presentation at The Fifth UN Special Thematic Session on Water and Disasters Draft Chair's Summary, June 25th, 2021.

Water-related disasters, such as floods, droughts, storm surges and tsunamis already account for 90% of all disasters in terms of number of people affected. This number is still increasing. The poor, vulnerable groups, women and girls are suffering the most. Economic and environmental losses associated with water-related hazards are rising in all regions[9].

Figure 1: Climate change trends



These graphs (figure 1) show that:

- concentrations of the major greenhouse gases have increased
- 2011-2020 is the warmest decade on record
- 2020 was extremely warm over the Arctic

Asia and the Pacific is the most disaster-affected region in the world, home to more than 40% of disasters and 84% of people affected. Major delta cities along the coastlines are becoming increasingly vulnerable to climate change risks and disasters— flood events, sea level rise, and droughts— threatening lives, livelihoods, and public health and compounded with huge economic losses.

Over the past 50 years, natural hazards in Asia and the Pacific have affected 6.9 billion people and killed more than 2 million, almost all of whom were victims of water-related disasters, such as floods, droughts, and storms. Nevertheless, fewer people have been dying; there has been a substantial fall in the average loss of life per year, which in

[9] https://www.wateranddisaster.org/cms310261/wp-content/uploads/2015/04/03Leaflet_Climate-Change-Position-Paper.pdf

2019 and 2020, fell to around 6,200 people. Nevertheless, the average number of people affected per year has fallen only slightly to 122 million people.

The challenges facing cities are numerous under any and all circumstances, and range from rapid urbanization, demographic shifts (rapid progress in aging, large youth population), to a centralization of the national capital with the ensuing decline of rural areas. For Southeast Asian cities in particular, the challenges revolve around rapid urbanization, that cause issues and challenges in quality of life for the residents, environment and infrastructure. In addition, some 38% of the largest port cities in the world are located in Asia, and most of these (27%) are in deltas[10]. Cities in deltaic settings are subject to higher coastal flood risk as they tend to be at lower elevations and experience significantly more subsidence (natural and anthropogenic).

Cities in Asia and the Pacific do have different circumstances, and hence their local hydrological risks and will differ and they will face different types of natural hazards. Figure 2 presents an overview of different natural hazards (though not all of them are climate change related in this presentation). Broadly speaking, Asian urban centres can be categorized as:

1) Coastal cities: more vulnerable to climate change impacts, through typhoons, floods, storm surges, etc.
2) Inland cities: in mountains, more vulnerable to landslides, GLOFs, flash floods, etc.
3) Inland cities with monsoon seasons: with heavy monsoon followed by parched dry annual season cycles.

An OECD study forecasted the Top 20 cities with the most vulnerability in terms of population exposure (including all environmental and socioeconomic factors) by 2070s (figure 2). These are: Kolkata, Mumbai, Dhaka, Guangzhou, Ho Chi Minh City, Shanghai, Bangkok, Rangoon, Miami and Hai Phòng. Except for Miami, all the cities are in Asian developing countries. In terms of assets exposed, the top 10 cities are Miami, Guangdong, Greater New York, Kolkata, Shanghai, Mumbai, Tianjin, Tokyo, Hong Kong, and Bangkok[11]. Cities in Asia, particularly those in China, India and Thailand, are hence the most vulnerable in terms of population and asset exposure. This is due to the rapid urbanisation and economic growth expected in these countries.

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[10] OECD, 2007. https://climate-adapt.eea.europa.eu/metadata/publications/ranking-of-the-worlds-cities-to-coastal-flooding/11240357
[11] OECD, 2007. https://climate-adapt.eea.europa.eu/metadata/publications/ranking-of-the-worlds-cities-to-coastal-flooding/11240357

Figure 2: Top 20 cities to be impacted by flooding in the 2070s

Rank	Country	Urban Agglomeration	Exposed Population Current	Exposed Population Future
1	INDIA	Kolkata (Calcutta)	1,929,000	14,014,000
2	INDIA	Mumbai (Bombay)	2,787,000	11,418,000
3	BANGLADESH	Dhaka	844,000	11,135,000
4	CHINA	Guangzhou	2,718,000	10,333,000
5	VIETNAM	Ho Chi Minh City	1,931,000	9,216,000
6	CHINA	Shanghai	2,353,000	5,451,000
7	THAILAND	Bangkok	907,000	5,138,000
8	MYANMAR	Rangoon	510,000	4,965,000
9	USA	Miami	2,003,000	4,795,000
10	VIETNAM	Hai Phòng	794,000	4,711,000
11	EGYPT	Alexandria	1,330,000	4,375,000
12	CHINA	Tianjin	956,000	3,790,000
13	BANGLADESH	Khulna	441,000	3,641,000
14	CHINA	Ningbo	299,000	3,305,000
15	NIGERIA	Lagos	357,000	3,229,000
16	CÔTE D'IVOIRE	Abidjan	519,000	3,110,000
17	USA	New York-Newark	1,540,000	2,931,000
18	BANGLADESH	Chittagong	255,000	2,866,000
19	JAPAN	Tokyo	1,110,000	2,521,000
20	INDONESIA	Jakarta	513,000	2,248,000

Table 1: Top 20 cities ranked in terms of population exposed to coastal flooding in the 2070s (including both climate change and socioeconomic change) and showing present-day exposure (Source: Nicholls et al (2007), OECD, Paris)

Rank	Country	Urban Agglomeration	Exposed Assets Current ($Billion)	Exposed Assets Future ($Billion)
1	USA	Miami	416.29	3,513.04
2	CHINA	Guangzhou	84.17	3,357.72
3	USA	New York-Newark	320.20	2,147.35
4	INDIA	Kolkata (Calcutta)	31.99	1,961.44
5	CHINA	Shanghai	72.86	1,771.17
6	INDIA	Mumbai	46.20	1,598.05
7	CHINA	Tianjin	29.62	1,231.48
8	JAPAN	Tokyo	174.29	1,207.07
9	CHINA,	Hong Kong	35.94	1,163.89
10	THAILAND	Bangkok	38.72	1,117.54
11	CHINA	Ningbo	9.26	1,073.93
12	USA	New Orleans	233.69	1,013.45
13	JAPAN	Osaka-Kobe	215.62	968.96
14	NETHERLANDS	Amsterdam	128.33	843.70
15	NETHERLANDS	Rotterdam	114.89	825.68
16	VIETNAM	Ho Chi Minh City	26.86	652.82
17	JAPAN	Nagoya	109.22	623.42
18	CHINA	Qingdao	2.72	601.59
19	USA	Virginia Beach	84.64	581.69
20	EGYPT	Alexandria	28.46	563.28

Table 2: Top 20 cities ranked in terms of assets exposed to coastal flooding in the 2070s (including both climate change and socioeconomic change) and showing present-day exposure (Source: Nicholls et al (2007), OECD, Paris)

Source: OECD, 2007

Figure 3: Number of fatalities and people affected by floods, 1991-2020

FIGURE 1-8 Number of fatalities and people affected by floods, 1991–2020

Source: Data from EM-DAT – The International Disaster Database. Available at https://www.emdat.be/ (accessed on 4 May 2021).

The current annual losses from both hydro-meteorological and geophysical natural hazards are estimated to be around $780 billion. UN-ESCAP has estimated that under a moderate scenario of climate change, these losses will increase to $1.1 trillion, and under a worst-case scenario, to around $1.4 trillion.

Figure 4: Total economic loss by kids of disasters in 2018

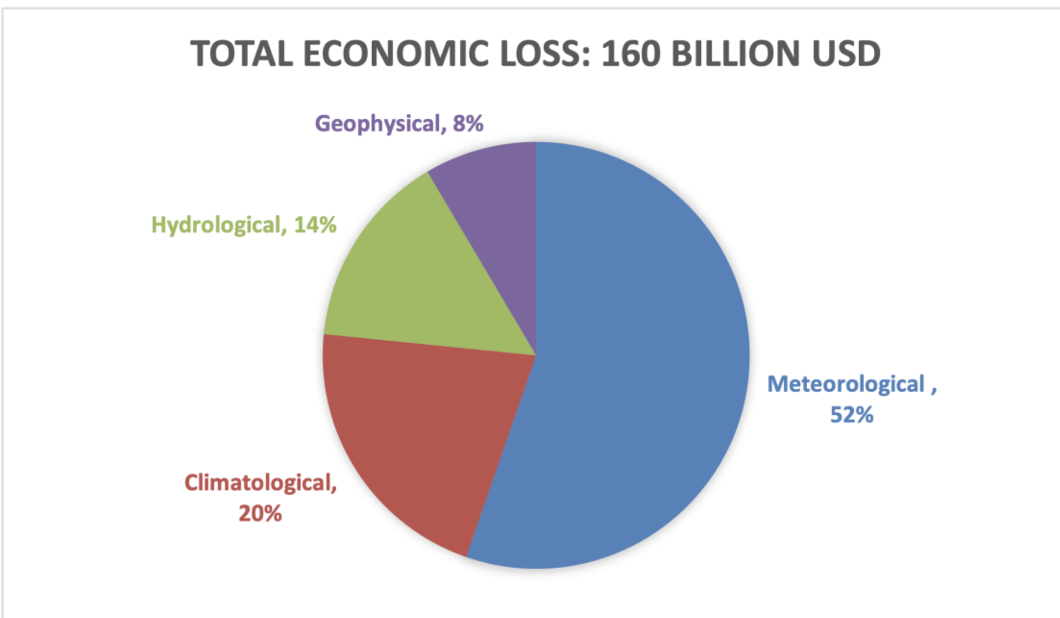
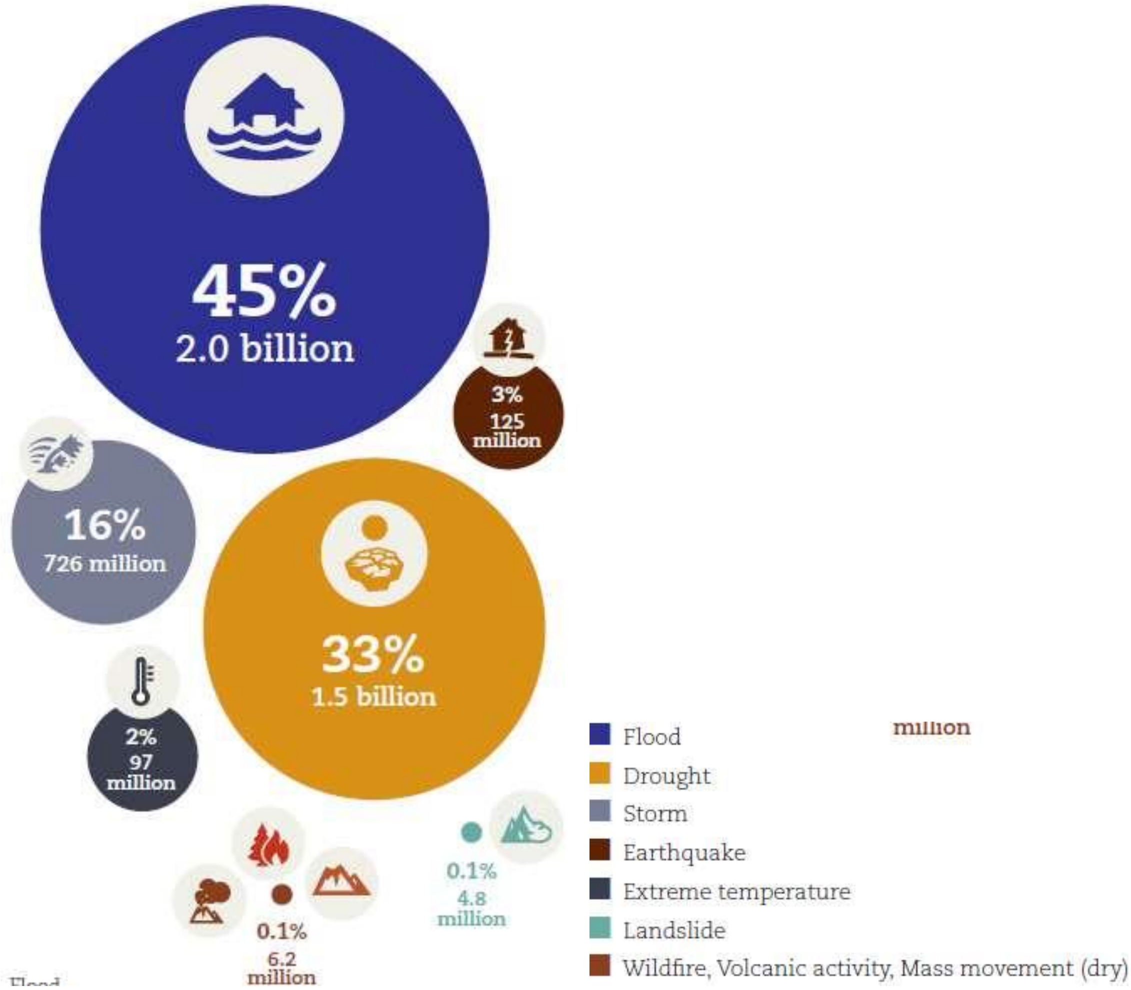


Fig. 1.1 Economic loss by kinds of disasters in 2018

Made from Munich Re. Report 2018

https://www.munichre.com/topics-online/en/climate-change-and-natural-disasters/natural-disasters/the-natural-disasters-of-2018-in-figures.html



Source: WMO

Worldwide climate change predictions are such that with an average ground temperature rise of 4 degrees (compared to the temperature of the pre-Industrial Revolution), there is a 1.3 increase in rainfall to be expected. For a 2 degree temperature rise, this involves a 1.1 increase of rainfall compared to rainfall volumes of the end of the 20th century.

In addition, in many coastal cities throughout the world, satellite data indicates that land is subsiding faster than sea level is rising, primarily due to groundwater extraction. If subsidence continues at these recently observed rates, these coastal cities will be challenged by flooding much sooner than that projected by sea level rise models. The most rapid subsidence is occurring in South, Southeast, and East Asia.[12]

Sediment disasters and slope failures are another projected impact of climate change, since when rainfall increases, landslides and mudflows are consequently more likely to occur. For instance, in Japan it is expected that such disasters are likely to occur more frequently as a result of rainfall changes due to climate change, even in areas that are

[12] https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022GL098477

not identified to be vulnerable to such disasters. This highlights the need to identify such vulnerable areas, and to plan appropriate alert and evacuation strategies, in addition to the regular monitoring of vulnerable areas.

These climate change forecasts are further compounded by the fact that many developing countries in Asia lack robust climate resilient infrastructure and services that are critical to mitigate the impacts of climate change. Hence, these countries will suffer the most.

Traditionally, disaster countermeasures are based on past events and experiences. And clearly the mitigation measures would differ depending on the hydrological circumstances for each urban centre (ie: coastal, inland and mountainous, South Asian). So, for instance, mitigation measures for inland cities in mountain settings might focus more on land management interventions, whereas diversion of river flows to overcome water shortage during dry seasons or to avoid flood damage during the monsoon might be a more prevalent consideration for South Asian cities. However, as unexpected events occur, and as society and science and technology rapidly change, future water-related risk reduction should be based on the future risk prediction under climate variability scenarios. The best defence against future shocks is to build resilience into systems now, by assessing and preparing for climate change impacts now. Specifically, this involves actions that reduce the vulnerability, exposure and inequality that drive disasters. In addition, lessons learned in real-time from the COVID-19 pandemic are also important.

Figure 5: An overview of natural hazards and urban concerns

An overview of natural hazards and urban concerns

Natural hazards affect cities in different ways but there is potential for disaster as city authorities struggle to manage overcrowding, rapid urbanization, and environmental degradation.

Earthquake

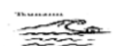
Urban concerns: Many densely built and populated cities lie on earthquake belts. Non-engineered and poorly-built or badly-maintained buildings cannot withstand the force of seismic shocks, and are more likely to collapse. Most earthquake deaths are due to building collapses.

Landslide

Urban concerns: A growing number of badly built or makeshift homes that have sprung up on or below steep slopes, on cliffs or at river mouths in mountain valleys, combined with poor drainage or slope protection, means that more people are exposed to catastrophic landslides, triggered by rainfall saturation or seismic activity.

Volcanic Eruption

Urban concerns: Settlements on volcano flanks or in historic paths of mud/lava flows put millions of people at risk. Adequate early warning systems and constructions to withstand ash and lahar flows are concerns for urban and rural areas near volcanoes.



Tsunami

Urban concerns: Many cities have been built along tsunami-prone coasts. Adequate construction, early warning systems and evacuation plans are primary measures to address these.

Tropical Cyclone

Urban concerns: Many urban areas are exposed to cyclones, strong winds and heavy rain. Wind resistant constructions, early warning systems with advice for households to lock up windows and secure property and, if necessary, evacuate are primary measures (see also flood).

Flood

Urban concerns: Flash floods are a growing urban hazard because concrete and compacted earth will not absorb water, because open spaces have been colonised, because engineering works have diverted river flows, because city drainage systems are inadequate. Housing on river banks or near deltas, may be badly built or dangerously sited.

Fire

Urban concerns: Urban fires stem from industrial explosions or earthquakes. Accidental fires are serious, especially in informal settlements. Fire risks are increasing due to high density building, new construction materials, more high-rise buildings, and greater use of energy in concentrated areas. Uncontrolled wildfires can reach urban areas.

Drought

Urban concerns: Drought is an increasing slow onset disaster that triggers migration to urban areas, putting pressure on housing, employment, basic services and the food supply from surrounding countryside. Many slums in Africa are filled with rural families driven from their villages by prolonged drought or conflict.

Source: Prevention Web, https://www.preventionweb.net/files/14043_campaignkit1.pdf

Module 2- Resilience and Smart Cities

Educational aim

Resilience is an important element for establishing the smart city and making cities safer, livable, and sustainable. This module covers the smart city-idea, concept, principles, objectives and vision focusing on water-related DRR and the impact of climate change in cities and communities.

Key learning points:

- Resilience is the capacity for a city to absorb, utilise or even benefit from perturbations.
- Water-related resilience: minimizes the loss of human lives and economic damages, even during maximum water-related disasters, responding and recovering early and avoiding the breakdown of social and economic activity.
- Since 2005, and the adoption of the Hyogo framework, there has been a paradigm shift from one of disaster management to disaster prevention.
- The importance of increasing investments in disaster risk reduction is increasingly prioritised by the international community.
- The bulk of international assistance is overwhelmingly directed toward emergency response and reconstruction, rather than for disaster prevention and preparedness.
- Investing in resilient infrastructure is an investment in the future. Every $1 invested in making infrastructure disaster-resilient saves $4 in reconstruction.[13]
- Cascading effects mean that cities are not only vulnerable directly to water-related events, but also indirectly through disruptions to food or energy production systems for instance.
- Smart cities: can leverage digital infrastructure and data to enhance disaster prevention, prevention, management and recovery.

Disaster risk reduction is the concept and practice of analyzing and reducing the causal factors of disasters by decreasing exposure to hazards, lessening vulnerability of people and property, improving management of land and the environment, and enhancing preparedness for adverse events. Disaster risk reduction also includes establishing adequate financial protection, including financial planning and investment as well as the sharing of risk through financial mechanisms. Disaster risk reduction activities at local, national, regional and global levels are guided by an international blueprint known as the Hyogo Framework, which was adopted by the United Nations General Assembly in 2005. Its adoption reflects a paradigm shift from disaster management – that is, from coping with impacts – to prevention. The Hyogo Framework's five priorities for action emphasize that reducing disaster risk requires strengthened governmental commitment and investment, risk information and early warning capacity, education and public awareness, understanding the underlying risk factors, and preparedness to respond to impacts that could not be avoided. Disaster risk

[13] https://www.un.org/sg/en/content/sg/speeches/2021-06-25/remarks-5th-un-special-thematic-session-water-and-disasters%C2%A0

reduction is primarily concerned with hazards of natural origin – such as earthquakes, floods, droughts and cyclones – and related technological threats. These hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination.

The Hyogo Framework was succeeded by the Sendai Framework, adopted in 2015 (rf. Box ##). The Sendai Framework serves as the global blueprint for reducing risk and building resilience. Advancing towards the goal of the Sendai Framework for Disaster Risk Reduction to strengthen resilience, there is a need to focus on water management. This is essential for all of the Sendai Frameworks four priority areas - understanding risk, ensuring governance structures are in place, investing in DRR for resilience and to "Build Back Better". The effort needs to connect to and enable a joint push with the Sustainable Development Goals, in which water plays a central role, as well as the joint push with the Sustainable Development Goals, in which water plays a central role, as well as the Paris Agreement, in which floods and droughts top the list of climatic hazards identified in Governments' Nationally Determined Contributions (NDCs).[14]

More than 100 countries now have a disaster risk reduction strategy at least partially aligned to the Sendai Framework. And in at least 55 countries, local governments have their own disaster risk reduction strategies – essential to building resilience from the ground up. This however still represents a minority of countries, and requires countries and local governments to work together, forging partnerships with the private sector and civil society to accelerate implementation by building resilience from the ground up through disaster risk reduction strategies.[15]

The importance of increasing investments and financing for disaster risk reduction is now widely recognized in international agreements, such as the Sendai Framework for Disaster Risk Reduction. However, about 90% of the international assistance is directed for emergency response and reconstruction/rehabilitation, while the amount disbursed for disaster prevention and preparedness is limited to only 10%.[16]

And yet, the reality is that investing in disaster risk reduction pays off significantly. On average, every $1 invested in disaster risk reduction can render benefits of $4 in avoided and reduced losses.[17] Some studies even conclude that in certain situations every euro/dollar spent on preventive measures can pay back up to ten-fold in avoided damage and loss of life. As the incidence and severity of extreme events are expected to continue to increase, investment in prevention is becoming increasingly advantageous.[18]

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[14] https://www.preventionweb.net/files/globalplatform/5cca9d74f1649WS14-Issues_Brief_-_GWP.pdf

[15] Antonio Guterres, OECD, The Fifth UN Special Thematic Session on Water and Disasters Draft Chair's Summary, June 25th, 2021

[16] HELP Principles on Investment, https://www.wateranddisaster.org/cms310261/wp-content/uploads/2019/07/HELP-Principles-Full-Final-Printing.pdf

[17] *Ibid*., p.6

[18] https://www.wateranddisaster.org/cms310261/wp-content/uploads/2015/04/03Leaflet_Climate-Change-Position-Paper.pdf

"A sustainable future occurs when planning lays a foundation; resilience guards against future risk; smart cities deploy the best technology for the job; and financing tools help pay for it all."[19]

Figure 6: Major resilience characteristics that should be built in as part of an urban resilience solution

Source: UNESCAP (rf. Footnote 16)

In a recent UNESCAP report on The Future of Asian and Pacific Cities, UNESCAP characterized stresses as slow onset ones, such as drought, sea-level rise, land-use changes for instance, and shocks as abrupt events, such as flooding, power cuts, food shortages, among other disruptions. And that resilience measures are most effective when pursued through combined approaches that deal directly with interdependent problems.

A broad- based definition of resilience for a city is: "the capacity for urban systems and settlements to absorb, utilise or even benefit from perturbations, shocks and stresses".[20]

[19] Figure from : https://www.unescap.org/sites/default/d8files/Future%20of%20AP%20Cities%20Report%202019_CHAPTER2_RESILIENCE_0.pdf , p. 71 . Quote from Executive Summary, p.21.

Box 1: Risk Reduction in Global Agreements

The Sendai Framework on Disaster Risk Reduction 2015-2030 (Sendai Framework) provides Member States with concrete actions to protect development gains from the risk of disaster. The Sendai Framework outlines seven global targets to be achieved by 2030: reduce global disaster mortality, reduce the number of affected people globally, reduce direct economic loss in relation to GDP, reduce disaster damage to critical infrastructure and disruption of basic services, increase the number of countries with national and local disaster risk reduction strategies, substantially enhance international cooperation to developing countries, increase the availability of and access to multi-hazard early warning systems.

Transforming our World: the 2030 Agenda for Sustainable Development (2030 Agenda) sets out 17 Sustainable Development Goals and provides an all-encompassing policy framework to tackle all forms of poverty, hunger, inequalities among and within countries (based on gender and other socioeconomic status), and tackling environmental degradation and climate change. SDG 11.5 specifically addresses disasters: "By 2030, significantly reduce the number of deaths and the number people affected and substantially decrease the direct economic losses relative to global GDP caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations."

The Paris Agreement "is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial level. "The Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts under the United Nations Framework Convention on Climate Change also recognizes the importance of averting, minimizing and addressing loss and damage due to climate change, including extreme weather and slow-onset hazards and changes (UNFCCC, 2013). Comprehensive risk assessment, risk insurance facilities and climate risk pooling are important tools that link climate action under the Paris Agreement with risk reduction under the Sendai Framework." (Global Risk Assessment Report on Disaster Risk Reduction 2022, UNDRR, p.2)

Water-related disasters ought to also be seen within the bigger picture context, whereby there are cascading impacts that intersect to compound or alleviate the impacts of water-related events (rf. figure 7). A water-related disaster occurs within this larger context of cascading impacts, whereby there are underlying correlations and feedback loops already in place at the time of the event. These 'bigger picture' components are the background context against which overall water resources management in general, and specifically disaster preparedness, as well as recovery and reconstruction, occur.

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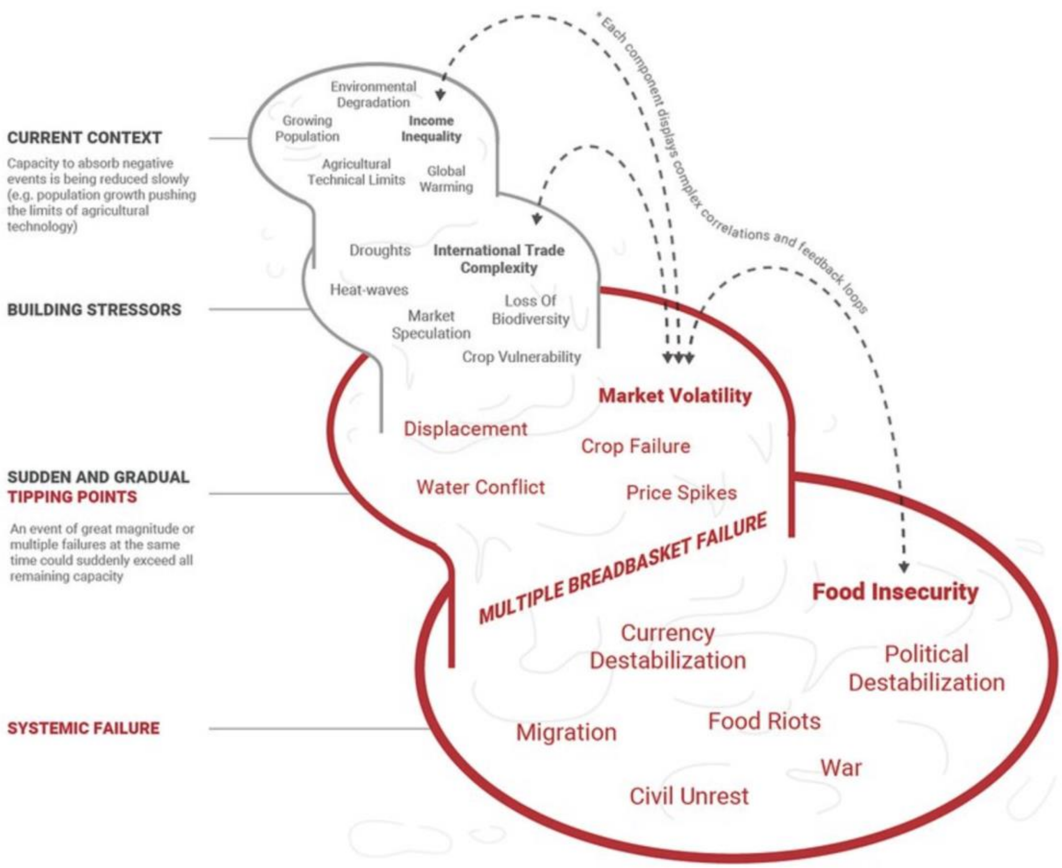
[20] Meerow, Newell, and Stults, 2016, quoted by ESCAP in https://www.unescap.org/sites/default/d8files/Future%20of%20AP%20Cities%20Report%202019_CHAPTER2_RESILIENCE_0.pdf, p.72

Though this is a conceptual analysis, it can help urban managers better understand where the most prominent hurdles are that hinder enhancing disaster preparedness and risk reduction measures. And also, it can help make the case as to why preparedness and DRR are worthwhile endeavours for society, so as to minimize the downward cascading impact from a water-related disaster. In sum, if the city is better prepared to handle the disaster. In times of peace, nothing undermines development and progress like a disaster.

“The COVID-19 pandemic has reminded the world what the Sendai Framework for Disaster Rick Reduction 2015-2030 is all about: risk is systemic, interconnected and cascading. Climate change is driving increased risk across all countries, and unpredictable hazards can have devastating cascading impacts on all sectors, with long-lasting, debilitating socio-economic and environmental consequences.”[21]

Figure 7: The cascade



Source: UNDRR[22]

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[21] UNDRR Strategic Framework 2022-2025, p.2, available at: https://www.undrr.org/publication/undrr-strategic-framework-2022-2025

[22] https://gar.undrr.org/infographics.html

Definition of Smart City: A smart sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.[23]

The smart city is an approach that seeks to make the best use of data, technologies, and available resources to improve city planning, management, and service delivery, to engage citizens, and to enhance accountability. For smart cities, advancing cutting-edge technologies such as Artificial Intelligence (AI), big data, and IoT (the Internet of Things) is geared towards creating cities that are sustainable and can generate agile prosperity. Innovative technologies are key enablers at the core of smart cities, and can promote efficient integration and alignment in urban planning and management.

Digitalization is rapidly progressing in various situations in civic life and economic activities. Against the backdrop of COVID-19, numerous cities in the region have seen the expansion of e-commerce and the spread of remote work. These new trends, in which technologies and various data are utilized may bring new rays of hope in disaster prevention by improving the capacity to prepare and respond quickly on the basis of real-time data.

Technological innovation in the field of information technology has propelled opportunities for enhanced monitoring, prediction and communication. The advent of 5G, IoT, development of big data and the use of AI technology through enhanced computer capacity is increasing the precision of observation and information gathering, which in turn enables the predictions and grasp of phenomena difficult to predict so far. Such enhanced precision supports evacuation measures and various disaster prevention activities.

[23] UNECE & ITU, https://unece.org/housing/sustainable-smart-cities

Figure 8: Data utilization within a city

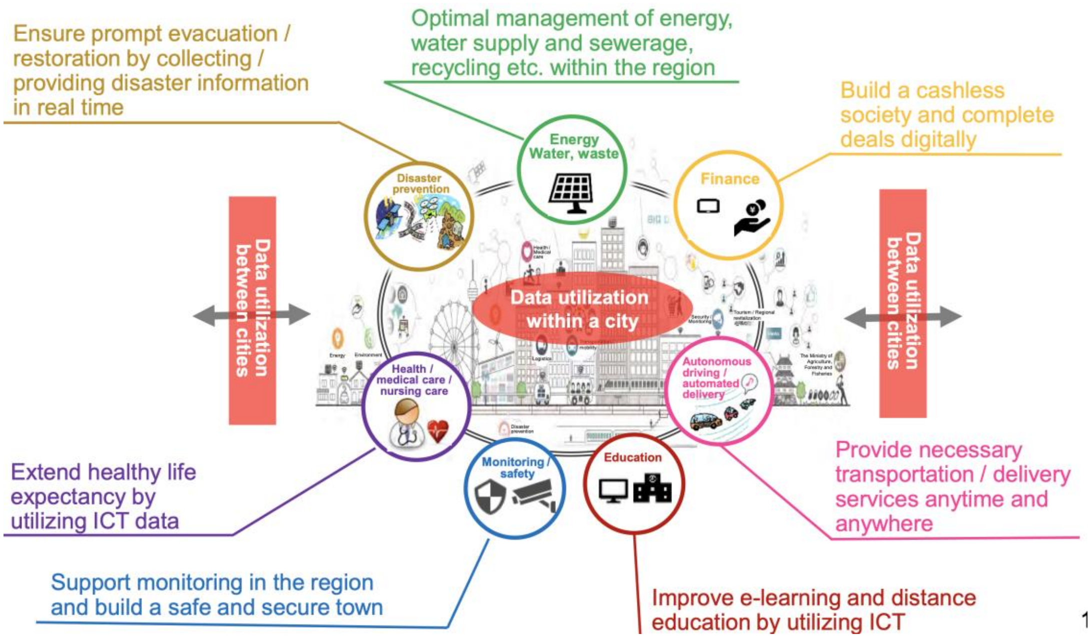
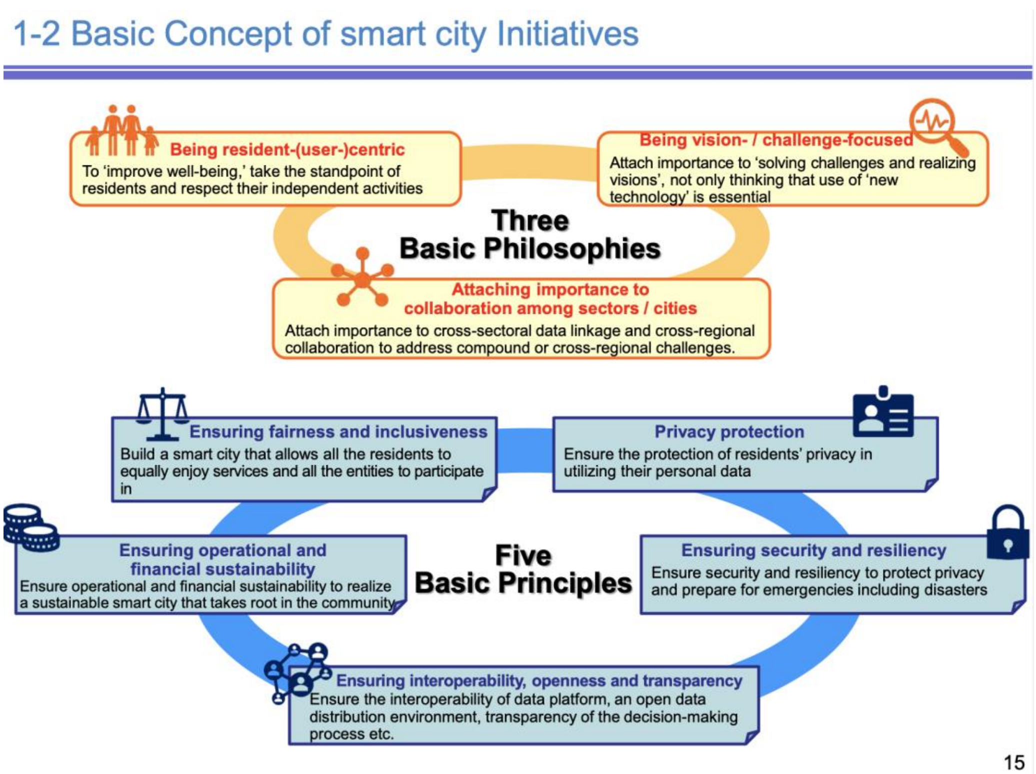


Figure 9: Basic concept of smart city initiatives



(https://www8.cao.go.jp/cstp/society5_0/smartcity/01_scguide_eng_1.pdf , p.15)

Module 3- Disaster risk reduction and ICTs

Educational aim: This module focuses on water-related disaster risk reduction action plan, road map and strategies- addressing disaster risk and vulnerability, strengthen the urban built environment and urban systems, disaster prevention, mitigation, preparedness, response, and recovery aspects. This section further highlights how information and communication technology increasingly offer new tools to support water-related disaster risk management to strengthen resilience and minimize the vulnerability of water-related disaster impacts, save the loss of lives and property damages in the context of the Sendai Framework for Disaster Risk Reduction 2015-2030.

Key learning points:

- Smart city technology offers new and powerful possibilities in the arsenal of tools for DRR.
- The advent of hi-speed internet provides cities with new powerful tools to better predict, prepare, respond and recover from water-related disasters.

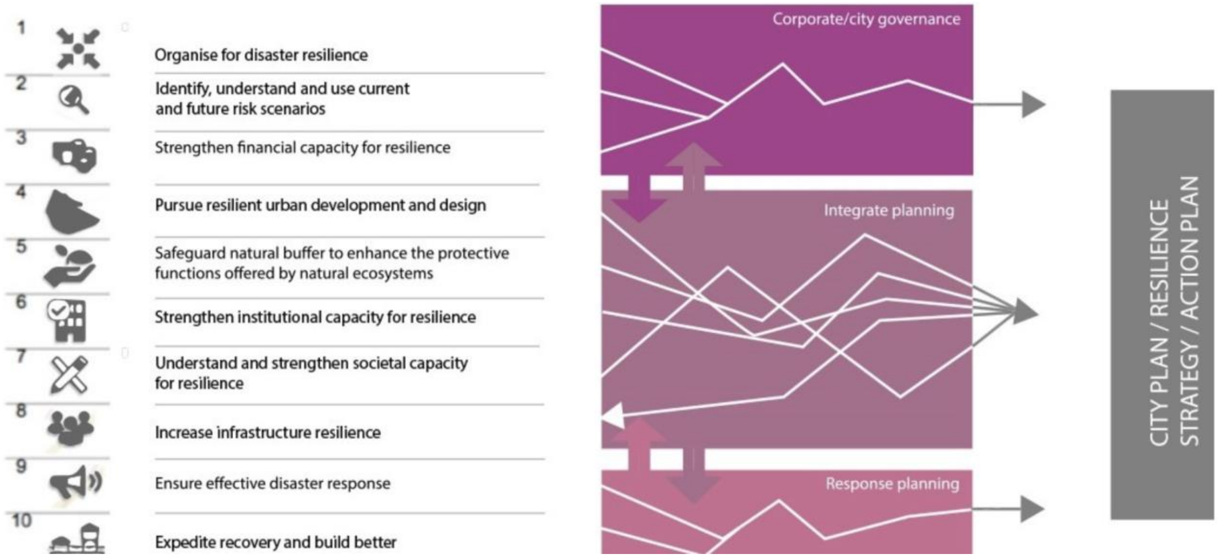
Initiatives to combat the urgent issue of the impacts of climate change include: reviewing current disaster-prevention and response plans; and, implementing preventive measures to reduce risks of damages or plans for "Build Back Better" from catastrophic disasters. Data is accumulating on the interventions that contribute to the reduction of damages such as, disaster risk information and the current status of infrastructure. Governance can be reinforced by assessing the impact of investments. Other tools to be considered are resilience ratings, strengthened regulations, enhanced capacity, access to financing, stress-testing and enhanced reporting against the Sendai Framework Targets.

"Most investment decisions today do not consider disaster risks at the transaction level. Notwithstanding the gravity of large-scale and long-term systemic threats, most investors still treat these risks as temporally remote, limited, uncertain and/or unquantifiable at the level of an individual project or asset, and thus discount them. The continued reliance on short time horizons as the basis for financial decisions remains a significant contributor to the failure of policymakers, investors, corporations, and project developers to fully consider and respond to disaster risk. Moreover, there is a need to foster the positive perception in political decision makers that financing prevention is achievable and will successfully avert disasters."[24]

The UN Office for Disaster Risk Reduction has set up a programme for 'Making Cities Resilient 2030'. As a broad guideline, it outlines the following ten step essentials for making cities resilient (figure 10):

[24] UNDRR Strategic Framework 2022-2025, p. available at: https://www.undrr.org/publication/undrr-strategic-framework-2022-2025

Figure10: Ten step essentials for making cities resilient



Source: UNISDR[25]

Smart city technology offers new and powerful avenues in the arsenal of tools for DRR. In this regard, the Internet of Things is the network of physical objects, 'things', that contain sensors, software, and other technologies that connect and exchange data with other devices and systems over the internet.

The advent of hi-speed internet can accelerate the adoption of smart city technology, such as sensors, smart-metering, monitoring and communication systems. Greater data transmission can enhance better performance of equipment and infrastructure. This can provide cities with critical information on the *in-situ* conditions of their cities: to mitigate and predict disasters more accurately, and to be better prepared, respond and recover more effectively when disasters do strike. IoT-enabled prediction and early warning devices can be pooled into systems, which along with IoT-enabled response systems, can improve disaster risk mitigation, preparedness and response.

IoT applied to water-related DRR

Prediction and Preparation
Connected IoT devices and sensors can collect near-real-time data on things like water levels, atmospheric conditions, etc., making it possible to monitor conditions in real-time, and provide the opportunity to send early warnings. For instance, early-warning of storm paths can give a head-start to authorities on alerting citizens, protecting property, or evacuating people if need be. In addition, sensors can detect critical infrastructure repair needs and hence facilitate their predictive maintenance. In addition, IoT devices can also monitor strategic reserves of critical supplies, such as food, water, clothing, medical equipment, and others to ensure acceptable levels.

[25] https://www.unisdr.org/campaign/resilientcities/toolkit/article/the-ten-essentials-for-making-cities-resilient.html

Response and Recovery

In the immediate aftermath of a disaster, situational awareness is critical to ensuring resources are prioritized and get it to those who need it the most. Information can be spread quickly through digital signs present throughout the cities to alert citizens and can be updated quickly and flexibly as the situation evolves. In extreme conditions, battery powered IoT-enabled devices can continue to operate and transmit wirelessly, which gives cities data network resilience during a disaster. Smart sensors on first responders can enhance situational awareness and also keep first responders safe.

Collaboration and sharing of resources between different disaster response and recovery personnel (i.e.: local and international emergency response personnel, NGOs, military, etc.) can be coordinated through IoT in disasters. During the recovery phase, IoT devices can continue to disseminate information and to monitor post-disaster conditions and vital resource stockpiles.

Human losses from water-related disasters can be substantially reduced by making effective use of the time lag between the occurrence of natural catastrophic events (ie: heavy rain, winds and low pressure typhoons/hurricanes) or the arrival of a natural force event (ie: flood, tsunami, high tide) and its hit onto people and communities. Since such time lags exist for all water-related disasters, timely early warnings and the facilitation of people's quick actions, such as evacuations, are key.

Module 4- Build back better

Educational aim: This module focuses on the needs of mainly recovery, rehabilitation and reconstruction phases from water-related disasters and their implication for re-building cities and communities safer, smarter, resilient, and sustainable. This module highlights major policy approaches, planning process, management ideas; institutional arrangements, financing mechanisms, governance, and leadership capacities; collaboration, networking, and partnership opportunities for reducing water-related disaster risk of cities and communities.

Key learning points:

- Future water-related disaster risk reduction should be based on future risk prediction under climate variability scenarios, with specific projections for local hydrological basins.
- The COVID-19 pandemic has focused governments and people's attention on mitigating the pandemic. However, threats of water-related disasters are as imminent now as ever, especially in the face of the changing climate and its impacts.
- Urgent actions are needed to prevent concurrent catastrophes of water-related disasters and COVID-19 that, as a duo, aggravate each other.

- As nine out of 10 natural disasters are related to water, water must be at the core of adaptation strategies in order to build back better to achieve climate and development goals for our societies.
- Priority 4 of the Sendai Framework states: “Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.”
- ‘Mainstreaming disaster risk reduction’ in all sectors such as land use regulation in city planning is important to avoid catastrophic damages caused by large scale disasters with low frequency.

Disaster policies and countermeasures have traditionally been based on past events and experiences. However, future water-related disaster risk reduction should be based on the future risk prediction under climate variability scenarios, with specific projections for local hydrological basins.

Preparedness and risk reduction

Use forward-looking scenarios to plan for the future. As a society, we continue to use historical data, statistical analysis and current conditions to design infrastructure that will still be in use 50 years into the future, and then wonder why it is inadequate. We know the world is changing, both naturally and by our actions — land subsidence from groundwater pumping, increased runoff from development, reduced water storage as we grade and pave wetlands, putting more assets in unprotected, exposed areas; coupled with increasing temperatures and storm intensity are resulting in increased flood damages. Rather than rely on past conditions, we must begin to use regional worst- case historical information coupled with projections of future climate and development scenarios in our planning.

Response

Trust the public with information that helps them manage their safety and preservation of assets. During a disaster, timely dissemination of information gives people more opportunity to protect themselves and their assets. Key to successful communication is to plan in advance how and what to communicate, know who will provide the messaging, and identify who this information is being communicated to and how materials need to be presented to reach that audience.

Partnerships and relationships are fundamental to resilient response and recovery. The people and organizations that had pre-established relationships that they could call on for preparedness, response, recovery and business continuity were able to react more quickly and, for those impacted, immediately begin recovery. This type of relationship building needs to be an intentional focus during non-disaster periods.

“…fostering peer learning through networks across and within countries can help to scale up smart city initiatives. Municipal governments in many cases may not have the human capacity or infrastructure required to develop and adopt comprehensive smart city initiatives on their own. Countries are at different levels of development in the

Emerging Asia Region, which provides an opportunity for cities that are less developed to learn from leaders of smart city initiatives within the region. The ASEAN Smart Cities Network as well as the United Cities and Local Governments Asia-Pacific are two subnational networks aiming to contribute to capacity building, to facilitate co-operation across cities and to raise funding from a range of public and private sources." (Source: OECD, p.20, https://www.oecd-ilibrary.org/docserver/4fcef080-en.pdf?expires=1656493447&id=id&accname=guest&checksum=6EB3CAF0DE7193EC97FC31EA7C5B74AF)

The HELP 'Guiding Principles to Build Resilient Post-Corona World Towards building a more resilient and adaptive post-corona society', box 2:

Box 2: Guiding principles to build resilient post-corona world

Principle 1: Integrate all crisis-related sectors including DRR and pandemics prevention

- Make the concept of Building Back Better, from the Sendai Framework, become the world's vision for recovering from the COVID-19 pandemic. All stakeholders should implement the policy and plan to envision a post-corona world.
- Be aware how tightly interwoven our social and economic ties are, which should be taken into account when addressing the pandemic and climate disasters; floods, cyclones and droughts.
- The organizations that are mandated to address DRR and the pandemic should propose ways to integrate practices between both.
- Introduce pandemic response into project designs of DRR-related sectors. For example, the proposed Integrated Urban Flood Management in Chennai, India, would help prevent infections and control COVID-19 by enhancing water, sanitation and hygiene at schools and community health centers.
- OECD Network focused its efforts on adapting measures for managing water-related risk to the COVID-19 context.

Principles 2: Keep effectively coping with disasters and COVID-19 until the pandemic is fully abated

- Fully apply HELP Principles in countries to Address Water-related DRR under the COVID-19 Pandemic to policies and practices.
- DRR sectors should proactively assist vaccination delivery and other activities for COVID-19 to subside.
- Adapt to the new operating environment and make risk-informed decisions based on objective assessments of COVID-19 related risks to the workforce and its impacts on program delivery.
- Develop standard operating procedures for deploying support to emergency response operations, which includes several checklists for both managers and personnel, all designed to mitigate the risk of contracting or spreading COVID-19 while responding to emergencies.
- Promote understanding of the public on various risks and policy impacts of risk reduction to deal with this pandemic and for necessary resource mitigation through website collaboration with various nongovernmental organizations and civil society organizations.

- Support provision of vaccines, PPEs, and sanitation and hygiene materials to developing countries to swiftly abate and contain the pandemic.

Principle 3: Improve governance systems, decision making and funding to cope with a crisis by reflecting on experiences of COVID-19

[governance system]

- Develop new forms of governance that can quickly detect and respond to an emerging crisis, swiftly and flexibly make science-based decisions, communicate with the public in transparent, accountable and convincing manners, and implement policies with proper adjustment to changing situations.
- Establish disaster risk reduction policies and plans based on data and science, and develop adequate budget allocation systems to reduce future risks.
- Develop transparent and accountable procedures for crisis management actions. Mitigate public concerns for uncertainty by proactively ensuring transparency and accountability.
- Differentiate legislative systems between normalcy and a mega-crisis, so that catastrophes can be addressed in a flexible and prompt manner.

[decision making]

- Enhance the capability to detect and sense-make crisis including early warning.
- Promote and support science-based decision making before, during and after catastrophes. Role of science in risk evaluation, risk management, and risk communication should be clearly defined in transparent and accountable manners before, during and after a catastrophe, and particularly at the time of critical decision making.

[funding]

- Invest in critical infrastructure including hospitals and health facilities and take measures to ensure their functions at all times.
- Based on the Sendai Framework, strengthen the following three pillars of actions: (i) realization of pre-disaster investment and critical infrastructure for capital concentration centers, especially in mega cities, (ii) establishment of DRR institutions for understanding disaster risk and strengthening disaster risk governance, and (iii) establishment of the principle of Build Back Better in disaster-affected areas. Strengthening the three pillars will be essential for disaster risk reduction in a post COVID-19 world.
- Increase the share of climate funds to make pandemic, as well as disaster prone regions, more resilient by tracking climate-related expenditure and humanitarian operations.

Principle 4: Reflecting the experiences of COVID-19 on practices

- Reflect lessons learnt when responding to COVID-19, improve the way we approach development, to ensure that it is genuinely risk informed, to protect lives and livelihoods, and secure our progress towards the center framework for disaster risk reduction and SDGs.
- Provide inputs to the governments on how we respond to the pandemic in terms of operational technicalities as well as financing and budgeting.

- Introduce experiences of the pandemic response into project designs. For example, the proposed Integrated Urban Flood Management in Chennai, India, would help prevent infections and control COVID-19 by enhancing water, sanitation and hygiene at schools and community health centers.

Principle 5: Develop and fully utilize science and technology for crisis management

- Increase financing for and accelerate development of R&D to prepare for future disturbances such as pandemic, climate change and disasters.
- Promote holistic, integrated and interdisciplinary science approaches in order to connect water, human and nature, and coordinate the capacity development component of the SDG6 global accelerator framework.
- Scientific knowledge is needed for inclusive evidence-based and agenda transformative water policies, and sustainable water development and management.
- Develop political science to help make critical decisions balancing economic and social impacts of a policy on various sectors.

Principle 6: Position water and sanitation as a foundation of sustainable development in the post-corona society

- Remind leaders of the urgency to address the challenges related to clean water and sanitation for all as a foundation for building resilience.
- Establish the link between water security and resilience to COVID-19 and to all forms of existing or future pandemics.
- Launch a hand-washing campaign to prevent infectious diseases, including COVID-19, and improve public health.

Principle 7: Strengthen global solidarity and international cooperation to cope with disaster/pandemic challenges

- Strengthen global and regional networks on various risks, including pandemics and disasters, to share information and take preventive actions to enhance readiness for another pandemic and disturbances.
- Create networks as exemplified by the Asia-Pacific Disaster Resilience Network to support and mobilize cooperation efforts for integrated multi hazard warning systems, including those for biological hazards.
- Keep funding mechanisms for COVID-19 that support their developing members to ensure a more resilient post-pandemic recovery.

Principle 8: Share and pass on the memory of the COVID-19 response to enhance risk preparedness for all sectors

- Create global archives for policies, lessons, good practices and guidance notes and manuals for key sectors which were created during and after to help government response, recovery, and rejuvenation for the next pandemic.
- Create dialogue forums with institutions related to health, environment, resiliency, and global supply chain institutions.

- Use opportunities on the Global Platform for Disaster Risk Reduction, to be hosted by the Government of Indonesia as of May 2022, and the midterm review for the Sendai Framework in 2023, to share lessons and good practices during COVID-19.
- Organize regional conferences to learn from lessons and experiences concerning policies and decision making and present best practices to address COVID-19 and co-occurring disasters from risk management perspectives. OECD intends to convene a conference on drawing interim lessons learned from the COVID-19 crisis to inform needed improvements to governance of critical risks.
- Organize workshops by individual sectors to learn from experiences to address COVID-19 and feed in the lessons, to enhance preparedness of the sectors.

The 2017 report entitled "Build Back Better" the United Nations Office for Disaster Risk Reduction also offers tangible steps: https://www.unisdr.org/files/53213_bbb.pdf

Module 5- Smart water supply and sanitation systems

Educational aim: This module focuses on the preparedness to the water-related disasters and the impact of climate change in managing water supply and sanitation infrastructure by strengthening capacity of water and sanitation utilities.

Key learning points:

- Smart water technologies provide an efficient means for water utilities to monitor and assess damage during disaster episodes.
- Nature-based solutions provide urban water utilities with other tools for water-related DRR.

"Despite remarkable achievements, 326 million people still live under the poverty threshold
of $1.90/day. The region is home to a total of 563 million urban slum dwellers, challenging the municipalities' ability to provide basic services. About 300 million people in the region still have no access to safely managed or basic services of drinking water, and 1.2 billion lack adequate sanitation. Poor access to water and sanitation disproportionally impacts vulnerable groups, who are particularly susceptible to external economic shocks, e.g., rise in food prices or infectious diseases such as the coronavirus disease 2019 (COVID-19)."[26]

Climate change and its ensuing disaster risk hazards are exacerbating this already existing reality for water supply and sanitation services. With climate change, operators of water supply and sanitation services must prepare for a future of more severe droughts and floods, more unpredictable rainfall patterns and dramatically rising sea

[26] AWDO 2020, p. 3, https://www.adb.org/sites/default/files/publication/663931/awdo-2020.pdf

levels. Smart, water-related solutions can assist in building resilient water supply and sanitation systems. For instance, smart water technology in the case of disasters can help identify leakages and gauge water distribution issues. Or the technology can more efficiently assess the contamination-level of the water source if it has been compromised during the disaster event. Sensors that detect flow, temperature, salinity, conductivity, contaminant loads, among others, can be placed on pipes or pumps. The data and messages generated by these sensors is then transmitted in real time over the internet, and the information can then be used by the operators to prioritise repairs. In the aftermath of a disaster, this data and the rapidity with which it is available would be of critical value of course. However, the cost of these technologies and their operation can be a barrier for urban water utilities in developing income countries.

Another avenue for water utilities to pursue in preparing for water-related disasters and the impact of climate change is that of nature-based solutions (rf. box 3). Nature-based solutions are seen as being more accessible to address local water challenges, both in urban and rural settings. Nature-based solutions include measures such as, restoration of watersheds through reforestation, reducing erosion from arable land or protecting riverine riparian zones, recreating wetlands for controlling urban (and agricultural) diffuse pollution. For instance, constructed wetlands and sponge cities can yield benefits for water supply, wastewater treatment and water flow regulation.

Box 3: Definition of nature-based solutions, UN Environment Programme

Nature-based solutions are actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, simultaneously providing human well-being, ecosystem resilience and biodiversity benefits. They are designed to address major societal challenges, such as biodiversity loss, climate change, land degradation, food security, disaster risks, urban development, water security, as well as social and economic development, human health and a large range of ecosystem services, while applying social and environmental safeguards, building on existing relevant safeguards, including those under the Rio Conventions.

Definition adopted at the 5th UN Environment Assembly, 16 December 2021[27]

In times of disasters, smart city communication systems can also be of service to communicate safe water distribution points to the population when the water supply system breaks down.

27 https://wedocs.unep.org/bitstream/handle/20.500.11822/37720/EU%20resolution%20proposal%20on%20NBS_16Dec.pdf?sequence=1&isAllowed=y

Educational aim: This module aims to present how the basin approach can help better mitigate, prepare and respond to disasters, particularly in the case of municipalities.

Key learning points:

- Municipalities are located within the larger context of its hydrological basin.
- A city's water-related disaster vulnerabilities have to be assessed within the larger context of its hydrological basin.
- A city's disaster risk reduction strategy must take into account the hydrological basin where it is located, to better mitigate, prepare, respond and recover from disasters.
- Climate change forecasts have to be 'localized' into scenarios for to assess risks and plan for disasters in the context of each hydrological basin.

Municipalities are located within hydrological basins. Hence, water-related disasters are not necessarily only limited to the conditions within their own boundaries and jurisdictions, and conditions that are present upstream, or disasters that occur elsewhere in the basin, can in turn impact them downstream. Consequently, it is necessary to consider the river basin as one comprehensive system and involve all stakeholders, even those who did not join before in disaster risk reduction planning.

Cities ought to appraise water-related hazard risk within the context of the entire basin's hydrological circumstances, with municipalities' policies and plans to be developed accordingly.

A river basin management approach increases flexibility in natural ecological functions integrated with human activities, thus improving the resilience and robustness of the hydrological basin under a variety of stresses, including climate change.

Maintaining the safety in the face of water-related disasters only through traditional structural measures by river administrators will be increasingly difficult considering the increasing external force of climate change, as structural measures take time to implement. Therefore, it is necessary not only to accelerate traditional disaster risk reduction projects by public administrators, but also to consider the river basin as one comprehensive system from its catchment to river area including the floodplain, and to involve all stakeholders even those who did not join disaster risk reduction efforts before.

Figure 11: Basin Approach Example from Japan

Overview of the new policy, River Basin Disaster Resilience, and Sustainability by All
The national Ministry of Land, Infrastructure and Transport in Japan is promoting the following measures to implement the new flood management policy, River Basin Disaster Resilience and Sustainability by All:

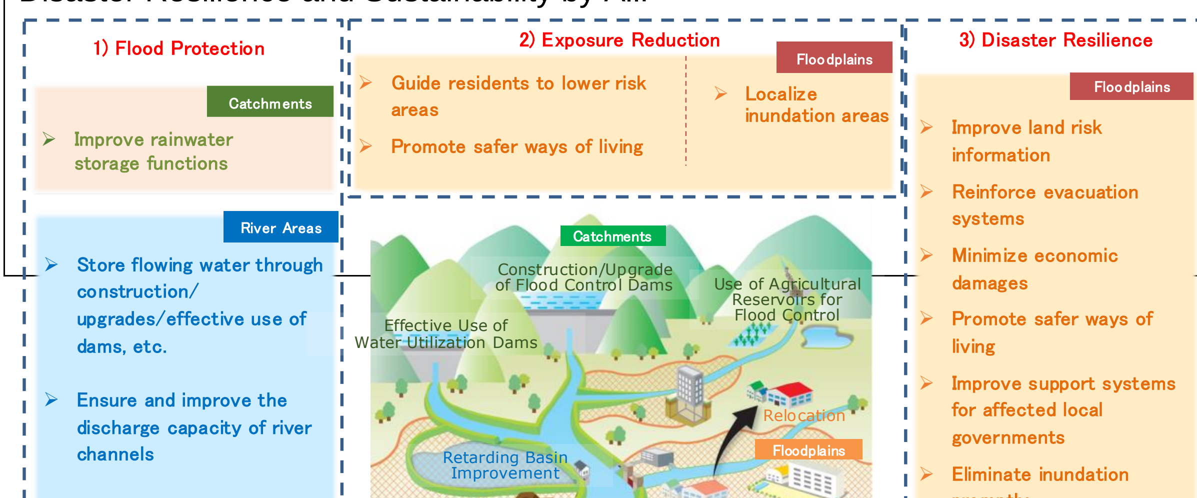


Fig. 9 Image of the new policy, "River Basin Disaster Resilience and Sustainability by all"

1) Flood Protection - Enhancement of flood prevention measures

It is necessary to enhance and effectively combine flood prevention measures such as storing rainwater and running water, increasing the discharge capacity of rivers, and controlling flooding water for improving safety against water-related disasters in the whole basin.

It is first necessary to further accelerate ongoing structural measures such as embankment improvement, channel dredge, dam and retarding basin construction by river administrators, and the improvement of rainwater line and underground storage by sewage administrators.

It is important to ask for cooperation from the stakeholders who have not been consulted previously. The platform where such stakeholders can cooperate for the basin management should be set and flood prevention measures such as the implementation of preliminary discharge by water users' dams, installation of rainwater storage/penetration facilities around urbanized/populated areas by local governments or private sectors, and conservation of forests and agriculture lands to maintain water-holding and retarding function, considering the characteristics of the river basin.

Further, the technological research and development about embankment reinforcement should be advanced for "persevering embankment" difficult to burst even if flooding occurs. This can reduce the flood amount during flooding, at higher risks in particular.

2) Exposure Reduction - Measures to reduce a damaged target

The flood prevention measures are primarily taken to reduce water-related disaster risks, but it is also desirable to take the measure for damage minimization as well in case that flood may occur. Specifically, following measures are effective for reducing flood damages: regulation for land use and way of living in water-related high-risk areas, leading resident and urban function to the lower risk areas, limiting the flooded area, the augmentation in land for housing in an area with flooding risk, and the device of building structure.

Land use and the building structure have been regulated by designating the high-risk area as a hazard area, but these were performed with river works. There is still new development even in the area with high water-related hazard risk, and flood damage occurs there. Therefore, it is important to collaborate with urban planning sectors, connecting water-related disaster risk reduction with "compact plus network", lead to the low-risk zones and give devices of how to live. For local revitalization, the community should take the leading measures for urban planning resilient to water-related disasters according to each characteristic.

It is necessary that all kinds' information about water-related hazard risk is being estimated appropriately and is being reflected in actual measures. Risk information about water-related disasters has been published mainly for smooth evacuation by residents to protect their lives, but these should be improved for urban planning. Water-related hazard risk evaluation should apply to the risk reduction around a whole basin

3) Disaster Resilience -

The damage to people's live and social economic assets should be minimized even when floods and sediment disasters become inevitable. Public sectors should provide the information on water-related hazard risks appropriately. It is important that every stakeholder in the basin have information and attitude on water-related disasters, prepare beforehand, and take appropriate actions during the disasters.

Various measures for more effective evacuation have been taken place, such as designating flood forecast and flood alert rivers for flood suffered rivers, preparation of flood hazard area maps, flow observation, and providing information to the resident. Besides, the flood fighting act was amended to oblige facility managers to prepare a flood prevention plan and to conduct evacuation drill for underground facilities with high flood risk, and to prepare a plan to secure evacuation for welfare facilities for people who need special assistance. The national and local governments have been cooperating to support the facility managers to implement the obligations.

The evacuation drill and disaster risk reduction education have been implemented all over the country for awareness raising and effective evacuation. "My timeline" has been developed as an individual action plan for emergency situations.

The 2019 Typhoon Hagibis shows the damage to people's lives in the water-related risk information blank areas as well as in the estimated flood inundation areas because of escape delay. Evacuation system should be further improved by reinforcing existing activities.

National support including TEC-FORCE has worked for assistance to affected areas as measures of early response and recovery. Such support mechanism by national government should be reinforced and strengthened by the cooperation among all stakeholders in a whole river basin.

Module 7- Best practices

Educational aim: This module aims to present smart city best practices, examples, and case studies from different part of the world emphasizing water-related DRR in cities and communities.

Key learning points:

- Several examples of Smart Cities initiatives and tools are proposed in this module. There are however as of yet few examples specifically on smart cities and water-related disaster risk reduction. Maybe your city can be featured next time?

1) Smart City Guidebook by Japan Cabinet Office and Ministries:
https://www8.cao.go.jp/cstp/society5_0/smartcity/01_scguide_eng_1.pdf
This Guidebook presents compiled information, including the significance of / need for smart city, effects of its introduction and ways to proceed it, into this Guidebook on the basis of the successful / unsuccessful experiences of regions that have already embarked on smart city projects.

2) Smart City ASEAN Guidebook: https://asean.org/wp-content/uploads/2022/06/ASEAN_SmartCityPlanningGuidebook_en_WEBSITE.pdf
A Guidebook prepared by by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan, In Consultation with the ASEAN Smart Cities Network (ASCN) and the ASEAN Secretariat (ASEC). The Guidebook presents case studies of 26 pilot cities in ASCN.

3) ASEAN Smart Cities Network (ASCN) is a collaborative platform which aims to:
   1. Develop city-specific action plans and a joint framework for Smart City development in ASEAN
   2. Catalyse bankable projects with the private sector
   3. Secure support from ASEAN's external partners

4) Takamatsu Smart City: Example of an Early Warning System harnessing the smart city technologies -- "Takamatsu Wide Area Disaster Management Dashboard". https://opendata-portal.smartcity-takamatsu.jp/map?cate=2. The information collected on water levels, tide levels, flooding status, evacuation center information, etc. is displayed as icons on the map. By clicking on the icons, more detailed information such as measured values and camera images can be displayed there.
   1. Takamatsu City has created an IoT-based visualization system for disaster management. The system integrates a wide range of information and visualizes real-time emergency conditions on an integrated dashboard. These solutions have made it possible to mitigate disaster damage through delivery of flood sandbags and notification of emergencies to local transportation operators. It also allows for quick and timely evacuation advisories and instructions for the benefit of residents.

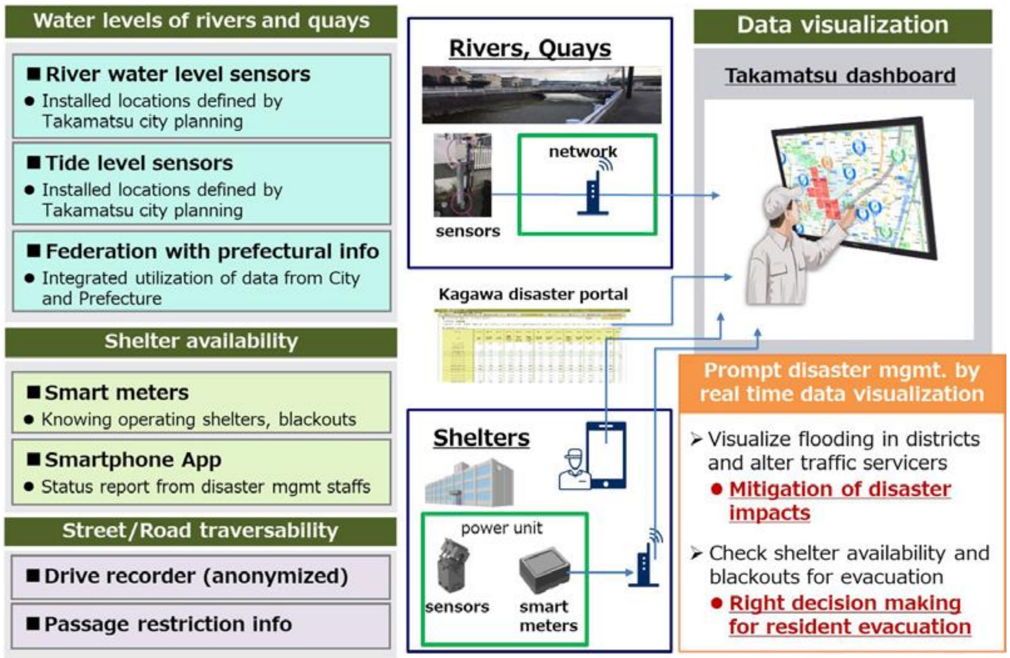
   2. Water level sensors have been installed to monitor water levels in rivers and canals, tides on quays, and underpasses. Video cameras have been also installed to monitor critical situations in real time. In addition, disaster information from the prefectural government is integrated.

   3. The "Rainfall Now-Cast" service provided by the government (Japan Meteorological Agency) provides 30-minute rainfall forecasts (updated every 5 minutes) for a geographical meshes of 1km2 mesh.

   4. A private service based on GPS-based vehicle passage counting is integrated to reveal the real-time traversability for vehicles to issue road closure announcement.

   5. The opening status of evacuation centers will be monitored by smart meter signals. It will also be used to assess the probability of power outages. In

addition, city officials will report information on the status of evacuation centers and evacuees using a smartphone application.



Takamatsu City's Disaster Management Solution
https://www.fiware.org/wp-content/uploads/FF_ImpactStories_NEC-Takamatsu.pdf

5) Busan Eco-Delta Smart City:
https://smartcity.go.kr/en/프로젝트/국가시범도시/부산-에코델타-스마트시티/
Busan plans to create a leading smart city model that creates innovative changes in the urban field.

6) The 4th Asia Pacifc Water Summit
During the 4th Asia-Pacific Water Summit, held in Kumamoto City Japan, 23-24th April 2022, and with 17 Heads of State and Government in attendance, the Kumamoto Declaration was adopted, available here:
https://www.waterforum.jp/pdf/other/KumamotoDeclaration.pdf

In addition, during the Summit Japan's Prime Minister Fumio Kishida launched the Kumamoto Initiative for Water. He declared that Japan would commit to leading the implementation of measures to develop quality infrastructure by making use of Japan's advanced technologies, thereby simultaneously contributing to addressing water and the social issues and sustainable economic development in the Asia-Pacific region, centering on two approaches: (1) implementation of measures for climate change adaptation and mitigation, and (2) measures to improve people's basic living environments. He also announced that Japan would provide financial assistance worth approximately 500 billion yen (nearly 4 billion dollars) over the next five years to the Asia and the Pacific region.

Further Resources for Cities

UN Disaster Risk Reduction publications: https://www.undrr.org/publications
High-level Experts and Leaders Panel on Water and Disasters: https://www.wateranddisaster.org

Making Cities Resilient Campaign, UN Office for Disaster Risk Reduction: https://www.undrr.org/publication/making-cities-resilient-my-city-getting-ready-campaign-kit

HELP Global Report on Water and Disasters 2021: https://drive.google.com/file/d/1GB0CNKzPe7sgebRmHS0FGywRoMVwe2NS/view

ASEAN Smart Cities Network (ASCN): https://asean.org/our-communities/asean-smart-cities-network/