E-resilience through e-government: global and regional perspectives

Photo credit: pixabay.com

In this chapter:

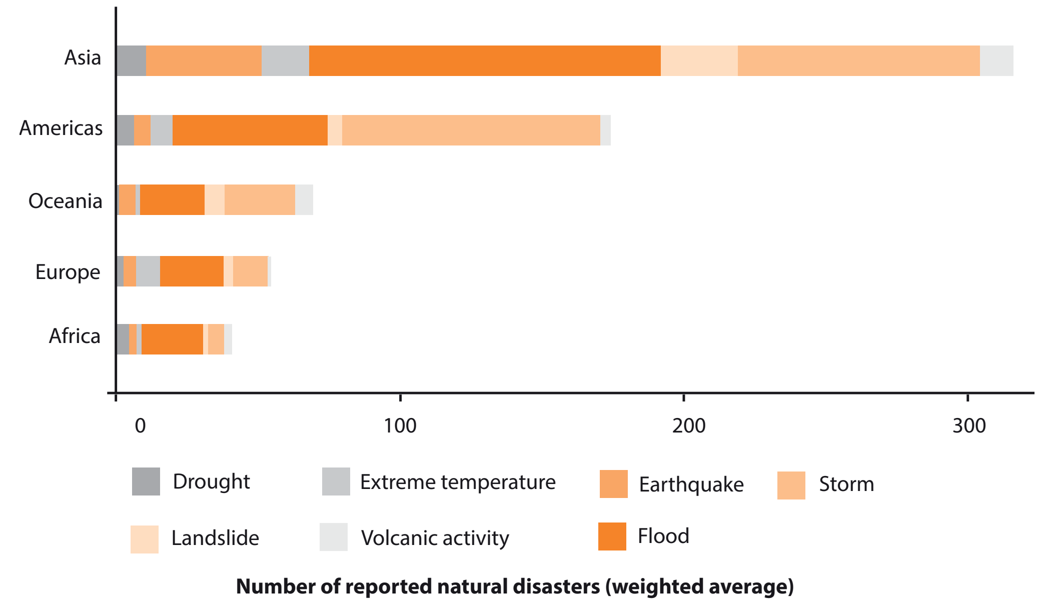
3.1 Introduction: Impact of Natural Disasters and Role of Policy and ICT in Disaster Risk Management

Natural disasters constrain government efforts in achieving the 2030 Agenda for Sustainable Development. The results of natural disasters are cataclysmic—from human loss and suffering to devastating economic repercussions, all of which erodes development gains. Not only are natural disasters hurting past and present development initiatives, but they are also forestalling new opportunities for growth and prosperity, causing harm to future generations.

Since 1970, the number of disasters[1] worldwide has more than quadrupled to approximately 400 a year. Although 2006 to 2016 saw a gradual decline in terms of numbers, their impact, in terms of casualties and monetary damage, has continued to soar. The total number of people affected by disasters in 2016 was 569.4 million, the highest since 2006 and far above the 2006-2015 annual average of 224.1 million. Losses from natural disasters have increased eight-fold in economic terms during the last four decades. Topping US $154 billion, it was up by 12 per cent in 2016 compared to the 2006-2015 annual averages. The cost of natural disasters doubled in 2017 to $306 billion compared to the previous year's tally. Disasters claimed more than 11,000 victims in 2017.[2,3]

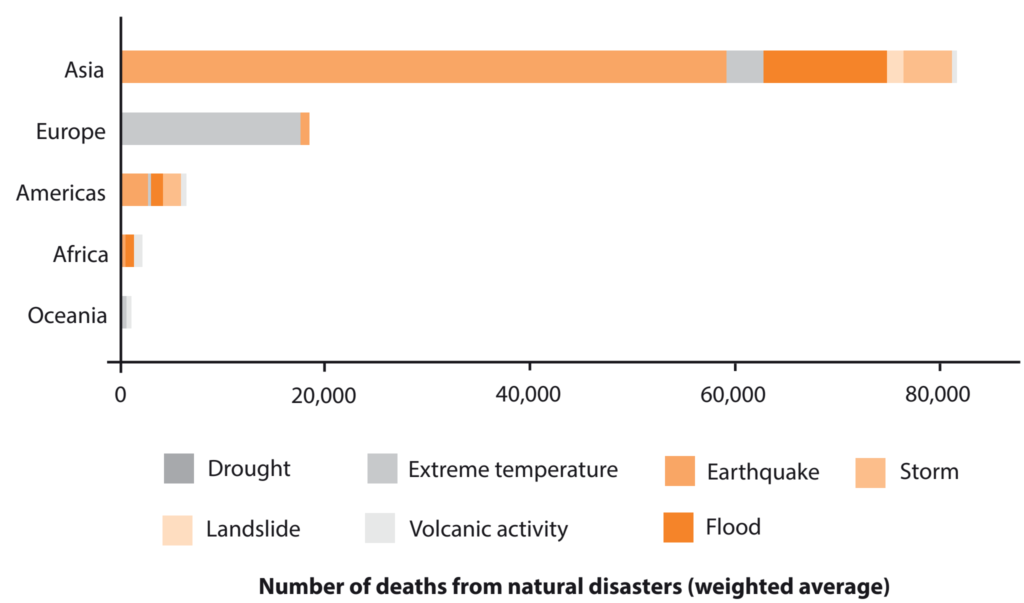
Asia and the Pacific experienced the highest number of natural disasters between 2000 and 2017 (Figure 3.1). The region suffered the most human casualties during the same period, owing to those events (Figure 3.2). More than half of the top 20 countries with the highest number of deaths from natural disasters worldwide from 2000-2017 comes from the region. China and the United States registered the highest number of casualties, generated in large part by storms and floods. Earthquakes were the deadliest natural disaster in Asia (Figure 3.3).

Figure 3.1. Number of reported natural disaster occurrences by region, between 2000 and 2017, per million of inhabitants.[4]



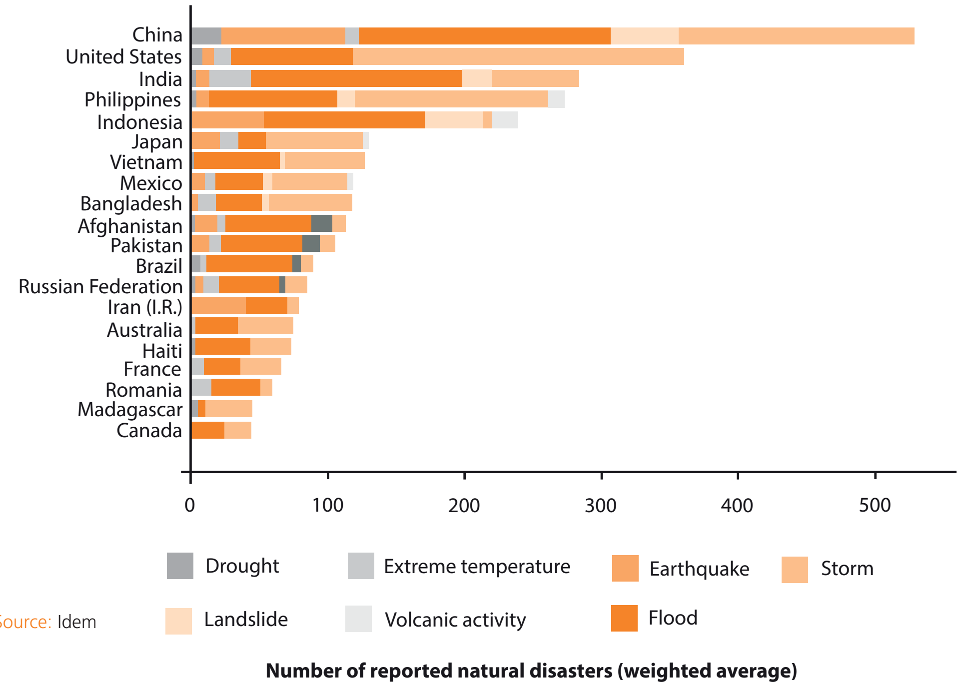
Source: Author's calculation based on data compiled from Centre for Research on the Epidemiology of Disasters (CRED) and Emergency Events Database (EM-DAT)

Figure 3.2. Total number of deaths from natural disasters (2000 - 2017), by major regions



Source: Idem

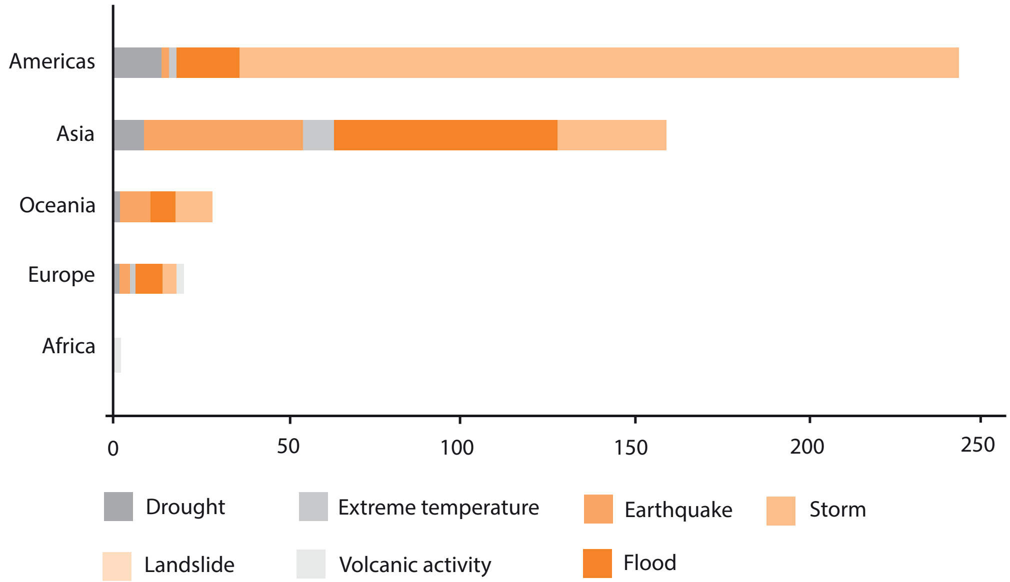
Figure 3.3. Number of reported natural disasters (2000-2017), Top 20 economies



Source: Idem

From an economic perspective, Asia and the Pacific[5] once more emerges as one of the most affected regions, second to the Americas where the year 2017 was the costliest for weather disasters in the United States (Figure 3.4). An ESCAP report notes that natural disasters[6] in 2016 alone caused 4,987 deaths, affecting 35 million people with an estimated damage of USD 77 billion in Asia and the Pacific[7].

Figure 3.4. Total damages from natural disasters (USD billion) (2000 - 2017) by major regions[8]



Source: Idem

Higher-income countries generally have better coping capacities against natural hazards, which often translate into fewer human casualties. Typically, the greatest exposure and impact is born by the poorest countries, which have scant capacity to prepare for and respond to the manifold disasters, to which they are prone. These countries include the least developed countries, the landlocked developing countries, and small island developing States. This is well illustrated in the case of the Asia and the Pacific region (Table 3.1.).

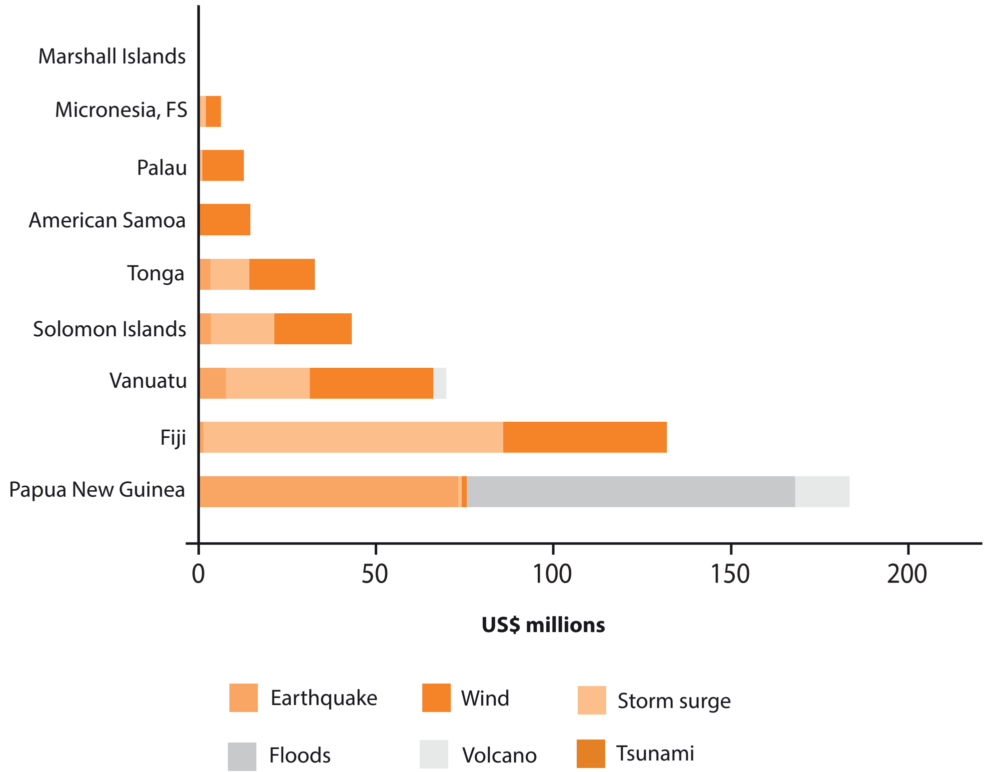
Table 3.1. Top 10 Member States with the highest commitment to cybersecurity

Country	Exposure		Coping Capacities (%)	GDP Per Capita (Current USD)
Vanuatu	63.66	Very High	Low	2,861
Tonga	55.27	Very High	Low	3,749
Philippines	52.46	Very High	Low	2,951
Japan	45.91	Very High	Very High	38,901
Brimeo Darussalam	41.1	Very High	High	26,939
Bangladesh	31.7	Very High	Very Low	1,359
Solomon Islands	29.98	Very High	Very Low	2,005
Fiji	27.71	Very High	Low	5,233
Cambodia	27.65	Very High	Very Low	1,270
Timor-Leste	25.73	Very High	Low	1,405

Source: ESCAP (2017) Asia-Pacific Disaster Report 2017. GDP Per Capita is obtained from the World Development Indicators. Accessed in March 2018.

Pacific countries, especially the small island developing States (SIDS), are particularly susceptible to natural disasters.[9] Between 2000 and 2016, the Pacific sub-region experienced 225 natural disasters, causing 1,752 fatalities, affecting 4.7 million people, and generating nearly USD 50 billion worth of damages. Since 2000, SIDS have lost over 1 per cent of their respective gross domestic product, or GDP, to disasters, compared with 0.4 per cent for all countries except the countries in special situations.[10] Estimates of the savings that those countries must set aside annually to cover the cost of long-term losses incurred from any unexpected hazard[11], known as the average annual loss (AAL), are telling (Figure 3.5.).

Figure 3.5. AAL figures for Pacific Island countries by hazard type[12]



Source: idem

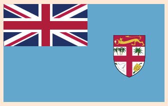
One recent case in Fiji illustrates the intensity and extent of damages (Box 3.1.).

Box 3.1. Disaster Response and Recovery: Impact of Cyclone Winston on Fiji in 2016

On 20 February 2016, tropical cyclone Winston (category 5) struck Fiji affecting 540,400 people, or 62 per cent of the population. The estimated cost of the damages was USD $0.6 billion-$0.9 billion, or approximately onefifth of the country's GDP.

The immediate damage in communication and electricity infrastructure triggered the loss of cellular, fixed-line, radio and television services. The cyclone disabled power and communication networks; 80 per cent of the population lost electricity. The total damage to the communication sector[13] was estimated to be near USD 24 million. The cyclone damaged cellular transmission towers and equipment. While mobile network services were partially restored in the aftermath of the disaster, up to 50 per cent of all sites operated on generators for a period due to the disruption of electricity networks. In places where fixed-line services were affected, the service provider, Fiji Telecom Limited, offered free wireless devices.

The lessons learned were many. The Government expressed its willingness to assist the private sector in building more disaster-resilient infrastructure through public-private partnerships and infrastructure-sharing arrangements. In addition, other mechanisms such as early warning systems were found to be critical for preparedness. As a result of post-disaster needs assessment, Fiji cooperated with the World Meteorological Organization (WMO) to boost its resilience to weather events, through the creation of early warning systems; feasibility studies on future investments related to disaster risk management, particularly in rural and remote areas were prepared.[14]

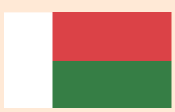


Source: Government of Fiji, 2016

In addition to post-disaster studies and technical solutions, policy plays a pivotal role in disaster risk management. The United Nations, in 2005, organized the first global meeting on natural disasters, in Kobe, Japan, which culminated in the adoption of the Hyogo Framework of Action 2005-2015. The Framework aimed at guiding disaster preparation and management. Building on the accord, the United Nations World Summit on Disaster Risk Reduction was organized in 2015 in Sendai, Japan, following the devastating tsunami in Japan. The outcome document, The Sendai Framework for Disaster Risk Reduction 2015-2030[15], shifted Hyogo's focus from responding to disasters to anticipating them so as to reduce and manage their disaster risk. The Sendai Framework proposed seven global targets and priority actions including: understanding disaster risk; strengthening disaster risk governance; investing in disaster risk reduction; enhancing disaster risk management; improving preparedness to respond to disasters and to duly implementing the Framework's "Build Back Better" priority.[16]

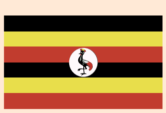
Like public policy, information and communications technologies are an essential element in disaster risk management. During disasters, ICTs, including geospatial technology and space applications, can be instrumental in providing swift response and ensuring emergency communication services. ICTs can support the operation of critical infrastructure in the energy and health sectors, as well as in natural resource management and transport, and can assist in weather forecasting, all of which have a role in the timely and effective dispatch of humanitarian aid in the aftermath of a disaster. They are vital to identifying, managing and mitigating risk before a disaster strikes, and can ensure continuous and critical communication and service delivery across all phases of disaster management.[17] Two examples come from Madagascar and Uganda (Box 3.2.).

Box 3.2. Disaster Communications Management, Prevention and Response in Madagascar and Uganda



Source: http://www.mid.gov.mg/

In **Madagascar,** the National Bureau for Risk and Disaster Management was set up within the Ministry of the Interior and Decentralisation. It is responsible for coordinating programmes and activities related to emergency response and relief, preparation and prevention, and disaster mitigation, and data collection. The data is used to evaluate the availability of food, sanitation facilities, equipment, shelter and medical needs and assistance. Various groups and stakeholders, such health and medical professionals, have access to available ICT channels to relay data to the disaster risk management system including through 1) telephone (free emergency number available to all operators); 2) Short Message Service (periodic messages regarding the current situation), and 3) data transmission (images from satellites or agents on the ground).



Source: Government of Uganda, 2014

The **Uganda** Communications Commission in collaboration with the Office of the Prime Minister, the Ministry of Water and Environment, and the District Local Government of Butaleja, jointly implemented a pilot project on setting up two flood early warning systems along the R. Manafwa basin in Butaleja district in Eastern Uganda. One of the systems installed in the Namulo Primary School in the Manafwa District was activated in September 2014 to warn the community about possible flooding, allowing many to run to higher ground for safety. The installation of the early warning systems has brought hope of saving lives and property to the people of Butaleja.

ICTs themselves are critical infrastructure to be protected from disasters, as discussed more extensively in Chapter 4. The following section concentrates on the role of ICTs and e-government in different disaster risk management stages and introduces the concept and practice of e-resilience.

3.2 E-resilience and its linkages to ICT and E-government[18]

Resilience is "ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions".[19] E-resilience is ICT contributions to resilience, particularly at the community level.[20] In other words, e-resilience is the use of ICTs during all phases of disaster risk management —prevention, reduction, preparedness, response and recovery — towards reducing risk and impact and maintaining the gains made towards sustainable development, including through e-government.

E-resilience entails two main dimensions (Table 3.2.): ICTs for disaster risk prevention, risk reduction and preparedness, as well as for disaster response and recovery, including the rapid restoration of ICT infrastructure and services.[21]

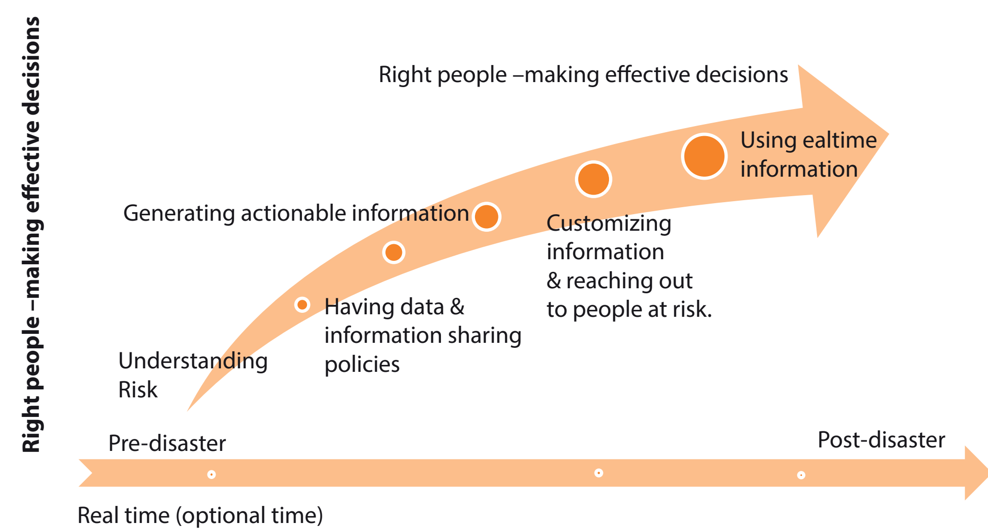
Table 3.2. E-resilience and Role of ICT in Disaster Risk Management

DRM Phases / ICT Roles	Prevention	Reduction	Preparedness	Response	Recovery
Key Tasks	Improving risk information as basis for investments and business strategies / operations	Reducing the chance of disasters and mitigating the level of disruptions, damage & losses	Planning and getting adequately and appropriately ready to respond to any disaster eventuality, in a timely manner	Saving lives, preventing further damage and losses and meeting immediate needs during disasters	Being able to restore functions, recover assets and operations, and build back better
ICT for its own resilience (ICT Sector)	• Not to create/ increase risks • Not to exacerbate existing risks • Avoid and transfer risks	• Address the underlying factors of risks • Reduce vulnerability • Increase capacity/ protection • Undertake retrofitting • Reduce exposure • Invest in early warning	• Plan System/network continuity • Implement system redundancy/backup • Ensure response readiness • Conduct training and drills • Set up emergency response and communication mechanisms	• Gather data and information on any damage and disruptions to the ICT infrastructure, facilities and services • Restore and repair services, data, facilities and equipment • Activate emergency communication systems, such as satellite systems and mobile communication units	• Conduct rapid assessment of damage and losses • Assess needs for recovery • Factor in additional investment to reduce future risks
ICT for society's resilience (non-ICT Sectors)	• Make ICTs available to improve risk assessments • ICT as crucial instruments for analysis • ICT to enhance development/ business investment planning	• Set up risk databases • Introduce Geo-Referenced Information Systems (GIS) for decision making, planning and mitigation • Expand ICT as a tool for disaster knowledge, innovation, education • Enhance coordination via ICT • Enhance risk observation, assessment and early warning by ICT	• Plan and put in place emergency decision making tools (assessment, mapping, databases, planning) with ICT • Set up and enhance emergency/humanitarian communication, application and coordination • Position ICT as one of comon services to all sectors	• Gather data and information on casualties, losses and damage for coordinated responses • Request for satellite imagery of affected areas • Activate data backup in case socioeconomic data is lost. • Inform citizens of available emergency services and information via SMS, website, radio or PA	• Enhance rapid assessments and detailed Post Disaster Needs Assessment (PDNA) • Use ICT systems and applications to facilitate disaster response efforts • Inform more robust future investment within the recovery framework

Source: ESCAP--E/ESCAP/CICTSTI(1)/5

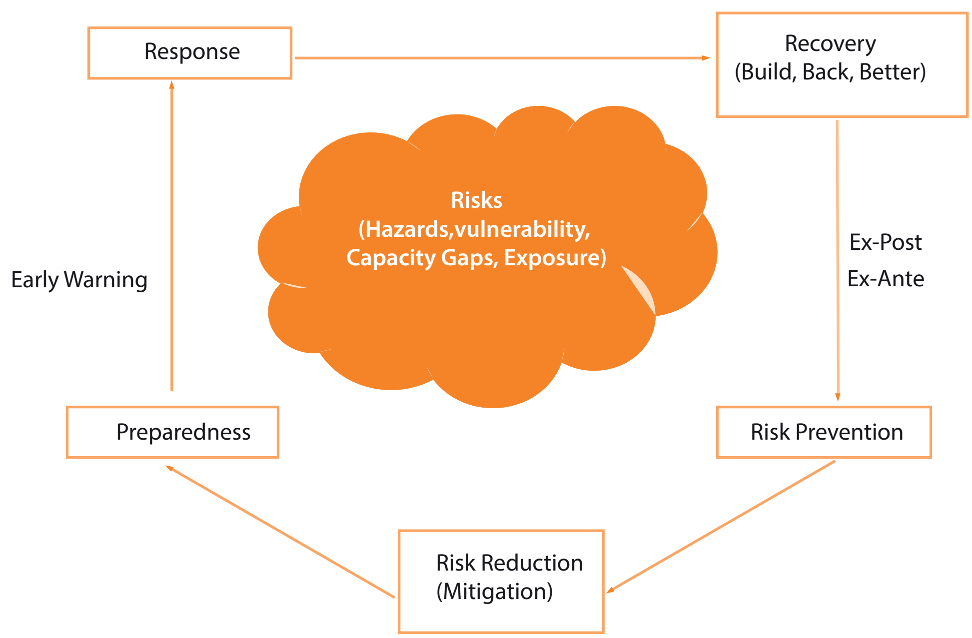
The Asia Pacific Disaster Report 2015 identified five essential steps and guiding principles to enhance e-resilience including through e-government initiatives, as follows: understanding risk; installing data- and information-sharing policies; generating actionable information; customizing that information and reaching out to people at risk; and using real-time information (Figure 3.6.). These steps are applicable to all stages of the disaster risk management cycle (Figure 3.7.).

Figure 3.6. E-resilience guiding principles



Source: ESCAP--E/ESCAP/CICTSTI(1)/5

Figure 3.7. Disaster Management Cycle

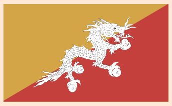


Source: ESCAP--E/ESCAP/CICTSTI(1)/5

Given the increasing recognition of the key role ICTs across the different phases of disaster risk reduction and management, Member States have been requesting more support in building and strengthening their eresilience, including in designing and implementing ICT applications and services and embedding them in egovernment initiatives as part of their overall disaster risk management systems and strategies. Addressed holistically, e-resilience has the potential to reduce disaster risks and improve disaster management, and it can be instrumental in reducing economic loss and preventing human casualties. Some e-resilience illustrations come from Bhutan and Japan (Box 3.3).

Box 3.3. Disaster Risk Prevention, Reduction and Response: DHMS Weather Monitoring and Early Warning in Bhutan and E-resilience in Japan

In **Bhutan,** the Department of Hydro Med Services (DHMS) website provides hazard related information on meteorology, hydrology, snow and glacier early warnings[22]. Each hazard monitoring system is linked to sensors, which send real time data generating actionable information, which then activates sirens to warn people in high-risk areas. This online weather information service of DHMS is an integral part of disaster risk reduction, preparedness and response contributing to the e-resilience of the country.



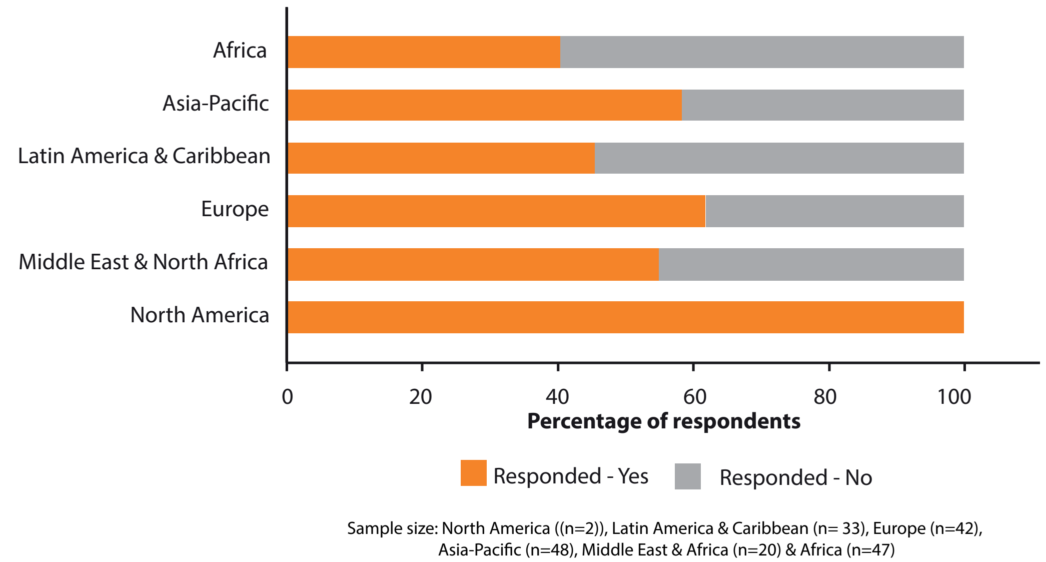
Source: http://www.hydromet.gov.bt

In **Japan,** the tsunami that followed the Great East Japan Earthquake, or Tohoku Earthquake in 2011 (magnitude 9.0) led to damages, among others, to ICT infrastructure such as underground (1700 Km) and overhead cables (6300 Km), causing communications breakdowns in the affected areas. This prompted Japan to start a national project to strengthen ICT infrastructure, develop applications and network control technologies, ranging from WiFi to satellite communications. Some of the measures taken were (a) relocation of communication offices/facilities to higher grounds, (b) deployment of dynamo-electric generators, (c) installation of new long-life battery system in active seismic zones, and (d) installation of underground fiber optic cable to strengthen ICT network resilience. A robust wireless mesh network using wireless and satellite technologies was also developed.[23]

Source: http://www.unescap.org

The data collected for the 2018 United Nations E-government Survey sheds light on the available functions and readiness of e-government in addressing challenges and creating opportunities associated with managing disaster risks and enhancing e-resilience. A preliminary regression analysis, which studied the relationship between broadband connectivity and disaster impact, shows that as broadband connectivity was increased disaster impact was reduced. Likewise, countries that provided relevant weather- and disaster-related information on their e-government websites had lower casualties as result of natural disasters.[24] Figures 3.8. and 3.9. below show the weather and agriculture updates, and energy-related e-government services.

Figure 3.8. Percentage of countries with e-government sites that share updates and information on electricity or power outage.



Source: UN DESA E-Govt 2018

Integrating e-resilience into e-government initiatives is thus paramount. The first step is to assess the specific disaster risks and their potential impact. Different disaster management tools and initiatives are needed for e-resilience of cyclone/typhoon-prone countries versus countries in a seismic zone. Similarly, preparedness efforts, in terms of data, application, back-up and communication methods, would take different forms. But integrating these tools and initiatives could save lives and minimise economic loss, as well as contain damage, with significant impact on sustainable development.

3.3 Emerging uses of artificial intelligence, social media, space technology applications and geospatial information for e-resilience

Many innovative disaster and crisis management tools are designed to consolidate structured and unstructured data for quick and effective decision-making. Some of these tools include Artificial Intelligence, social media, space technology applications and geospatial data.[25] These technologies along with enhanced data availability, analytics and functionalities hold much promise for advancing e-resilience initiatives towards the achievement of sustainable development.

Artificial Intelligence refers to "a set of computer science techniques that enable systems to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making and language translation"[26]. It includes, inter alia, the Internet of Things (IoT), fixed and mobile broadband, cloud computing, and big data.[27, 28] IoT collects and exchanges biometric data, behavioural information and unstructured information using network-connected sensors and devices. Big data are large data sets of voice, administrative records, electronic transactions, online activities and data transmissions collected mostly through mobile and broadband cloud computing technologies.[29] AI technology does not necessarily involve pre-defined behavioural algorithms since it can build on past iterations, characterized as machine learning or deep learning.[30]

Many examples illustrate the innovative applications of Artificial Intelligence on e-resilience. For instance, kinetic sensors are installed at the bottom of the Indian Ocean and are detecting waves and water flows, and transmitting data via sonic buoys and satellite links to emergency agencies. Drones are being used in effectively assessing damage after disasters, such as the series of earthquakes in Nepal in 2015. In the south of Thailand, a network of cameras is providing real-time monitoring of water flows and using closed-circuit television to aid with warnings of potential flooding. AI-based methods, including the IoT technologies, are being applied successfully on a range of hydrological problems in Australia.[31] Two examples come from Chile and Sri Lanka (Box 3.4.).

Box 3.4. Disaster Preparedness: Sensor Detection for Early Warning: The Cases of Chile and Sri Lanka

Chile is one of the most disaster-prone countries as it lies on the "ring of fire" plate. The 8.8 magnitude earthquake that occurred there in 2010 was the sixth strongest in the world since 1900.[32] In its aftermath, the government of Chile took progressive steps toward establishing a tsunami early warning alert system[33]. A network of pressure sensors was installed near the main fault lines in the Peru-Chile Trench. The sensors detect the number of seismic occurrences and the software estimates the magnitude and epicenter. The algorithm analyzes and interprets the data before transmitting it to the warning centers. The early warning messages are broadcasted through mobile phone network.

Source: http://www.shoa.cl/php/inicio.php

Sri Lanka's Disaster Management Initiative, Sahana, was created in the aftermath of the 26 December 2004 tsunami that hit several countries in Asia bordering the Indian Ocean. The Sri Lankan ICTs industry created Sahana to help track families and coordinate work among relief organizations. Sahana is a free open-source software, consisting of a series of integrated web-based disaster management applications. It automatically collates, aggregates, and calculates data, and provides situation and needs assessment in real-time.[34] Sahana fills a unique niche in the toolkit of emergency and disaster response agencies by facilitating information sharing and coordination of efforts across all types of organizations and individuals.

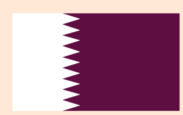
Source: UNDP-APDIP, 2006

While most practical applications of big data in disaster scenarios are still experimental, useful cases have emerged, such as in connection with the Haitian earthquake of 2010. A recent survey conducted by the Ministry of Internal Affairs and Communications of Japan has concluded that big data is expected to make significant contributions to disaster risk reduction in the country.[35] Mobile network big data has an immense potential in that regard. Mobility data collected in the aftermath of a disaster can help relief operations by locating affected populations and potential disease outbreaks.[36]

Social media and its various uses are also critical for e-resilience. Some examples come from Qatar, Austria and Germany (Box 3.5.).

Box 3.5. Disaster Preparedness and Response: Artificial Intelligence using Social Media

Qatar's Artificial Intelligence for Disaster Response (AIDR)[37] is a free and open source software that automatically collects and classifies social media feeds including tweets that are posted during humanitarian crises. AIDR maximises the use of machine intelligence and assists in making sense of significant amounts of data, video, images and texts on social media whenever disaster strikes. Once the collection starts and tweets begin to gather, different keywords and hashtags are created, such as #Medical Needs or #Shelter. The AIDR team works closely with United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), International Committee of the Red Cross (ICRC) and other organizations in carrying out the deployment of AIDR.



Source: http://aidr.qcri.org/

In **Austria** and **Germany,** researchers conducted studies on multi-stakeholder disaster response coordination and developed a public display application called City-Share. It aims to crowdsource relief activities to unaffiliated volunteers and emergent citizen groups within neighborhoods. As such, it supports self-help and civil society initiatives, and contributes to the alignment of activities between public authorities and other actors including aid organizations. It also assists public authorities in gathering information on loosely structured data, emergent citizen groups and their related activities.

Source: Zettl and others, 2017

Space technology applications and geographic information systems also play important roles in disaster risk management. By comparing satellite images before and after disasters, disaster management authorities can estimate the type and magnitude of the potential or actual damage. Such disaster data overlaid with other socioeconomic data such as on transport, infrastructure, medical facilities and population statistics, can be decisive in making timely and accurate decisions. Space technology applications and geographic information systems also contribute to assessing vulnerabilities, reducing risk and preventing and preparing for disasters.

One example is ESCAP's Regional Space Applications Programme for Sustainable Development in Asia-Pacific, which aims to enable countries with advanced space technologies to assist low-capacity and high-risk countries. The mechanism provides tools, services, capacity building and information to help drought-prone countries design drought management programmes that are tailored to their specific needs. One specific application of this mechanism comes from Mongolia (Box 3.6.).

Box 3.6. Disaster Risk Prevention, Reduction and Preparedness: Socio-economic Information to Supplement Drought Data

Eighty per cent of the land in Mongolia is capable of agricultural production, primarily extensive livestock production, while arable land occupies only 0.09 per cent of the total land area. Figure a. shows an example of a drought early warning product developed in June 2015 in a collaboration among Mongolian institutes, based on the ESCAP Regional Drought Mechanism. When compared with a land cover map of Mongolia (Figure b), it shows that drought was forecast primarily for pasture lands.

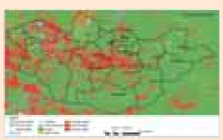


Figure a. Drought early warning for June 2015

Figure b. Land cover map of Mongolia

Figure c provides an overview of poverty by province and district and Figure d provides an overview of livestock, identifying those farmers at high risk of having their livestock affected by localized drought. This early warning product helps in the identification of localized pockets of intervention, relief and mitigation assessments and priorities, as well as the calculation of mitigation cost for livestock feed and other productive assets.

Figure c. Poverty headcount based on census data

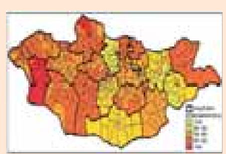


Figure d. Livestock density, heads per Km^2

Figure e shows the state of desertification and land degradation in Mongolia while Figure f shows the vegetation index, both of which provide an overview of the average stress on vegetation including soil stress and other environmental degradation. This informs relief and intervention activities including the assessment for parametric insurance products and initiatives.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

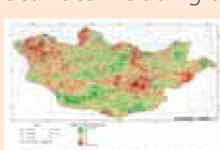


Figure e. Desertification and land degradation in 2014

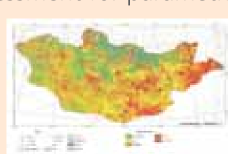


Figure f. MODIS NDVI, vegetation index

Similar initiatives are also being implemented in other drought-prone regions such as in Africa where livelihoods are closely intertwined with climate variability. Princeton University in collaboration with the International Hydrological Programme and the Information for Arid Zones of the United Nations Educational, Scientific and Cultural Organization (UNESCO)[38] has developed the African Flood and Drought monitor,[39] which monitors and forecasts meteorological, agricultural and hydrological drought at various temporal and spatial scales. It enables users to access the system's input and output data. It also contains a multi-decadal, historical reconstruction of the terrestrial water cycle. In the last two years, the data has been used in a wide range of e-resilience building initiatives including drought resilience, irrigation, health and epidemiology, and migratory movements.

Box 3.7. Using Spatial Technologies and Science-Based Modelling in Disaster Risk Management: Perspectives from Africa and the Caribbean

The African Risk Capacity (ARC) was established in 2012 as a specialized agency of the African Union to help Member States improve their capacities to prepare for, plan and respond to extreme weather events and natural disasters, thereby protecting the food security, safety, health and well-being of their vulnerable populations.

Source: http://www.africanriskcapacity.org/

Extreme Climate Facility (XCF) provides eligible ARC countries with additional funds should extreme weather events in their region increase in magnitude and/or frequency, as reflected by an objective data-driven index.

Outbreak and Epidemic Response (O&E) and contingency plans support ARC countries based on quantitative models of epidemic risk. Pay-outs are triggered as result of accurate detection of distinct epidemiologic events in a country. The first pilot country implementation is taking place in 2018.

Replica Coverage is a science-based risk modelling and government-led risk management system to assess drought probability. If rainfall levels fall below a pre-defined threshold, preventive disbursement of funds from the ARC Members, international community and donors is triggered.

As of 2018, ARC Member States include: Benin, Burkina Faso, Burundi, Central African Republic, Chad, Republic of the Congo, Côte d'Ivoire, Comoros, Djibouti, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Sudan, Togo, Zambia, and Zimbabwe, in addition to the Sahrawi Arab Democratic Republic.

The Caribbean Catastrophe Risk Insurance Facility SCP was developed in 2004 to help mitigate the short-term cash flow problems from which small developing economies suffer after major natural disasters. It is the first multi-country risk pool in the world, and a regional catastrophe fund for Caribbean governments (and Nicaragua), designed to limit the financial impact of devastating hurricanes and earthquakes by quickly providing financial liquidity.

Member States as of 2018 include: Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, and Nicaragua, as well as Bermuda, Cayman Islands and Turks and Caicos.

The Facility spearheads environmental management initiatives, aimed directly at reducing vulnerability and enhancing resilience at the community level. Examples include watershed management projects in degraded areas, and parametric insurance, which disburses funds based on the occurrence of a pre-defined level of hazard and impact without having to wait for an on-site loss assessment. The Facility's parametric model includes hazard, exposure, vulnerability, damage and loss modules, and applies to three types of disasters – earthquakes, hurricanes and excessive rainfall. It triggers payouts, from independently provided data, based on hazard inputs related to wind speed and storm surge in the case of tropical cyclones, ground shaking for earthquakes and rainfall amounts for excessive rainfall events. These hazard levels are then applied to pre-defined government exposure levels to produce a loss estimate.

Source: https://www.ccrif.org/

Additional innovative schemes for development financing are also using spatial technologies and geographic information systems, including, but not limited to, African Union's specialized agency, African Risk Capacity and its various tools and products of disaster risk management, and the Caribbean Catastrophe Risk Insurance Facility SPC[40], which offers earthquake, tropical cyclone and excess rainfall policies (Box 3.7).

Computational innovations and high-speed Internet have allowed geospatial data and various applications to be incorporated into early warning systems, resulting in increased operational efficiency. As disaster data are location-specific, using space-based technology and geospatial data becomes essential for the entire early warning phase and disaster management cycle. Such information provides answers to location-based questions as well as on disaster impact and supply routes for effective first response.

3.4 Mainstreaming e-resilience within e-government framework

From a development perspective, mainstreaming e-resilience in all phases of disaster management requires concerted efforts by various actors in myriad sectors, as well as coherent policy and a sound budget. E-government initiatives could be designed and implemented to facilitate the mainstreaming with an eye on the principles of the Sendai Framework and other comparable and supporting global initiatives of resilience through innovative applications of ICTs (Box 3.8).

Box 3.8. Global-level initiatives of disaster risk management and ICT

**Global Partnership for Preparedness–Upon the call of the United Nations Secretary-General to enhance the emergency response capacity of the 20 highest risk countries by 2020, the Vulnerable 20 (V20) Group of Ministers of Finance of the Climate Vulnerable Forum representing 48 high risk developing nations launched this partnership together with the United Nations agencies to support risk-prone countries to better prepare for responding to, and recovering from, disasters caused by natural hazards. (Source:https://www.agendaforhumanity.org/initiatives/3840)

**One Billion Coalition for Resilience (1BC)–Using data analytics and other related tools, the 1BC initiative maps the resilience of local communities and offers local action preparedness starter kits and grants. It aims to collectively enhance the impact of resilience building by integrating actions and strategies of individuals, households and communities on the ground. (Source: http://media.ifrc.org/1bc/)

**Insurance Development Forum (IDF)–First announced at the United Nations Conference of the Parties Paris Climate summit in 2015, IDF was launched by the United Nations, World Bank and the insurance industry in 2016. It addresses the risks associated with catastrophic weather and climate-related hazards through the design and dissemination of solutions for risk-sharing and transfer to increase global resilience.

**Platform on Disaster Displacement–Employing various data gathering mechanisms, this State-led Platform aims to address the protection needs of people displaced across boarders in the context of natural disasters and climate change. Its main goal is to implement the recommendations of the Nansen Initiative Protection Agenda of October 2015. (Source: https://www.agendaforhumanity.org/initiatives/3833)

**Inform (Index for Risk Management)–Inform is a global, open-source risk assessment for humanitarian crises and disasters. Its model is based on three specific dimensions of risk: hazards and exposure, vulnerability and lack of coping capacity dimensions. (Source: http://www.inform-index.org/InDepth)

Source: Authors' compilation and elaboration of select initiatives for illustrative purposes.

From a public administration perspective, internal mechanics of governments and State capacity[41] are important in mainstreaming e-resilience into e-government frameworks. Mediating factors between formal and information institutions, such as management practices, task structures and standard operating procedures as well as the organizational, institutional and technological change across various layers of government, play a critical role. Also significant is the degree of embeddedness of public and disaster policies in e-government initiatives and the extent to which they can benefit the public sector.[42] Finally, central government leadership in promoting and implementing e-resilience initiatives is paramount. [43]

To ensure that no one is left behind, Member States, the private sector, civil society organizations and various other partners should ensure that e-resilience initiatives reach the vulnerable groups, including those in remote and rural areas. While exponential growth in mobile and fixed broadband availability has been seen across the globe, there are still countries with low connectivity and groups of people that are unconnected altogether. Where the services are available, the alert messages and information communicated should be understandable and take into consideration the various linguistic and cultural diversities. While many e-government initiatives seek to tackle these challenges, the need for such considerations becomes acute when a disaster strikes and there is no time to translate the alert in different languages.

3.5 Conclusions and Policy Recommendations

E-resilience and sustainable development are highly interrelated. E-resilience and the use of ICTs in disaster risk management are part of key e-government initiatives and, used together, can support both the Sendai Framework and the 2030 Agenda for Sustainable Development. Artificial Intelligence,

Box 3.9. United Nations Economic and Social Commission for Asia and the Pacific (ESCAP): Linking disaster risk management with e-resilience

Asia and the Pacific remains the region most affected by natural disasters. ESCAP has been assisting Member States in building their capacities to withstand disasters, including through enhanced e-resilience. Some of ESCAP's initiatives include:

a) Intergovernmental cooperation platforms such as the Asia-Pacific Information Superhighway Steering Committee (AP-IS) initiative, which promotes affordable broadband connectivity and network resilience to reduce disaster risk.[45]
b) Regional early warning systems such as the Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (RESAP), which draws on space applications like satellite-derived imageries, geographic information system, big data; the Typhoon Committee and the Panel on Tropical Cyclones, established together with the World Meteorological Organization.
c) Advisory technical cooperation organisations such as the Pacific Centre for the Development for Disaster Information Management which addresses transboundary disasters including earthquakes, droughts, and sand and dust storms.
d) Advocacy and awareness-raising activities such as the ICT and DRR Gateway and the Asia-Pacific E-resilience Toolkit, online platforms which facilitate information sharing on the use of ICTs for disaster risk management and e-resilience.
e) Capacity building and training institutions and funds such as the Trust Fund on Tsunami, Disaster and Climate Preparedness, which strengthens institutional capacity for e-resilience in high-risk, low-capacity countries; and the Asian and Pacific Training Centre for ICT for Development, which trains government officials in disaster risk management and the use of ICTs.

Note: Figure shows some of the analytical research and publications produced by the ESCAP Secretariat to support the listed initiatives.

Source: http://www.unescap.org/

its associated digital technologies, space technology applications and geo-spatial technologies can buttress e-resilience initiatives contributing to all phases of disaster risk management.

Government leadership, both at national and local levels, also is vital. Disaster resilience in cities, particularly in the context of smart city ecosystems, is critical given that disasters pose higher risks for human and financial loss in urban than in rural areas.[44] The need for institutional and individual capacity development in designing and implementing e-resilience initiatives, particularly in countries in special situations, is significant. Some relevant initiatives come from ESCAP (Box 3.9).

Three key recommendations for policy-makers and practitioners working at the intersection of e-resilience and disaster risk management are the following:

Systematic and sustained efforts towards e-resilience

Knowing the specific disaster risks, and degrees and types of vulnerabilities is critical to designing and implementing appropriate e-resilience initiatives. If a country is on the path of seasonal cyclones or on a seismic zone, for instance, preparedness as well as measures for risk prevention and reduction will be different. Risk and vulnerability assessment is expected to identify infrastructure, data, applications, facilities and communities at risk, which will help design and improve e-resilience initiatives. Coherent and integrated ICT and disaster risk management policies should clearly map out organizational roles and responsibilities, including between central and local administrations. They should include budget allocations and division of tasks related to follow-up, monitoring and evaluation. They should harness and hone the instrumental role of emerging technologies for sustainable development. Systematic and sustained efforts will help mainstream disaster risk management for the implementation of both the Sendai Framework of Action and the 2030 Agenda for Sustainable Development.

Awareness raising, participation and capacity development

There are already capacity-building programmes, which assist government officials and partners in e-resilience, but awareness of disaster risks and e-resilience could be raised among ICT and disaster management authorities. Awareness-raising on emerging technologies, such as IoT, big data and cloud computing, deserves systematic support from international and regional partners, including the private sector, civil society and academia. There is also a need to go beyond tried-and-tested approaches and to include all citizens, in addition to technical experts, in a polycentric manner. Seeking and obtaining community buy-in early on, an approach which some have likened to "citizen science", is pivotal to the provision of extensive and real-time information for risk management (Paul and others, 2018). Such concerted efforts can prompt increased investment in e-resilience initiatives, including resilient infrastructure development and early warning systems. They can also ramp up ownership by linking knowledge management with resilience.

Sharing of good practices and lessons learned across the globe

Some disasters, such as floods, cyclones/typhoons and droughts are transboundary in nature. Glacial lake outbursts or monsoon rains upstream will have devastating impact in downstream areas and countries. Information and data sharing, coordination and cooperation in e-resilience among concerned countries are of utmost importance. Smaller economies might not have sufficient budgets or government manpower to take charge of all the phases of disaster risk management for all hazards. Resources such as remote sensing data collection and analysis could be supported through partnerships and global and regional cooperation.

This chapter presented a global and regional overview of natural disasters and their aftermath, and how those disasters affect regions and countries differently. Particularly worrisome are the inadequate coping mechanisms of countries in special conditions, such as landlocked and least developed countries, and small island developing States. This chapter also examined the global frameworks which encourage the mainstreaming of disaster risk concerns into all sectors, in cooperation with relevant stakeholders. It concluded that e-resilience through egovernment can be vital in managing disasters and their associated risks and in moving the world towards sustainable development.

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1 Note: For reasons of space and scope, this chapter covers natural disasters, and excludes health and financial crises as well as man-made emergencies. It examines both sudden onset natural disasters such as earthquakes, and crises that unfold over a period of time, such as drought.

2 Note: Data is compiled based on various sources including Reliefweb, UNISDR and SwissRe.

3 Guha-Sapir, D., Hoyois, P., Wallenmacq, P. & Below, R. (2017). Annual Disaster Statistical Review 2016: The numbers and trends. Centre for Research on the Epidemiology of Disasters. Brussels. October 2017. Available at www.emdat.be/sites/default/files/adsr_2016.pdf

4 Note: Countries may have different capacities and procedures for systematic reporting. This may result in under-reporting of incidents. EM-DAT is considered one of the most comprehensive disaster databases. For more, see http://www.emdat.be/. Accessed in January 2018.

5 Note: In this chapter, Asia and the Pacific is defined by the countries covered by ESCAP. Please see the list at http://www.unescap.org/about/member-states

6 Note: According to the 2015 Global Assessment Report on Disaster Risk Reduction, "disaster risk is considered as a function of the severity and frequency of the hazard, numbers of people and assets exposed to the hazard, and of their vulnerability or susceptibility to damage." (UNISDR 2015).

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13 Note: The sector includes private and public corporations, including Telecom Fiji Limited (TFL), state-owned and the sole provider of fixed-line telephone services; two mobile service operators (Vodafone and Digicel); two broadband service providers (Connect and Unwired); and other ICT support services (including televisions and radio broadcasters).

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18 Note: This section draws on research and publications of ESCAP, including, notably, the Report found at http://www.unescap.org/sites/default/files/Space_applications_as_a_critical_tool_for_enhanced_e-resilience_Eng.pdf

19 UNISDR (2009). 2009 UNISDR terminology on disaster risk reduction. p.24. Available at: https://www.unisdr.org/we/inform/publications/7817

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24 Note: Preliminary regression analysis is available upon request. It is an assessment based on one point in time, i.e., 2016 data of the UN E-government Survey. Two questions were examined based on the data from the UN E-government Survey dataset:(i) Do countries currently providing e-government services on weather or health related information minimize deaths incurred from natural disasters? (ii)Do countries with better broadband connectivity deliver more effective e-government services, thereby

minimizing deaths emanating from natural disasters? To examine these two questions, two binary (yes/no) variables from the UN E-government Survey 2018 dataset were used as independent variables: (i). Can people subscribe (via SMS, an email list, etc.) to keep updated about weather? and (ii). Can users subscribe to updates or alerts on Health services?). F-test was found to be statistically significant (p-value<0.01) for both dependent variables. In addition, the model specified was found to explain a high variation of the dependent variable—number of deaths of natural disasters (Adjusted-R2 = 0.73) for both the fixed broadband and mobile broadband variables.

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